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Forgiveness on Trial By Lily McKinney

Abstract

Capital punishment is a widely controversial subject that can be an extremely painful process for the victims' loved ones, who are also known as "co-victims" (Barielle). In this paper, I will argue that co-victims can forgive individuals who have been convicted while still supporting their execution by capital punishment. Forgiveness is complicated: I distinguish between emotional, decisional, and restrictive forms of forgiveness. I then argue that co-victims are able to restrictively forgive offenders out of a desire for justice, which is not the same as wanting revenge. Justice is good because it is necessary for a functioning society: revenge is not. I explain the contrast between justice and revenge in terms of their motivations and outcomes, as well as how co-victims can forgive someone and still support their punishment. I conclude the paper by distinguishing between retributive and restorative justice, and how they correlate to justice and revenge.

I. Introduction

Is it possible for forgiveness of an offender to coexist with the support for their death by capital punishment? In order to forgive someone who murdered a loved one, does one have to let go of all hostile feelings towards them? Can one support the offender dying without holding any hostility toward them?

These questions are extremely difficult to answer, but family and friends of victims face them when dealing with the aftermath of a violent crime. When a judge sentences the offender to the death penalty, they must reconcile their grief, anger, and personal feelings about the offender's death sentence alongside navigating the complex emotions felt toward the offender. In this paper, I will first explain how homicide negatively impacts the friends and families of loved ones, or "co-victims." I will then examine different types of forgiveness, and distinguish between emotional forgiveness, decisional forgiveness, and restrictive forgiveness. I then argue that co-victims are able to forgive offenders while still wanting them to receive justice for what they did. I distinguish between justice and revenge, and then argue that a desire for justice is good, by showing why justice is necessary in order to have a functioning society. Afterwards, I will distinguish between forgiveness and mercy, and explain the numerous psychological benefits to forgiveness.

II. Background: Co-Victims & Forgiveness

Here I give some background on the loved ones of victims as well as the idea of forgiveness. Forgiveness is a very complex subject, and it has many different dimensions. I also expand on how the loved ones of victims can feel and act towards the offender, and if they are able to achieve any sort of forgiveness towards them.

When a person dies by homicide, they are not the only victim impacted by the crime. Surviving family members and loved ones suffer the pain of loss and the burden of living with

the trauma and pain caused by the offender. These loved ones are also referred to as “co-victims”, for how they were also negatively affected by the acts of the offender (Barille, 2015). When the crime committed is so serious it puts the offender on death row, it is incredibly difficult for the co-victims to find a way to forgive them.

In these scenarios, forgiveness can often be confused with mercy for the offender, and clashes with many co-victims’ desire for justice. It is important to be able to distinguish between the two in order to balance them. Mercy is also unachievable in death row cases, as co-victims do not have the power to pardon offenders or spare them from their punishment: this belongs to the law. Forgiveness is not the mitigation of punishment but a process whereby co-victims can decide to release their negative feelings towards an offender and choose to not seek revenge (Hughes and Warmke, 2022).

The Oxford English Dictionary defines ‘forgive’ as “stop feeling angry or resentful toward (someone) for an offense, flaw, or mistake” and defines ‘forgiveness’ as “the action or process of forgiving or being forgiven” (Oxford Dictionary). Psychologists have defined three types of forgiveness: emotional, decisional, and restrictive forgiveness. It is important to understand these types of forgiveness.

Emotional forgiveness is one that does not happen by choice, and is much more common with minor offenses (Toussaint and Worthington, 2017). Emotional forgiveness happens when you don’t have any negative feelings toward the offender. These negative emotions often also turn into positive ones such as empathy, understanding, and compassion. Experiencing emotional forgiveness can give the ones wronged a sense of closure or peace surrounding the event. Suppose Stella forgot to pick Bridget up. Stella apologizes, promises to not forget again, and Bridget forgives her easily: she holds no resentment against Stella for what happened, and they just go on being friends! It’s not bad enough to merit punishment.

Decisional forgiveness, on the other hand, happens when you choose to forgive the offender for what they did and to not seek vengeance/punishment (Toussaint and Worthington, 2017). Imagine instead that Stella remembered that she was supposed to pick Bridget up, but was invited to Grace’s party, and chose to go to the party rather than picking up Bridget. Bridget can choose to continue to be friends with Stella, and act towards her as a friend, even though she may still feel negative emotions about the event. [sentence distinguishing clearly decisional and emotional - once is about actions, the other about feelings].

Criminologist Leo G. Barielle has defined one special kind of decisional forgiveness: restrictive forgiveness. Restrictive forgivers seek to let go of their resentment towards the offender, and choose not to act on the basis of their resentment, but still want the offender to face just punishment for what they did (Barielle, 2015). Mere emotional forgiveness doesn’t seem achievable or appropriate for co-victims of a homicide. The Oxford English Dictionary also defines ‘forgivable’ as a similar term to ‘forgive’, with it meaning “may be forgiven, pardonable, excusable”. Committing a homicide is not a pardonable act, and it seems impossible for a co-victim to emotionally forgive the offender.

In 2014, Barielle conducted 52 interviews in Texas and Virginia of co-victims of homicides and their varying responses to the crimes. Barielle conducted these interviews in order to see whether or not forgiveness was possible for co-victims in that situation. One woman they interviewed exhibited decisional forgiveness, and was able to forgive the man who murdered her son. She had sponsored mediation time with him, and told him that she forgave him for what he did and how that affected her and her family. When he killed her son, she at first wanted to get revenge for all the pain and suffering he caused her. This is a common emotional response that many co-victims endure, and proves how important it is for co-victims to take time to process the event and their feelings about it. Twelve years went by and as she went to counseling, she realized that she could not continue to hold on to these negative feelings; they would not allow her to live a pleasant life. She was holding on to what happened, and it was causing her to be miserable. This is also a common experience for co-victims, as often the loss of the victim affects them every day. Having this epiphany caused her to choose to forgive him, and this allowed her to let go of all of her bitterness and hatred. Despite this, she still supported the execution because she felt that justice was necessary for the crime committed. She emphasized how she did not want for him to suffer, just to be taken out of society. She recognized that he was a danger to those around him, and believed that this was the best way to prevent any future harm from him (Barielle, 2015). This proves how people are able to forgive the offenders because of how she held no resentment for him when he died, however still supported his killing.

It is important to distinguish between co-victims who forgive the offender, yet still want them to die, and co-victims who forgive and do not want them to die. Co-victims who still want the offender to die can be called “restrictive forgivers”. So how can these restrictive forgivers who claim to not be seeking revenge still support the punishment? Restrictive forgivers can choose to treat the offender civilly, and to adopt the mindset where they hold no hostile feelings towards them. Still, restrictive forgivers can practice decisional forgiveness and still lack any emotional forgiveness; they can choose to not actively resent the offender while still feeling upset about what they did. The intention to forgive also greatly affects restrictive forgivers. They might not feel that sense of relief at first, but they can “fake it till they make it”, and eventually let go of the bitterness they were harboring (Toussaint and Worthington, 2017). Even so, if a restrictive forgiver is claiming that they have no desire to harm or exact revenge on the offender, how can they want them to die by capital punishment? I answer this question in the next section by distinguishing between justice and revenge.

III. Justice and Revenge

If a co-victim is claiming to forgive an offender, how can the co-victim support the offender’s punishment? Wanting justice does not mean that a co-victim wants to get revenge. In this section, I distinguish between justice and revenge. Justice is crucial to having a civil society; revenge only leads to an unbalanced and uncivil society. Knowing the difference between the two is necessary because if a co-victim supporting the punishment for the offender was considered revenge, how could they want that and achieve forgiveness? In Section II when I

talked about justice, I was really talking about retributive justice. But we can think of other kinds of justice too, namely, restorative justice. Restorative justice doesn't conflict with retributive justice, and can help human beings heal.

While it may seem contradictory, co-victims are able to want justice for offenders, i.e. desire their death by capital punishment, while forgiving them. To reiterate, decisional forgiveness is the making the choice to forgive an offender and to not actively wish them harm. A co-victim can feel this way towards an offender while still wanting for them to face the consequences of their actions. They may feel that the death penalty is necessary for the offender to realize the true gravity of the crime and the effect that they had on the victim and co-victims. Some communities also emphasize the importance of justice as a way to honor the victim. They believe that because the offender is receiving the appropriate punishment, that the victim and the community can be at peace (Strelan, 2010). These arguments further support how co-victims could actively want the offender to be killed, however had achieved decisional forgiveness at the same time.

Justice and revenge are not the same. In an ideal system, someone experiencing the legal system and then the death penalty is a result of processes established to be fair and unbiased. Co-victims supporting the punishment for an offender are very different from those seeking revenge. One key difference between forgiveness and justice is the motivation for each. Revenge is one's emotional response to an event; one is driven by anger and desire for retribution that makes them want the offender to suffer as they have (Seltzer, 2014). Revenge is also often conducted impulsively, and often ends up being unreasonable or compared to the initial crime. Along with that, revenge can frequently lead to retaliation and continued patterns of vengeful retribution. Revenge is more chaotic; disproportionate reactions can lead to an unfair society. It is also hypocritical in how the avenger is only putting more bad deeds in the world.

On the other hand, justice is driven by the need for social and legal order. Without justice, society would be uncontrolled and could not function. Justice is regulated through legal systems, and follows processes that ensure that the punishment delivered is fair. Lastly, justice aims to help and rehabilitate both the victim and the offender. While death row cases don't offer offenders a chance to escape their fate, the punishment provides the co-victims the sense of closure and resolution they may need to recover from the event (Seltzer, 2014). That being said, the law can mess up. People have been wrongly executed or imprisoned for crimes they did not commit which can cause many to lose faith in the legal system. In spite of that, an imperfect system with solid ideals is better than no system at all.

As I mentioned above, justice has many positive aspects to it. Functioning societies need justice in order to create stability and fairness because they deter criminal activity. If murderers were able to get off unpunished, society would be dangerous and disorderly; there must be consequences for peoples' actions. Justice systems allow a country to maintain social order because the people in it are aware of the repercussions they might face should they commit a crime. If people believed that they could commit crimes such as homicide without having to face the consequences, that society would not be safe. Proper justice is also so important for the

co-victims because they know that the offender was properly dealt with for what they did. In capital punishment cases as well, the co-victims know that they face no threat from the offender anymore, and that they can cause no more harm to them or their loved ones (Roberts-Cady, 2003). In short, justice is needed in order to have a fair society with an established social order. Similar to forgiveness, justice has many dimensions to it as well (Barielle, 2015). One aspect is retributive justice. This focuses more on a fair punishment for the crime committed in order to balance out the circumstances of the offender and the victim. That being said, many who criticize harsh punishments are against retributive justice because it often doesn't give offenders a chance to change or improve from their actions. Another approach to justice is restorative justice. This has the punishment component in that offenders receive appropriate consequences for what they did, but they are given the chance to improve themselves and grow as people. In cases of homicide however, this is not a possible solution. Offenders are at most able to apologize to the co-victims, and even their forgiveness would not grant the offender pardon.

Co-victims' desire for retributive justice and closure for the offender does not mean that they cannot treat the offender with respect as a human being. As I mentioned, retributive justice aims at punishment while restorative justice emphasizes reconciliation between the victim and the offender while still conducting the right punishment. Restrictive forgiveness is a real kind of forgiveness but it stops at justice. Restorative justice aims at reconciliation: it goes beyond mere retribution. In the next section, I outline the personal and psychological benefits of forgiveness for both co-victims and offenders.

IV. Psychological Benefits of Forgiveness

In the last section, I argued how co-victims could want justice and still forgive the offender. In this section, I explain the benefits that the forgivers receive. These benefits further motivate co-victims to seek forgiveness, as they can escape many negative emotions that come from holding grudges. I also explain the harmful impacts of unforgiveness, and how that indicates unhappier people.

When co-victims are able to interact with their offenders, they are much more likely to empathize with them. While offenders are given chances to grow after committing minor offenses, when they are on death row, their only real chance at reconciliation is a genuine apology to the co-victims. A genuine apology significantly helps the co-victims achieve that state of decisional forgiveness where they hold no hostility towards the offender (Barille, 2015). But those co-victims who are able to forgive the offender reduce the impact of the surrounding negative emotional and psychological impacts. There are many factors that go into being able to forgive someone else. If the offense is minor, people can easily forgive or even forget that something happened at all. Regardless, co-victims are able to reconcile with the offenders while still wanting justice for the victim. The death penalty also assures the co-victims that the offender is gone and can no longer harm them or any other loved ones. This further supports how co-victims can truly hold no hostile feelings towards the offender simply because they want to feel safe, and do not want a similar event to happen again.

Holding a grudge against the offender may seem appealing to many victims as they need to express their anger for the situation in some way, however this has many negative effects. Choosing not to forgive someone can cause anger, resentment, bitterness, and worse mental and physical health. This resentment towards an offender can also lead co-victims to rumination: dwelling too much on a past event to the point where it fuels these negative feelings (Toussaint and Worthington, 2017). Rumination is especially common in co-victims when they do not receive an apology from an offender, they tend to ruminate angrily. This again leads to them with lingering bitterness, and makes it more difficult to forgive.

Forgiveness does offer many benefits to both the victim and the offender. If the co-victims are able to forgive the offenders before the punishment is executed, they are also granted a sense of closure and peace over the event. This motivates the co-victims to seek forgiveness even just as a way to move forward in their lives. The offender is also relieved of the burden of the grudge from the co-victims and is able to gain some closure from what happened as well. People who forgive more easily often report decreased anger, hostility, anxiety, and higher levels of self-esteem (Strelan, 2010). Forgiveness towards the offender also allows the co-victims to release so much built-up resentment and hostility that they otherwise would've held on to. As a whole, forgiveness brings personal harmony, and leads to better well-being and inner peace. Whether the offenders deserve to be forgiven or not, co-victims are almost always benefitted by forgiving them.

V. Conclusion

In this paper, I asked whether or not co-victims are able to truly forgive convicted offenders while still supporting their death by capital punishment. I distinguished three different kinds of forgiveness, showing how some co-victims can exhibit restrictive forgiveness, as opposed to decisional and emotional forgiveness. Restrictive forgivers seek justice for the offender, and justice is not revenge. Justice is necessary for orderly societies, so restrictive forgivers wanting it does not make them vengeful, but lawful. Similar to forgiveness, justice has many different layers. Capital punishment is not always the end of justice, restorative justice emphasizes personal growth and rehabilitation for the offender, even after their conviction. Forgiveness also brings co-victims many psychological benefits and helps them recover from the event.

Forgiveness is a concept with many dimensions, it is a much deeper concept than I previously thought. Forgiveness is complicated. I went into this paper believing that it was impossible for anyone to forgive an offender who caused them so much pain. People can choose to forgive, and that decision can truly benefit them and their relationships. Justice and revenge can be confused for each other, however they are starkly different. Co-victims can forgive and still support the punishment, this does not mean they want revenge. Justice is necessary, and is a crucial aspect to a functioning society. Forgiveness is important. A co-victims choosing to forgive can give them a sense of peace, and help them move forward from the event.

Writing this paper, I also encountered questions that I was not able to answer. I wondered if co-victims have ever successfully influenced a conviction to be killed, or not. While some co-victims may want the offender to die for safety or closure, others may oppose capital punishment. They may want for the offender to suffer in prison, or could just oppose the death penalty altogether. While they may not be able to directly change a court ruling, I wonder if a co-victims' testimony has ever impacted a jury to the point where they changed their verdict. That further makes me wonder what role forgiveness plays in the criminal justice system. How can it affect testifying co-victims and juries? While I did not answer these questions in this paper, forgiveness is an extremely relevant and dimensional topic.

That being said, co-victims can forgive offenders while still emotionally holding them responsible for what they did. Co-victims are able to give some grace to the offenders by forgiving, however mercy seems to be too generous for the acts committed by the offenders. This is sometimes the case as offenders feel a sense of relief when they know they can die without the co-victims holding a grudge against them.

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Targeting uPAR with CAR-NK Cell Therapy for the Clearance of Senescent Cells

By Lillian Li

Abstract

Cellular senescence is a permanent state of cell cycle arrest that occurs with age. The immune system is not effective at removing all senescent cells, so they accumulate in the body, causing age-related diseases such as osteoarthritis, Parkinson's disease, glaucoma, and cancer. CAR-NK cells are NK cells modified with a CAR molecule that provides targeted killing at a particular antigen or receptor, and senescent cells upregulate uPAR. Therefore, this paper proposes using CAR molecules engineered with a uPAR-binding antibody that allows CAR-NK cells to clear senescent cells. While this therapy has previously proven successful with CAR-T cells, CAR-NK cell therapy holds unique advantages, being nontoxic and having more accessible cell lines. However, NK cells have a short lifespan, reducing efficacy. Moreover, uPAR, while characteristic of senescence, is also moderately expressed in certain types of healthy cells, posing a health risk. To quantify the level of health risk and the CAR-NK cell lifespan needed for an effective therapy, the Complexity and Organized Behavior Within Environmental Bounds agent-based simulation software is used to model an environment of healthy pulmonary alveolar cells, which express uPAR moderately. Results from one control model and nine variable models show that CAR-NK cells should have a lifespan of at least six months. In addition, when the therapy is effective, there is noticeable and quantifiable damage to the healthy tissue, but the overall health impact of the damage requires further research in vitro and in vivo.

Introduction

Cellular senescence is a state of permanent cell cycle arrest that generally occurs in aged cells (Calcinotto et al.; Roger et al.). Naturally, senescent cells are cleared by macrophages, natural killer (NK) cells, neutrophils, and T lymphocytes recruited by factors that senescent cells secrete. However, the immune system does not remove senescent cells fast enough to maintain a low level of senescence and senescent cells have methods to promote immune evasion, such as by upregulating CD47 transcription to avoid macrophages (Kale et al.). As a result, senescent cells accumulate with age.

Due to molecules released by senescent cells, senescence is believed to play a role in many age-related diseases. Retinal ganglion cell senescence was identified in glaucoma patients; vascular smooth muscle cells and endothelial cells taken from atherosclerotic plaques were found to express many hallmarks of senescence like the upregulation of SA- β -gal; chondrocytes taken from osteoarthritic joints expressed markers of senescence; senescent fibroblasts created an environment conducive to prostate cancer; and mouse models show that eliminating senescent cells can delay Parkinson's disease (Coppé et al.; Calcinotto et al.). Therefore, finding techniques to eliminate senescent cells in humans is vital to slow cellular aging.

The method proposed in this paper uses chimeric antigen receptor natural killer (CAR-NK) cells to target and kill senescent cells. NK cells are known for killing infected cells as

a part of the innate immune system (Shimasaki et al.). CAR-NK cells are NK cells that are modified to express a chimeric antigen receptor (CAR) molecule. CAR molecules are customized to allow the NK cell to direct its killing to a particular antigen (Daher and Rezvani). By creating a CAR molecule from antibodies that bind to urokinase-type plasminogen activator receptor (uPAR), a CAR-NK cell can be developed to kill cells expressing high levels of uPAR. Since senescent cells express a very high level of uPAR, this therapy can target NK cell activity at senescent cells.

However, certain types of healthy cells also happen to express uPAR to a relatively high degree, which may threaten the therapy's efficacy (Leth and Ploug). Moreover, NK cells have a short lifespan of two to seven days and may die before being able to clear senescence (Wrona et al.). This paper aims to use an agent-based simulation to quantitatively determine the harms of these two drawbacks and identify future directions to reduce them. First, background is provided on cellular senescence, uPAR, and CAR-NK cells. Next, the use of the Complexity and Organized Behavior Within Environmental Bounds (COBWEB) agent-based simulation software and the results of the control model and nine variable models are described. Following this, the discussion concludes that CAR-NK cells should have a lifespan of at least six months to be effective and that in healthy areas of high uPAR expression, CAR-NK therapy will have negative effects that need to be researched further.

1. Cellular Senescence

1.1 Hallmarks of Senescence

There are six main characteristics of senescence. While senescent cells are defined as cells that have permanently exited the cell cycle, there are other states of cell cycle arrest, such as quiescence, that are not permanent; therefore, hallmarks are required to distinguish permanent arrest from temporary arrest (Calcinotto et al.). The hallmarks are summarized in Figure 1 and detailed below.

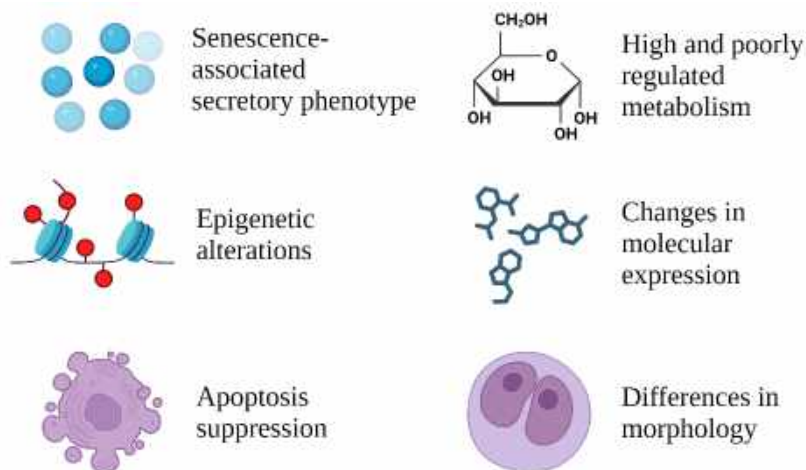


Figure 1: The 6 major hallmarks of cellular senescence. This figure was created with BioRender.com.

Each of the six hallmarks is complex: First, the senescence-associated secretory phenotype (SASP) is a group of factors secreted by senescent cells, including growth factors, cytokines, chemokines, and proteases that help flag senescence and affect the tissue microenvironment (Calcinotto et al.; Roger et al.). Second, epigenetic changes in senescent cells include the formation of senescence-associated heterochromatin foci (SAHF), telomere dysfunction-induced foci, and DNA segments with chromatin alterations reinforcing senescence (DNA-SCARS), all of which alter gene expression, such as by silencing proliferation genes (Calcinotto et al.; Olan et al.; Aird and Zhang; Dodig et al.). Third, senescent cells suppress apoptosis in various ways. To name a few, studies show that they cannot downregulate antiapoptotic protein BCL-2, they promote anti-apoptosis with heat shock proteins, and other aspects in their p53 pathway such as ubiquitin-specific peptidase 7 prevent apoptosis (Hernandez-Segura et al.; Hu et al.). Fourth, poorly regulated and high metabolism is caused by increased glucose consumption and lactate production by senescent cells alongside increased glycolysis caused by the upregulation of glycolytic genes (Nacarelli and Sell). Fifth, separate from the SASP are other changes in molecular expression. Senescent cells have an elevated expression of molecules inhibiting the cell cycle such as p16INK4a and p27, senescence-associated β -galactosidase (SA- β -gal) at a pH of 6, and other molecules such as lipofuscin, p53, p19ARF, and PAI-1 (Calcinotto et al.). Sixth, when observing the morphology of senescent cells in vitro, they tend to be enlarged, flattened, smoother, and often multinucleated and containing many vacuoles compared to proliferating cells (Beck et al.; Dennery and Yao).

1.2 Causes of Senescence

Senescence primarily exists to protect the body from damaged cells, and there are two main forms of senescence: replicative senescence and premature senescence.

Replicative senescence occurs when a cell reaches the Hayflick limit. After every cell division, at the 3' end, telomeres shorten by around 50 to 200 base pairs. The enzyme telomerase adds bases to telomeres to prevent erosion, but telomerase is unable to keep up with cell division. After enough divisions, the telomeres become so eroded that the DNA damage response is triggered, which ultimately causes senescence (Calcinotto et al.; Roger et al.). Unusual oxygen levels may accelerate telomere shortening (Calcinotto et al.).

Premature senescence occurs when cells undergo senescence before reaching the Hayflick limit and is unrelated to telomere erosion. There are several forms of premature senescence. Oncogenic senescence occurs when oncogenes are overexpressed or when tumor suppressor genes are lost. It appears to prevent possibly cancerous cells from proliferating. Senescence can also be caused by oxidative stress due to reactive oxygen species (ROS) produced during cellular respiration; endoplasmic reticulum stress; mitochondrial stress; and DNA damage caused by agents like ultraviolet light or chemotherapy (Calcinotto et al.; Dennery and Yao; Lee and Lee; Roger et al.).

1.3 Effects of Senescence

Disadvantageously, soluble signaling factors from the SASP including chemokines, growth factors, and interleukins can cause inflammation and induce senescence and apoptosis in nearby cells. ROS and other released molecules can cause dysfunction and promote cancer (Coppé et al.). On the other hand, senescence acts as a tumor-suppressing mechanism to prevent damaged or cancerous cells from proliferating; senescent cells are prevalent in and appear to support limb patterning and tissue remodeling during embryogenesis; and senescent cells support tissue repair and regeneration. Skin wounds in mice caused senescent endothelial cells and fibroblasts to appear and support clotting and repair, and when these senescent cells were eliminated, wound repair was slowed. Senescent cells also appear to affect the intermediate stages of limb regeneration in animals like salamanders (Calcinotto et al.).

Despite its benefits, in mature organisms and especially older people, senescent cells play a largely detrimental role and require removal. Therapies that remove senescent cells are known as senolytics (Kirkland and Tchkonja).

2. Urokinase-Type Plasminogen Activator Receptor

uPAR, also called CD87, is a cell membrane receptor coded by the PLAUR gene. It is anchored to the cell membrane with a glycosylphosphatidylinositol (GPI) linkage and is made of the homologous domains DI, DII, and DIII. uPAR traditionally binds urokinase-type plasminogen activator (uPA) to focus the proteolytic activity of uPA on the cell surface. This helps uPA more effectively trigger a cascade of proteolytic events to degrade the extracellular matrix (Crippa; Di Mauro et al.; Zhai et al.). uPAR expression is also linked to thrombolysis and cell migration during tissue remodeling, wound healing, inflammation, and embryogenesis (Zhai et al.).

Senescent cells were found to upregulate uPAR significantly more than healthy cells. RNA-sequencing datasets from three models of senescence found that PLAUR was most upregulated, excluding targets that were also upregulated in healthy cells. Public datasets verified the difference in uPAR expression between healthy and senescent cells (Amor et al.). uPAR expression also tends to be high in cancerous cells and can promote tumor angiogenesis. High uPAR expression has been found in breast, lung, bladder, ovarian, prostate, etc. solid tumor tissue samples and cells found in the tumor microenvironment, such as vascular endothelial cells (Zhai et al.).

However, in a few groups of healthy cells, there is a noticeable level of expression, which poses a large hurdle to targeting uPAR to eliminate senescent cells. These include pulmonary alveolar cells, keratinocytes, white blood cells, endothelial cells lining blood vessels, and glomerular cells (Leth and Ploug).

3. Chimeric Antigen Receptor Natural Killer Cells

3.1 Natural Killer Cells

NK cells are a type of innate lymphoid cell that make up around 5–15% of leukocytes in human peripheral blood (Xie et al.; Shimasaki et al.). NK cells are characterized by the expression of neural cell adhesion molecules and the absence of the surface T-cell receptor and related CD3 molecules (Shimasaki et al.; Daher and Rezvani). They differentiate and mature from multipotent CD34+ hematopoietic progenitors found in the bone marrow and lymphoid organs (Shimasaki et al.).

NK cells have various methods of killing, such as by releasing molecules from the tumor necrosis factor family to upregulate death ligands that bind to death receptors on the target cell. Alternatively, they may induce cell lysis by releasing cytotoxic granules containing perforin and granzyme. During these processes, NK cells produce IFN γ , which helps trigger the adaptive immune response (Daher and Rezvani).

NK cells are primarily responsible for killing cells that do not properly express class I major histocompatibility complex (MHC). MHC class I molecules suppress NK cell function by binding to the NK cells' inhibitory killer cell immunoglobulin-like receptors (Shimasaki et al.). However, NK cells recognize senescent cells slightly differently. First, senescent cells express ligands like MICA and MICB that bind to the NKG2D receptor on NK cells; and second, senescent cells secrete chemokines and cytokines that recruit immune cells. Both mechanisms result in NK cell action (Pereira et al.; Sagiv et al.). Unfortunately, not only do the immune system's senescence-clearing mechanisms decline with age, but senescent cells may evade death by upregulating ligands like HLA-E, which inhibit NK cell function (Pereira et al.; Gasek et al.).

3.2 CAR-NK Cells as a Senolytic

CAR-NK cells are NK cells modified to express a customized CAR molecule, which allows the NK cell to direct its killing at a particular antigen (Daher and Rezvani). As shown in Figure 2, a CAR molecule targeting uPAR is composed of four parts: First, an extracellular antigen recognition domain is made of a single-chain variable (scFv). Typically, the scFv would be derived from antibodies that bind the antigen of choice, but to target uPAR directly, the scFv can be derived from antibodies that bind to the receptor (Amor et al.). Second, an extracellular hinge domain connects the recognition domain to the transmembrane region to provide flexibility to and stabilize the CAR. Third, the transmembrane region connects the intracellular and extracellular CAR domains, keeps the CAR embedded in the cell membrane, and carries signals into the cell (Gong et al.). Fourth, the intracellular signaling domain activates the NK cell (Gong et al.; Daher and Rezvani).

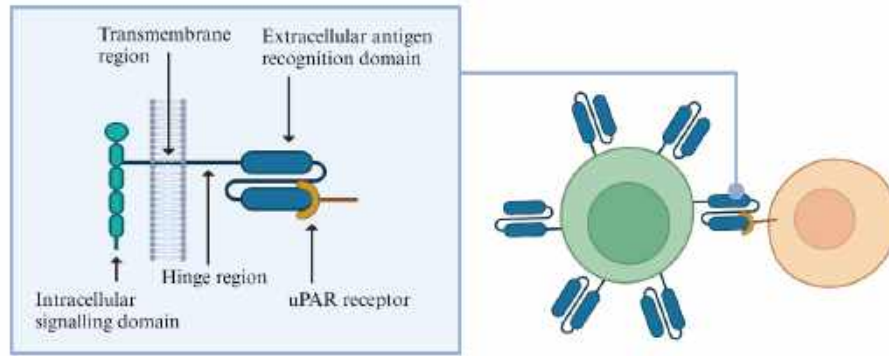


Figure 2: CAR-NK cell targeting uPAR. This figure was created with BioRender.com.

To induce CAR expression in NK cells, lentiviruses and retroviruses are commonly used, but gene delivery is often inefficient and may cause apoptosis or integration of viral DNA. Non-viral methods include using transposons, mRNA, episomal vectors, and CRISPR-Cas9 technology (Schmitt et al.).

3.3 A Comparison to CAR-T Cell Therapy

The concept of CAR-NK cell therapy came from the highly similar CAR-T cell therapy, which has proven successful. CAR-T cells have been used to treat leukemia and lymphoma in humans and tumors in mice (Zhai et al.; Huang and Liu). CAR-T cell therapy has also extended the lives of mice with lung adenocarcinoma and restored healthy tissue in mice with induced liver fibrosis (Amor et al.). Unfortunately, CAR-T cells tend to be toxic and difficult to produce because they must be taken from the patient and not a donor (Albinger et al.). Comparatively, CAR-NK cells are nontoxic and can be obtained in several ways, including from immortalized NK cell lines, donor blood, archived umbilical cord blood, or pluripotent cells differentiated in vitro (Wrona et al.).

However, CAR-NK cells tend to have much shorter lifespans of around two to seven days, which is too short for effective results (Wrona et al.). In comparison, CAR-T cells can live for months or years (López-Cantillo et al.). There are three main methods used to lengthen the lives of CAR-NK cells: First, interleukin 2 (IL-2) or IL-15 can be administered, but this often leads to capillary leak syndrome and exhausted NK cells. Second, a transgene of interleukin such as membrane-bound IL-15 can be introduced to help NK cells self-activate. Third, memory-like NK cells tend to live longer, so these cell lines can be chosen instead (Wrona et al.).

4. Method

Pulmonary alveolar cells in lung tissue were chosen to be simulated, although their results will be extrapolated to the other tissue types.

The COBWEB software was used to simulate the injection of a varying number of CAR-NK cells into lung tissue made of pulmonary alveolar cells. COBWEB is an agent-based

research simulation software, and agents were modified to behave in a way that mimics cells. A screenshot of tick zero for the simulation used in this paper is shown in Figure 3.

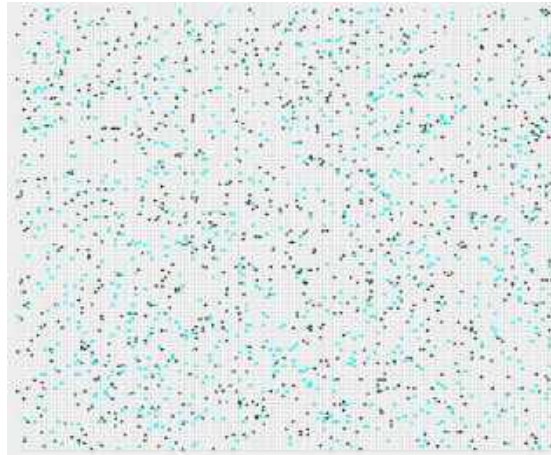


Figure 3: Initial state of every simulation. The black triangles represent agents while the blue squares represent food. There are 50 senescent agents, represented by triangles with a blue dot inside, and 950 healthy agents, represented by triangles with a green dot inside.

4.1 Control Model

The goal of the control model is to simulate the slow increase in senescence of lung tissue from age 25 onwards. The percentage of senescent cells should appear to rise from around 5% to 10% from age 25 to age 63, assuming the individual has no lung complications (Tsuji et al.; Melo-Narváez et al.).

Time: Time in COBWEB is measured in ticks, which is an arbitrary unit. In this simulation, each tick shall represent two days. The first 2000 ticks are ignored to allow the population to stabilize. Therefore, tick 2000, the beginning of the simulation, represents the mature lung tissue of an individual aged 25. One tick represents two days, with tick 8388 representing age 60. CAR-NK cells will be added at various ages to assess the impact of the treatment.

Environment: The width and height of the simulation were set to a 160 by 160 grid, where each cell takes up one square. This allows the cells to move but remain close together, as in most tissues. There is a horizontal and vertical wrap; that is, if a cell leaves from the top of the grid, it reappears at the bottom and vice versa; this works the same for the left and right. This allows the grid to simulate a small patch of tissue with cells entering and exiting. Random seed 42 was used in all models to ensure identical cell behavior in each model.

Resources: There is only one type of food that all cells consume. It starts at 1000, spawns at a rate of nine per tick, and depletes by 50% every two ticks. These settings are arbitrary and were chosen to ensure a constant cell population count throughout the simulation.

Agents: There are two agents; senescent cells and healthy cells. There are a total of 1000 cells at the beginning of the simulation, with 50 senescent and 950 healthy. None of the default settings were changed except for asexual breed chance. Senescent cells have a 0.4% chance of

breeding and healthy cells have a 5.8% chance. These settings were chosen after over 30 test runs to ensure that cell count stays fairly constant and that by age 60, the percentage of senescent cells rises from 5% to around 10%. Senescent and healthy cells both move at a speed of one square per tick.

4.2 Variable Models

Disease: To simulate CAR-NK cells recognizing and killing senescent cells, the Disease tab is used. CAR-NK cells carry a disease that has no effect on them. However, when the disease is transmitted to a senescent or healthy cell, the step energy of that cell is increased 10,000-fold, instantly killing the cell when it tries to take a step forward, as the cells are always moving. When a CAR-NK cell contacts a senescent cell, there is a 90% chance of transmission, and when it contacts a healthy cell, there is a 40% chance of transmission, as senescent cells express uPAR approximately 50% more than healthy cells. This is a very rough estimate based on the differences between patients with and without chronic obstructive pulmonary disease, a disease partially caused by cellular senescence (Barnes; Wang et al.).

Agents: A CAR-NK cell agent is added to the simulation. It behaves differently from senescent and healthy agents in three ways: First, the CAR-NK cells do not die; the simulation is instead paused at the point they are expected to die. Second, they move at 10 times the speed of the healthy and senescent cells because pulmonary alveolar cells are much less motile. Third, they consume food but do not gain any energy from it, as they are already immortal in the simulation. However, they still consume food to mimic the realistic nutrient depletion by CAR-NK cells entering the body. 50 CAR-NK cell agents are manually added to the simulation at a predetermined tick. They are added at approximately the center of the grid to mimic an injection site. 50 CAR-NK agents were used because it would allow them to make up around 5% or less of the tissue environment, a reasonably small estimate.

Two independent variables are being tested: the timing of the CAR-NK cell injection and the lifespan of the CAR-NK cells. There were eight variable models and one control used in this simulation, as shown in Table 1.

Table 1: The eight variable models.

Model #	Age the CAR-NK cells were injected at (ticks)	Age the CAR-NK cells were injected at (years)	Lifespan of CAR-NK Cells (ticks)	Lifespan of CAR-NK Cells (months)
Control	N/A	N/A	N/A	N/A
1	6563	50	30	2
2	6563	50	91	6
3	6563	50	183	12
4	8388	60	30	2
5	8388	60	91	6
6	8388	60	183	12
7	10213	70	30	2
8	10213	70	91	6
9	10213	70	183	12

5. Results

Two dependent variables are being analyzed: The decline in the number of healthy cells after injection and the decline in the number of senescent cells after injection. The decline in the number of healthy cells will be compared to that of the control model at each point while the percentage of senescent cells remaining after each injection will be calculated to determine the new “age” of the tissue.

5.1 Data

Except for the control, there are four graphs per model.

Graph 1: The cell populations. This ensures that cell populations match the control simulation and that there are no errors.

Graph 2: The percentage of healthy cells (out of 1000, which was the initial count) that are alive from the tick when the CAR-NK cells were added until the end of the simulation. This, when compared to Figure 6 in the control simulation, gauges the harm of the therapy to healthy lung tissue. A percentage was used rather than the cell count for readers to more intuitively understand the fraction of lung tissue left from what it began with.

Graph 3: The percentage of total healthy and senescent cells that are senescent from the tick when the CAR-NK cells were added until the end of the simulation. This will be used to determine the drop in senescence and the approximate percentage the tissue is hovering at by the end of the therapy. This percentage was used rather than a simple senescent cell count because the level of senescence in a tissue is dependent on the fraction of senescent cells and not the number; therefore senescence should be measured as a fraction of the entire cell population.

Graph 4: Percentage of total healthy and senescent cells that are senescent from tick 2000 to the end. By comparing Graph 3’s percentage drop in senescence to Graph 4, the new “age” of the tissue can be assigned. For example, if the 50-year-old tissue dropped from 10% to 7% in Graph 3 and Graph 4 shows 7% to be at age 30, then the tissue has been “reversed” to age 30. This tests for the effectiveness of the drug.

5.1.1 Control Model

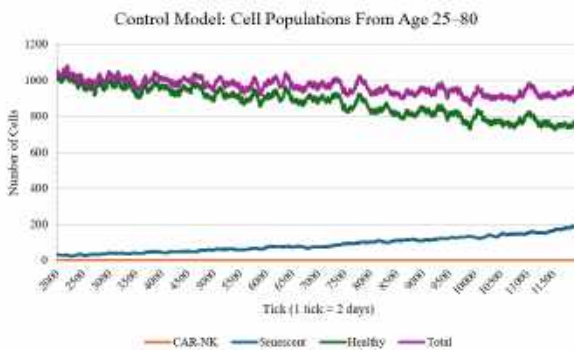


Figure 5

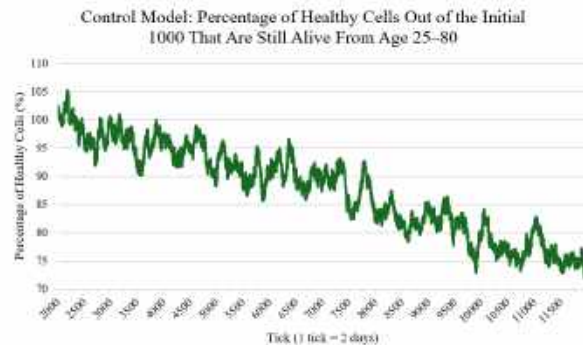


Figure 6

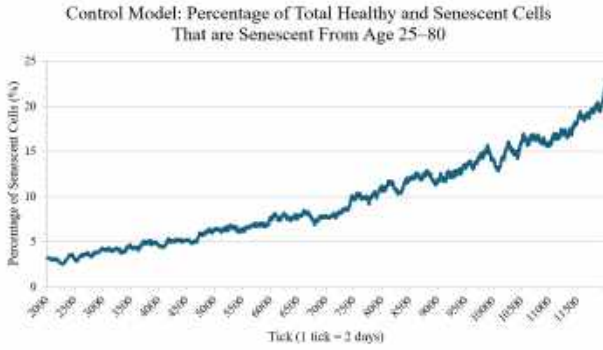


Figure 7

The cell population remains at approximately 1000, and the number of senescent cells increases over time while the number of healthy cells drops. There is a decline in healthy cells by 30% (from 100% to 70%) in Figure 6, which is expected as the lungs slowly deteriorate over time with the reduced production and function of stem cells to replenish them (Han et al.). The percentage of senescent cells rises over time in a curve that appears slightly exponential but mostly linear up to age 80, which is expected as more and more cells reach the Hayflick limit over time.

5.1.2 Model 1

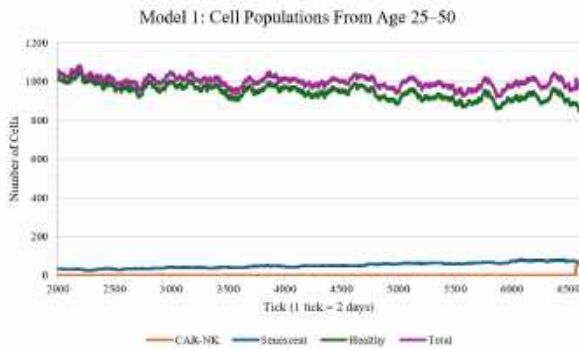


Figure 8

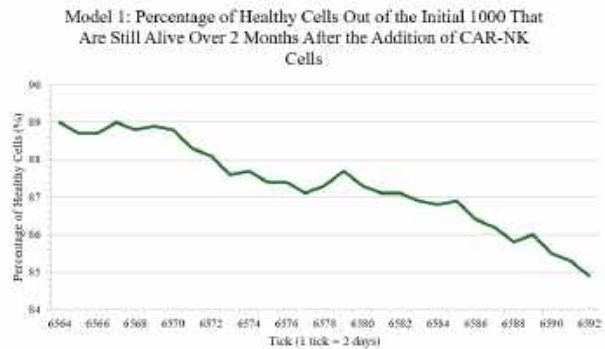


Figure 9

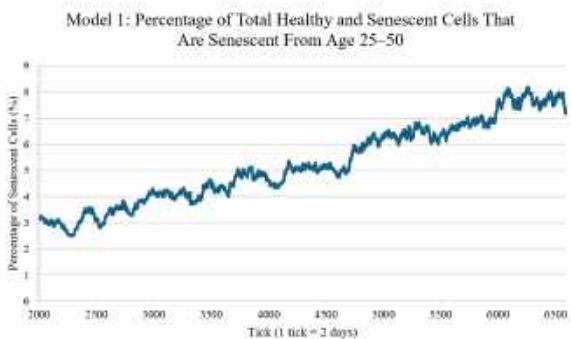


Figure 10

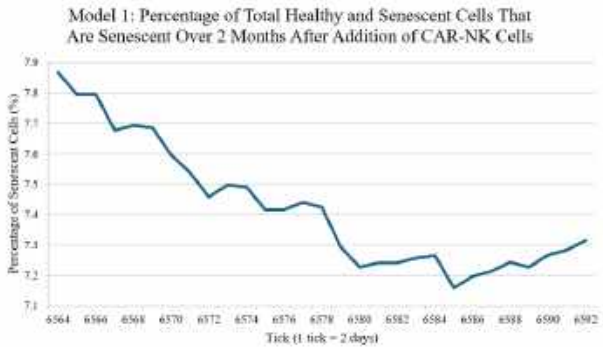


Figure 11

The overall cell populations show a similar trend to the control model. After the injection of CAR-NK cells, the healthy cell population drops from 89% to 85%, but there is a similar occurrence at tick 6500 in the control model, so it does not seem to be a health threat. The percentage of senescent cells appears to drop by almost 1%, which is a noticeable change but not enough to “reverse” the age of the tissue environment when compared to Figure 10, as the rate of senescence was already fluctuating around 7% and 8% before the CAR-NK cell addition.

5.1.3 Model 2

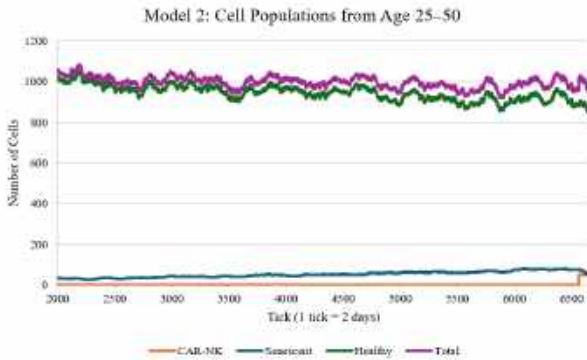


Figure 12

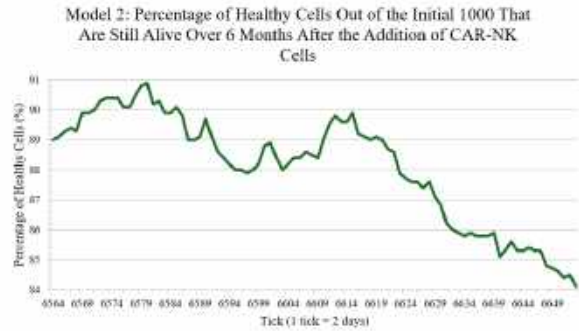


Figure 13

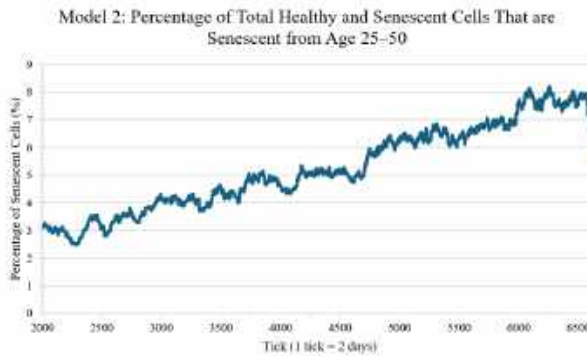


Figure 14

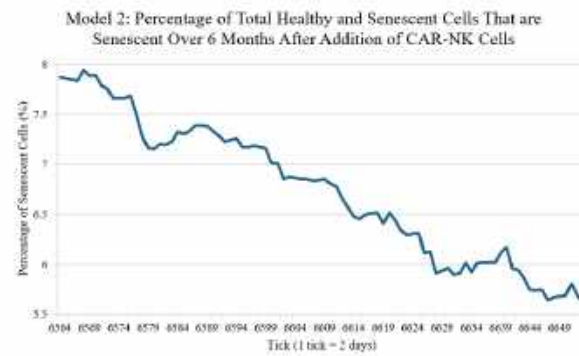


Figure 15

The cell populations look like the control model except for the dip in the number of senescent cells at the end. The percentage of healthy cells dips by around 6% (from 90% to 84%), which is insignificant and poses no threat to health, as the control model shows the same fluctuations at around tick 6500. The percentage of senescent cells drops almost 3% after injection, and when compared to Figure 14, it can be estimated that the CAR-NK cell therapy restores the tissue to around tick 4800, or age 40.

5.1.4 Model 3

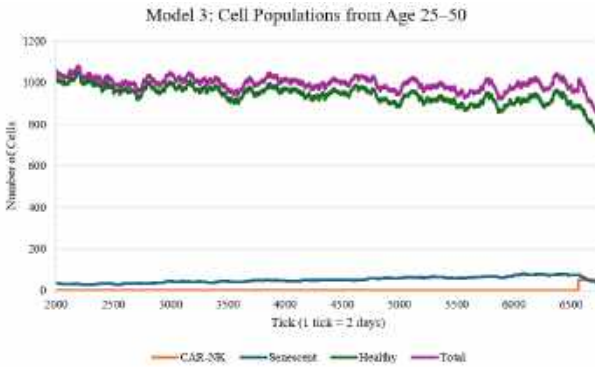


Figure 16

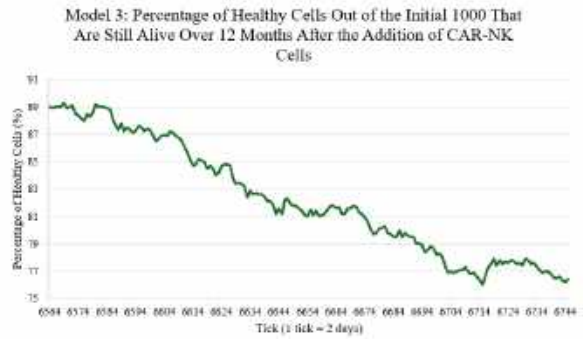


Figure 17

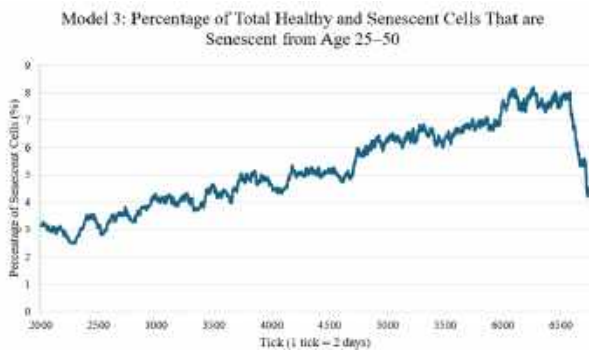


Figure 18

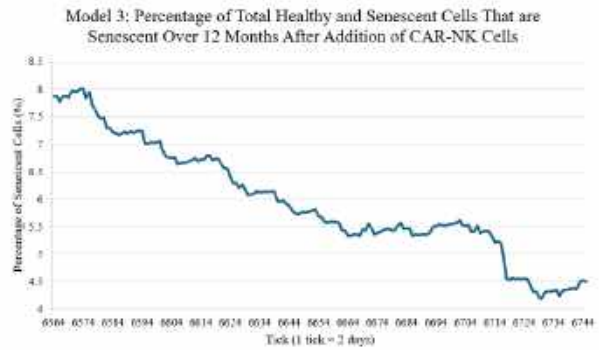


Figure 19

The cell population shows a noticeable dip at the end due to the deaths of both senescent and healthy cells. The percentage of healthy cells drops around 14% after injection, which is significant when compared to the control model, suggesting that Model 3 may lead to lung deterioration that brings the lungs to a state that is typically only seen at tick 10,000, or age 69. The percentage of senescent cells drops around 4% after injection, restoring the tissue to tick 3000, or approximately age 30.

5.1.5 Model 4

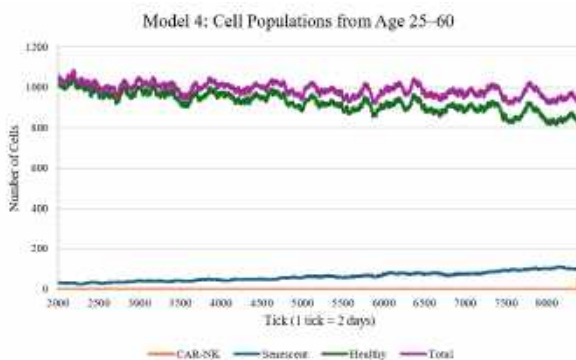


Figure 20

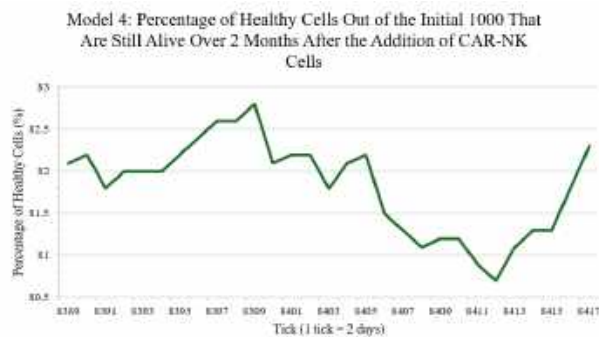


Figure 21

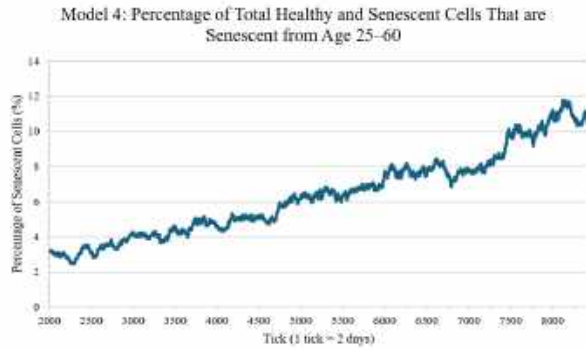


Figure 22

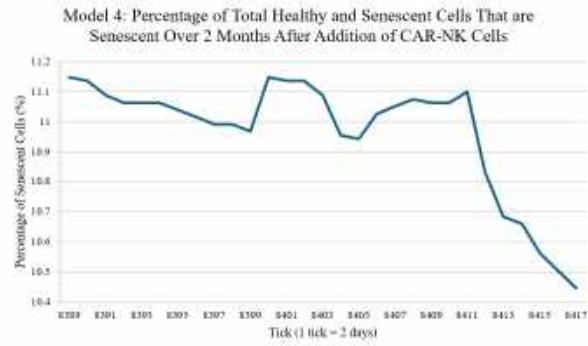


Figure 23

The cell population and changes in the percentage of healthy cells after injection appear to resemble the control model, so Model 4 does not appear to pose health threats. The percentage of senescent cells dips almost 1% (from 11% to 10%), which does not make a difference as the senescence rates were already hovering at around 10% and 11% before the injection.

5.1.6 Model 5

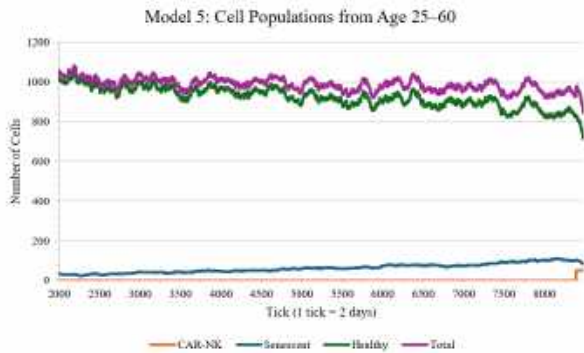


Figure 24

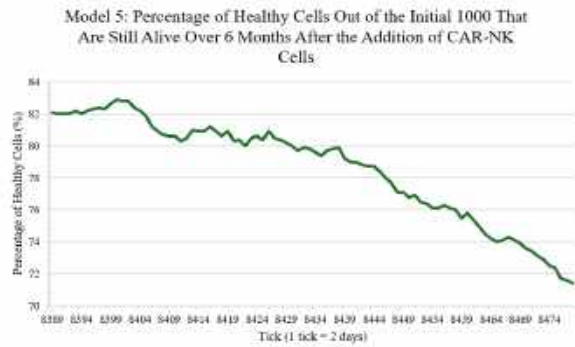


Figure 25

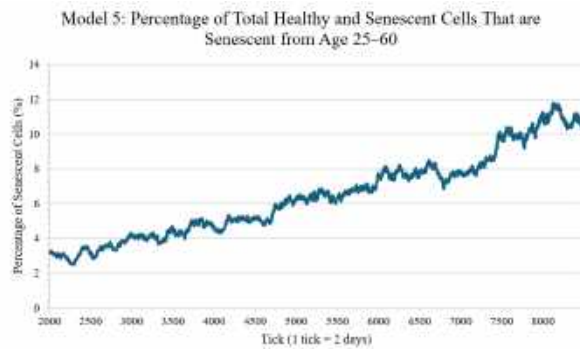


Figure 26

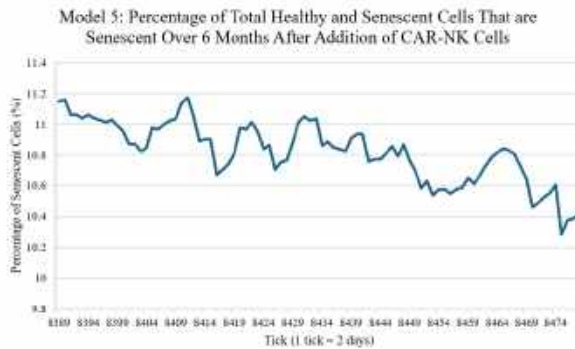


Figure 27

The cell population appears to dip from the deaths of senescent and healthy cells. The healthy cell population drops by almost 12% (from 82% to 70%), which, when compared to the control model in Figure 6, has deteriorated the lung to at least tick 10,000, or age 69. The

percentage of senescent cells seems to drop by almost 1%, which, when compared to Figure 26, makes no difference to its pre-therapy state.

5.1.7 Model 6

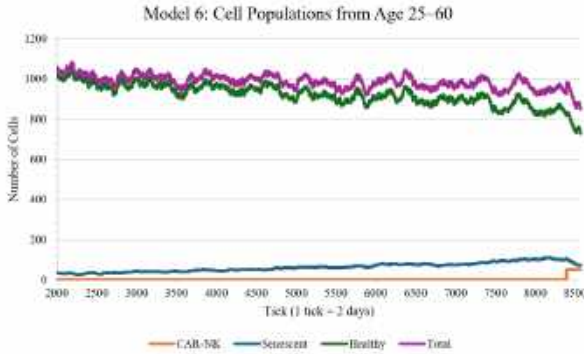


Figure 28

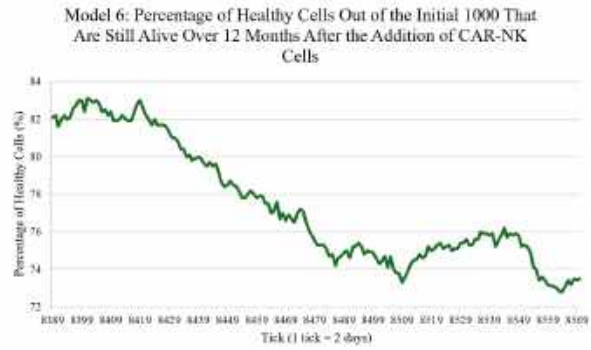


Figure 29

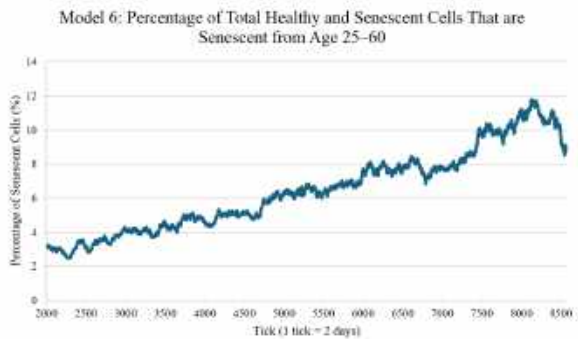


Figure 30

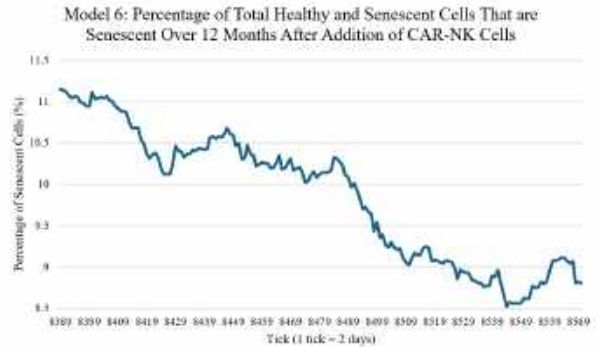


Figure 31

The healthy and senescent cell populations show a noticeable decrease near the end of the simulation. The healthy cell population drops by around 10%, which appears to deteriorate the lung tissue to at least tick 10,000, or age 69. The percentage of senescent cells drops by almost 3% (from 11.5% to 8.5%), which is a noticeable decrease that reduces the apparent age of the tissue down to tick 7500, or age 55.

5.1.8 Model 7

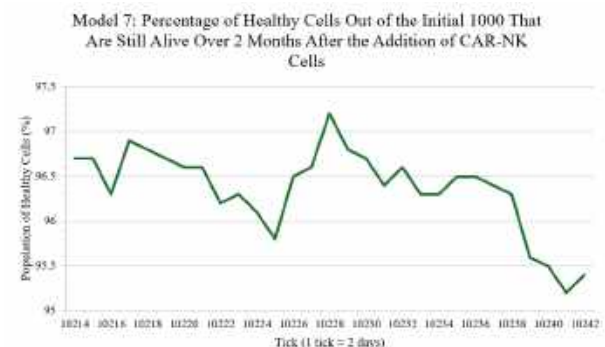
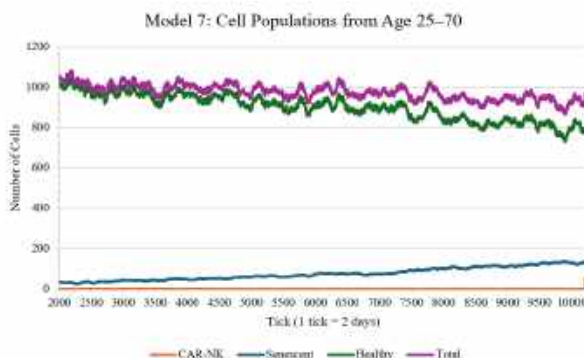


Figure 32

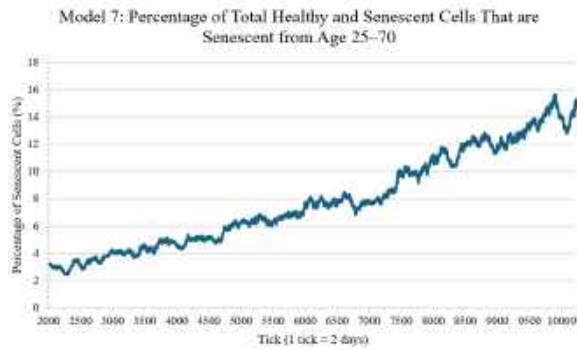


Figure 34

Figure 33

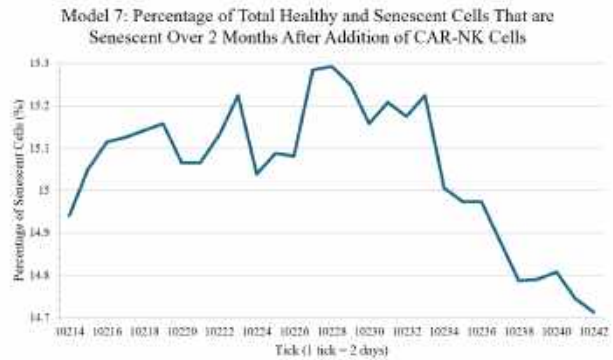


Figure 35

The overall cell populations and decrease in healthy cell populations after the CAR-NK injection appear to match the control model. The population of senescent cells appears to not change when compared to the pre-therapy state.

5.1.9 Model 8

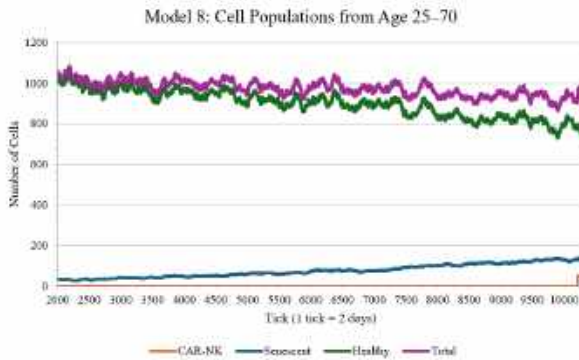


Figure 36

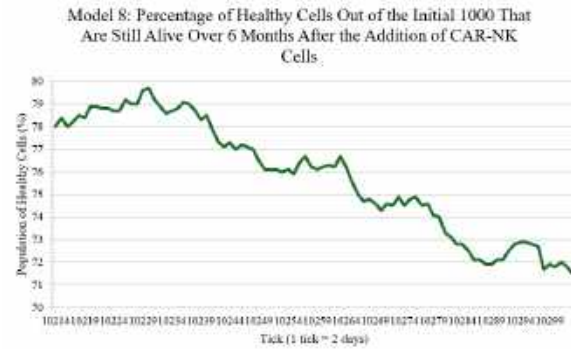


Figure 37

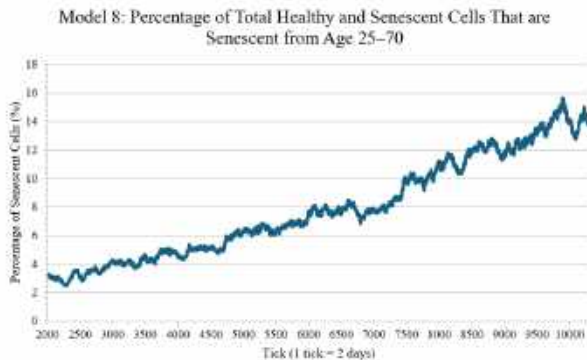


Figure 38

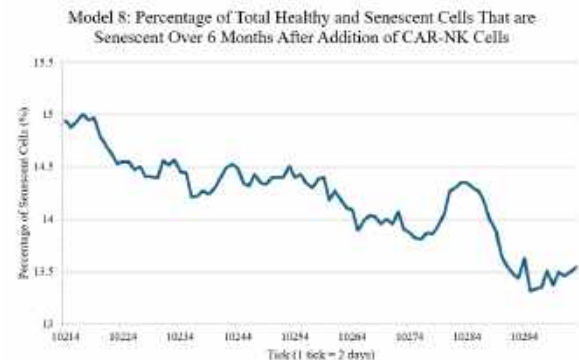


Figure 39

The cell population appears to match the control. The percentage of healthy cells drops by around 7% (from 78% to 71%), which appears to have “aged” the tissue to at least tick

12,000, which is equivalent to age 80. The percentage of senescent cells drops around 1.5% (from 15% to 13.5%), which makes no difference to the pre-therapy state.

5.1.10 Model 9

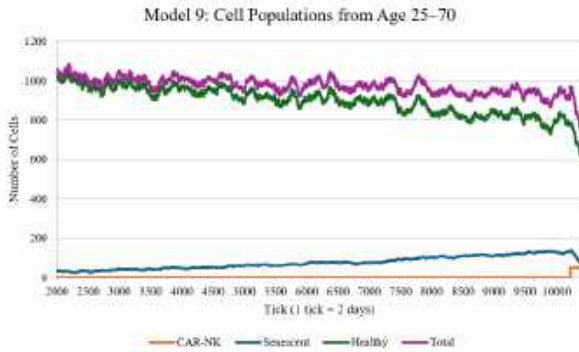


Figure 40



Figure 41

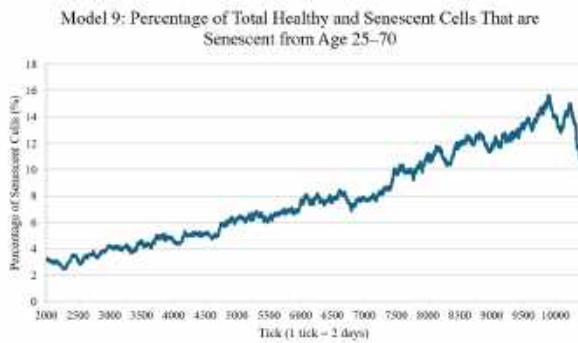


Figure 42

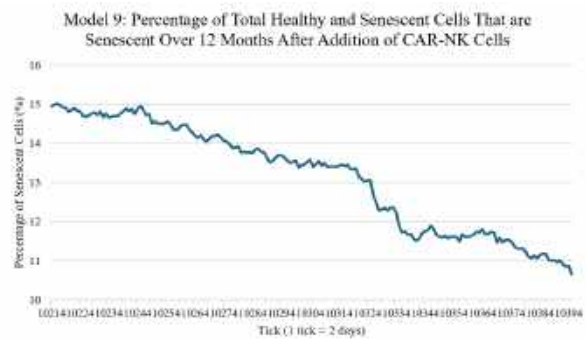


Figure 43

The healthy and senescent cell populations both seem to dip significantly when compared to the control. The percentage of healthy cells drops by 16% (from 78% to 62%), which theoretically ages the cell to beyond tick 12,000, or age 80. The percentage of senescent cells decreases by almost 5% (from 15% to 10%), which has “reversed” the age of the tissue to tick 8000, or age 58.

5.2. Analysis

Table 2 organizes the data to summarize the new apparent ages of the tissue described in 5.1 Data.

Model #	Change in healthy cells (\pm %)	Change in age of healthy tissue (\pm years)	Change in senescent cells (\pm %)	Change in age of senescent tissue (\pm years)
1	-4	0	-1	0
2	-6	0	-3	-10
3	-14	+19	-4	-20
4	0	0	-1	0
5	-12	+9	-1	0
6	-10	+9	-3	-5
7	-2	0	0	0
8	-7	+10	-2	0
9	-16	+10	-5	-12

Table 2: Summary of the effects of each model. All values are rounded to the nearest whole number.

Of the CAR-NK cells with a lifespan of two months (models 1, 4, 7), the change in age of the healthy and senescent tissue were both 0, meaning the therapy has little to no effect. With a lifespan of six months (models 2, 5, 8), only model two helped reverse the age of senescent tissue by 10 years without damage to the healthy tissue. The others only increased the age of the healthy tissue. At 12 months (models 3, 6, 9), there was a reversal in age of the senescent tissue but also resulted in healthy tissue damage. On the other hand, the effect of the age at which the CAR-NK cells were injected appears random until a lifespan of 12 months, in which case the damage to healthy tissue by year is much larger at age 50 than 60 and 70.

To conclude, the longer the lifespan of the CAR-NK cell, the more effective it is, but the more damage it will do to healthy tissue. Moreover, CAR-NK cells should ideally live six months or more to have any impact, and the age of injection is negligible.

6. Discussion

While uPAR-targeting CAR-NK cell therapy shows great potential as a senolytic, the short lifespan of CAR-NK cells and its potential to cause healthy cell death are critical drawbacks to explore and quantify to improve the therapy.

Looking at the lifespan of CAR-NK cells, using IL-15 to maintain CAR-NK cell survival in mice allowed for high levels of CAR-NK cells to survive for 49 days, with CAR-NK cells still detected at smaller amounts after 75 days (Xiong et al.). However, according to the results of the simulation, for a uPAR-targeting CAR-NK cell senolytic to be effective, this lifespan will need to be extended to around six months, which is presently unfeasible. Further research must be done on memory-like NK cell lines and other aforementioned methods to extend CAR-NK cell life. An alternative would be providing multiple injections over the course of the therapy.

As for the impact on healthy tissue, for the senolytic to offer decades' worth of tissue age reversal, it also costs years' worth of healthy tissue deterioration in parts of the body that express uPAR to a relatively high degree. While there is no literature on the exact expression of uPAR in senescent and healthy versions of the different cells of the human body, this pulmonary alveolar cell model suggests that other cells with a high expression of uPAR, such as the glomerular cells and keratinocytes mentioned previously, may face similar healthy tissue damage if exposed to

the same CAR-NK therapy. Further research is needed to determine if this deterioration is more harmful to the body than the increasing rate of senescence that would otherwise occur. Without this information, a CAR-NK senolytic must be localized to areas of disease where senescence is particularly high and where they do not pose a threat to most healthy tissue. However, this also remains difficult because NK cells are found throughout peripheral blood so CAR-NK cells can easily migrate into the bloodstream to reach the rest of the body (Razizadeh et al.).

6.1 COBWEB Limitations

The nature of the COBWEB simulation software may limit the accuracy of this model. First, the values required for the simulation were difficult to find in the literature, so many of the values were approximations, like the 50% uPAR expression and the 5% senescence at lung maturity. Moreover, only two points of reference were used to create the control model: Approximately 5% senescence at the beginning and 10% at age 60. Therefore, the growth pattern from 5% to 10% may be incorrect; it may require a more linear or exponential growth pattern than what occurred in the simulation. Second, the movement speed of the agents was set arbitrarily; each senescent and healthy cell moved at a speed of one square per tick, where each tick represents two days, while CAR-NK cells moved 10 times faster, but this is likely not the case. Third, the random movement of the agents in COBWEB does not perfectly match the movement of cells; agents move on a strict grid while cells should flow freely.

Ideally, the tests done in this paper should be replicated in vitro or in vivo to confirm these results.

Conclusion

Currently, much research is focused on curing age-related diseases, but by tackling cellular senescence and other root causes of aging, age-related diseases can be prevented. The CAR-NK senolytic proposed in this paper can act as a preventative measure against aging and a cure for any complications caused by large regions of senescent tissue. COBWEB models have demonstrated that while this therapy is effective at clearing senescent cells, CAR-NK cells need a lifespan of at least six months and that the body's ability to tolerate damage to healthy tissue needs to be researched further to determine whether CAR-NK cell therapy with uPAR poses dangerous side effects. It may be in its fetal stages of development right now, but successfully targeting uPAR with CAR-NK cells can bring an accessible prevention mechanism to aging for generations to come.

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Reducing Food Waste Through Choice Architecture: Insights From Denmark, the UK, and San Francisco By Raymond Xu

Abstract

Food waste poses significant environmental, economic, and social challenges, with approximately 1.05 billion tonnes wasted globally in 2022, accounting for 19% of available consumable food (UNEP, 2024). This paper explores the effectiveness of choice architecture in reducing food waste, highlighting successful initiatives in Denmark, the U.K., and San Francisco. Denmark's "Stop Wasting Food" initiative achieved a 25% reduction in food waste through clear labeling and pricing strategies (Juul, 2019). The U.K.'s "Love Food Hate Waste" campaign reduced household food waste by 21% by providing practical tools and educational resources (WRAP, 2018). San Francisco's comprehensive waste management program, including mandatory composting and recycling laws, diverted 80% of waste from landfills (S.F. Environment, 2021). The paper suggests that governments and organizations can implement similar strategies, such as regulatory frameworks, public-private partnerships, and consumer education, to reduce food waste. It also identifies areas for further research, including the long-term sustainability of these interventions and their adaptability to different cultural and social contexts. These findings emphasize the importance of innovative approaches through choice architecture to reduce food waste for environmental sustainability and economic efficiency.

Introduction

Food waste remains a significant challenge to sustainability and global food security. According to the United Nations Environment Programme (UNEP), in 2022, globally, about 1.05 billion tonnes of food was wasted, accounting for roughly 19% of available consumable food (UNEP, 2024). 60% of total food waste is generated at the household level, while food service and retail sectors are responsible for the remaining 40% (UNEP, 2024; Drishti IAS, 2024). Food waste is a significant contributor to greenhouse gas emissions, responsible for roughly 8-10% of global emissions, nearly five times the total emissions from the global aviation sector (UNEP, 2024; U.N. News, 2024). Additionally, the decomposition of organic waste in landfills produces methane, a potent greenhouse gas contributing to climate change.

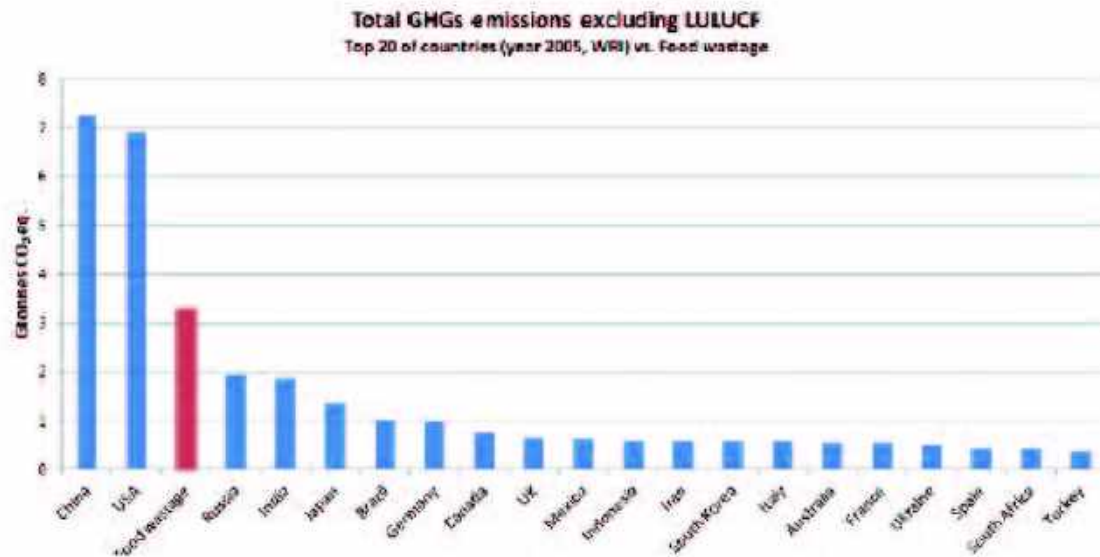


Fig 1. A graph of the top twenty greenhouse gas emitting countries including emitted greenhouse gasses from food wastage. The Food and Agriculture Organization (FAO) estimates that if food waste were a country, it would be the third-largest emitter of greenhouse gasses globally, following China and the United States.

Besides environmental consequences, food wastage has a significant economic and social cost. Food waste costs the world an estimated \$1 trillion annually, including the value of the food wasted and the associated disposal costs (World Resources Institute, 2023). Global food waste contrasts starkly with global hunger statistics: around 783 million people suffer from hunger, and approximately one-third of all food produced is never consumed. (U.N. News, 2024). To put it into perspective, the World Bank states that reducing food loss and waste by just 25% would be enough to feed an extra 870 million people yearly, illustrating the need for solutions. (World Bank, 2023).

Choice architecture offers one of the best areas to reduce food waste, as it subtly touches human behavior through behavioral economics by designing the context within which people make choices, nudging them toward more sustainable decisions entirely subconsciously. For instance, research proves that a slight decrease in portion sizes leads to decreased waste within a food service context: in the U.S., portion changes at college dining halls cut food waste by up to a third (Kallbekken & Sælen, 2021). For instance, if perishable goods, such as fresh fruits and vegetables, are positioned at eye level in a grocery store, the consumer will select these over the goods with a longer shelf life, reducing waste. Additionally, public-private partnerships offer a powerful tool for scaling up the implementation of choice architecture. The Pacific Coast Food Waste Commitment is another example demonstrating how partnership and coordinated action by retailers, governments, and nonprofits can deliver success in reducing food waste. Over the three years of the program, from 2019-2022, a 25% reduction in unsold food was seen, saving almost 190,000 tons of food from going to waste and \$311 million (BioCycle, 2024).

The problem concerning food wastage is not limited to wealthier countries; it is an issue independent of the income grade of countries. The average household food waste per year per

capita differs by only 7 kg between high-income, upper-middle-income, and lower-middle-income countries, indicating that food wastage is a problem also independent of economic class. Moreover, as stated by the World Economic Forum, addressing food waste could mitigate other challenges like water scarcity and biodiversity loss by reducing the need for land and water to produce food that ultimately goes uneaten (World Economic Forum, 2023).

The challenge of food waste demands urgent, comprehensive action. Integrating choice architecture and public-private partnerships presents a realistic avenue for step change to ameliorate food waste, underpin environmental sustainability and economic efficiency, and provide better food security. With a rising global population and strained resources, these interventions are not merely optional but necessary for a sustainable future.

Defining Food Loss and Waste

Food waste refers to food suitable for consumption but discarded or left to spoil at retail, household, or food service levels. It differs from food loss, which occurs earlier in the supply chain due to production, post-harvest treatment, and processing issues. The Food and Agriculture Organization (FAO) categorizes food waste into three categories:

- **Avoidable Food Waste:** Edible discarded items, such as leftovers or surplus food.
- **Possibly Preventable Food Waste:** Edible food that some people eat but others might not, such as bread crusts or apple peels.
- **Unavoidable Food Waste:** Inedible parts of discarded food, such as bones, eggshells, or fruit pits.

Food wastage is a major issue that greatly affects the environment and economy. When accumulated in landfills, organic food waste decomposes to produce methane, a greenhouse gas with 80 times the effect of carbon dioxide (in the first 20 years of reaching the atmosphere) (Environmental Defense Fund). Transportation, manufacturing, and agriculture all create greenhouse gasses, making food waste a far more significant environmental issue than one might initially expect.

Community-level initiatives are part of the solution to curbing food waste. In New York City, residents disposed of 1.2 billion pounds of food, a staggering number (NYC Department of Sanitation, 2023). Of this discarded food, 86 million pounds, or 6.8%, were still in intact packaging, leading to the implementation of the organics collection program, which minimizes the likelihood of collected food being food scraps than in packaging. Similarly, San Francisco has considerably reduced the amount of waste from its food service sector destined for landfills through its mandatory composting and recycling laws. This “zero-waste” program has, since 2012, reduced 80% of discarded waste going to landfills, significantly reducing the environmental cost of San Francisco’s waste management (Natural Resources Defense Council, 2017)

Defining Choice Architecture

Choice architecture is the design of the context in which people make choices that can nudge them to make better decisions without forbidding any options. Some important concepts include:

- **Nudges:** Simple interferences that guide peoples' decisions in a particular direction without removing their freedom of choice. An example is putting healthy food options at eye level in the cafeteria.
- **Defaults:** Pre-set options that take effect if no active choice is made. An example is automatically enrolling employees in retirement savings plans to boost participation rates.
- **Framing:** Presenting information in a way that has an impact on decision-making. An example is labeling an item "75% lean" instead of "25% fat" because the former labeling has a more positive connotation from a consumer perspective.
- **Anchoring:** Using some initial information as a reference point in subsequent judgment. An example is using initial price offers in a negotiation to set an anchor for final agreements.

Choice architecture has already been applied successfully in various fields. Nudging has been shown to push people toward healthier behaviors, such as using visual cues in cafeterias to highlight healthy food or defaulting them into opt-out organ donation systems. This circumstance significantly raises donor rates (Johnson & Goldstein, 2003). Individuals have been able to save more by automatically enrolling in retirement savings programs and encouraging responsible use of credit cards by setting lower default limits. Choice architecture also encourages sustainable behaviors such as recycling and energy conservation through default settings on appliances and providing feedback on energy consumption compared to neighbors (Allcott, 2011).

Previous Studies and Analysis

Research on food waste and behavioral interventions has highlighted several effective strategies. A study by Schmidt and Matthies (2018) found that educational campaigns, combined with practical tools like meal planning and shopping lists, can lead to a 15-20% reduction in household food waste. This study combines informational and behavioral strategies to achieve more substantial and sustained household food waste reductions. A meta-analysis by Stöckli, Niklaus, and Dorn (2018) reviewed the effectiveness of various nudges in reducing food waste. These included "stop signs" on buffet tables and public commitments to reducing food waste, which decreased food waste by up to 30% in households and food service environments. This analysis highlighted the versatility and effectiveness of nudges in different contexts, reinforcing the potential of behavioral interventions to address food waste.

Furthermore, a study by Wansink and van Ittersum (2013) explored the impact of plate size on food consumption and waste. The research found that smaller plates can reduce food intake by approximately 22%, subsequently reducing food waste. This finding supports the idea that simple changes in the dining environment can significantly affect consumer behavior and waste reduction.

Successful Applications of Choice Architecture

Stop Wasting Food — Copenhagen, Denmark

The “Stop Wasting Food” initiative, known in Danish as “Stop Spild Af Mad”, was founded by Selina Juul in 2008 and has become a significant force in reducing food waste in Denmark. This grassroots movement utilizes principles of choice architecture to influence consumer behavior and reduce food waste. In just five years, Denmark has managed to reduce its food wastage by a significant 25%, leading the world in food waste reduction (Cremer, 2018). “Stop Wasting Food” often partners with supermarkets to add labeling on products nearing their expiration dates. These labels, combined with substantial price reductions, serve as visual nudges that encourage consumers to purchase items that might otherwise be discarded and add economic incentives to reducing food waste. Reports indicate that such initiatives have helped reduce food waste in participating stores by up to 25% (Stop Wasting Food, 2020; Second Harvest, 2021). These methods have been so successful that Denmark has taken this idea further by opening Wefood, the nation’s first grocer to exclusively sell recently expired food with minor flaws or damaged packaging. The first Wefood was so successful that a second store opened within a few months.

Additionally, the initiative promotes reducing portion sizes for ready-made meals and fresh produce in supermarkets. By offering smaller portions, the initiative addresses the problem of over-purchasing, particularly in single-person households, which often leads to waste. This aspect of choice architecture aligns portion sizes more closely with consumer needs, reducing the likelihood of food spoilage.

The initiative’s impact extends beyond consumer behavior to influence national policies and corporate practices. For example, the Danish government has incorporated food waste reduction goals into its environmental policies, largely due to the “Stop Wasting Food” advocacy efforts. On the corporate front, major food retailers such as REMA 1000 and Coop have adopted many of the initiative’s recommendations, such as reducing the size of bread loaves to match consumption patterns better. (Wikipedia, 2020; Independent, 2020).

Technological solutions have also been part of the initiative’s strategy: Danish tech startup “Too Good To Go” developed a mobile app that connects consumers with businesses to rescue surplus food at the end of the day. This app allows restaurants, bakeries, and grocery stores to sell unsold but still fresh food at a discounted price, thus preventing it from being discarded. This approach has reduced food waste and provided consumers with affordable food options.

The “Stop Wasting Food” initiative exemplifies the effective use of choice architecture in reducing food waste. The initiative has successfully influenced consumer behavior and policy through strategic labeling, portion size adjustments, educational campaigns, advocacy, and technological innovations. This comprehensive approach demonstrates the power of combining various strategies to reduce food waste significantly and serves as a model for other countries aiming to address this critical issue.

Love Food Hate Waste — United Kingdom

“Love Food Hate Waste” (LFHW) is an initiative launched by the Waste and Resources Action Programme (WRAP) in the U.K. in 2007. Like “Stop Wasting Food”, LFHW has reduced food waste through the strategic use of choice architecture, altering consumer behavior by employing various nudges and educational tools to help individuals make more sustainable choices regarding food consumption and waste. Since 2007, household food waste has decreased by 1.1 million tonnes, preventing 2.3 million tonnes of total waste. The carbon savings of this reduction is estimated to be around 930,000 tonnes of CO₂ per year. In terms of household food waste, there has been a reduction of 3.75, or 270,000 tonnes per year, between 2010 and 2012, showing the impacts of this initiative in such a short timeframe. Since 2007, avoidable household food waste has been cut by 21% (Marsh).

Relevant behaviours Mostly or always	2009 (n=1200)	2019 (n=523)
Check what food is already in the house	66	67
Plan the meals to be cooked in the next few days	35	50
Buy food according to a set budget	46	47
Buy food based on what is on special (including two-for-one deals)	42	42
Buy items 'in bulk'	18	22
Check the 'use by' or 'best before' dates before purchasing food items	66	68
Consider portion sizes and only make as much as you need	46	48
Make extra for a future planned meal (e.g. lunch or dinner the next day)	28	35
Make extra just in case it is needed	20	22
Save leftovers in the fridge and consume them afterwards	52	60
Save leftovers in the fridge and throw them out later	10	12
Save leftovers in the freezer and consume them afterwards	36	39
Save leftovers in the freezer and throw them out later	8	9
Dispose of leftovers immediately after the meal	11	9

Fig 2. This table from the Love Food Hate Waste 2021-2022 tracking survey shows food planning, shopping, cooking and preparation, storage and disposal behavior participation (by percentage of people participating in the survey) in 2009 and 2019. Positive behaviors that have encouraged reductions in food waste have generally increased in frequency.

One of the primary strategies LFHW uses is disseminating practical tools and resources that encourage better food management. For instance, LFHW provides portion calculators to help consumers determine appropriate serving sizes, which reduces the likelihood of over-purchasing and subsequent waste. This tool is a classic example of a nudge, subtly guiding individuals to make more informed and sustainable choices without directly restricting their freedom (WRAP, 2021).

Educational campaigns are a significant component of LFHW’s strategy. The annual Food Waste Action Week, part of the initiative, focuses on raising awareness and promoting behavioral changes through various events, workshops, and media campaigns. The 2023

campaign, themed “Win. Don’t Bin”, provided tailored tips on making the most of purchased food, encouraging consumers to use leftovers and plan meals more effectively (Love Food Hate Waste, 2023). This effort leverages social norms by showcasing waste reduction as a standard and desirable practice, encouraging widespread adoption.

LFHW has partnered with supermarkets to simplify food labeling and promote better purchasing decisions. Labels now include storage instructions and reminders to use products before they expire. Supermarkets like Aldi, Lidl, and Tesco have incorporated LFHW advice into their packaging, making it easier for consumers to follow these practices. This partnership exemplifies how modifying the choice environment can significantly reduce food waste at the consumer level.

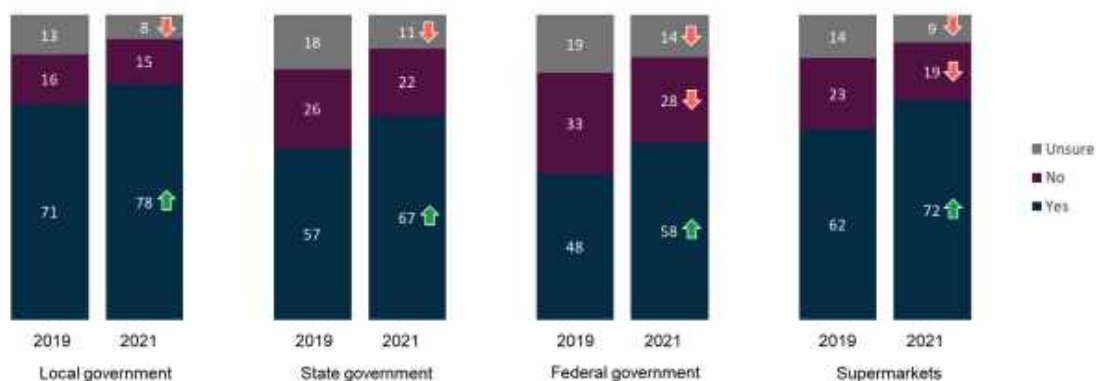


Fig 3. This bar graph from the Love Food Hate Waste 2021-2022 tracking survey shows peoples’ expectations of the role of agencies in assisting communities to reduce food waste. The percentages shown represent the number of people surveyed that believe the agency should be responsible for reducing food waste. Nearly every agency depicted has seen an increase in expectation to act on reducing food waste, while uncertainty and opposition has decreased.

The initiative’s success has also led to its adoption in other countries, including Australia, Canada, and New Zealand. These international campaigns adapt the LFHW model to local contexts, sharing global insights and strategies to reduce food waste. LFHW’s international reach emphasizes its approach’s effectiveness and its principles’ universal applicability.

Zero Waste - San Francisco, California

San Francisco has established itself as a leader in waste management, particularly through its ambitious zero-waste goals and innovative use of choice architecture. The city’s comprehensive approach to waste reduction includes mandatory composting and recycling laws, public education campaigns, and partnerships with various stakeholders.

In 2002, San Francisco set a goal to divert 75% of its waste from landfills by 2010 and achieve zero waste by 2020. Remarkably, the city exceeded its initial target, recovering over 80% of waste and significantly reducing landfill disposal (EPA, 2021). The foundation of this success

lies in the strategic application of choice architecture, which involves designing the environment to nudge individuals and businesses toward more sustainable behaviors.

One of the critical components of San Francisco’s strategy is its mandatory recycling and composting ordinance, enacted in 2009. This law requires all residents and businesses to separate recyclables, compostables, and trash into three distinct bins. The ordinance leverages the concept of defaults by making recycling and composting the standard practice, thereby reducing the effort required for individuals to participate. As a result, the city has seen substantial compliance and a marked increase in waste diversion rates (SF GSA, 2020).

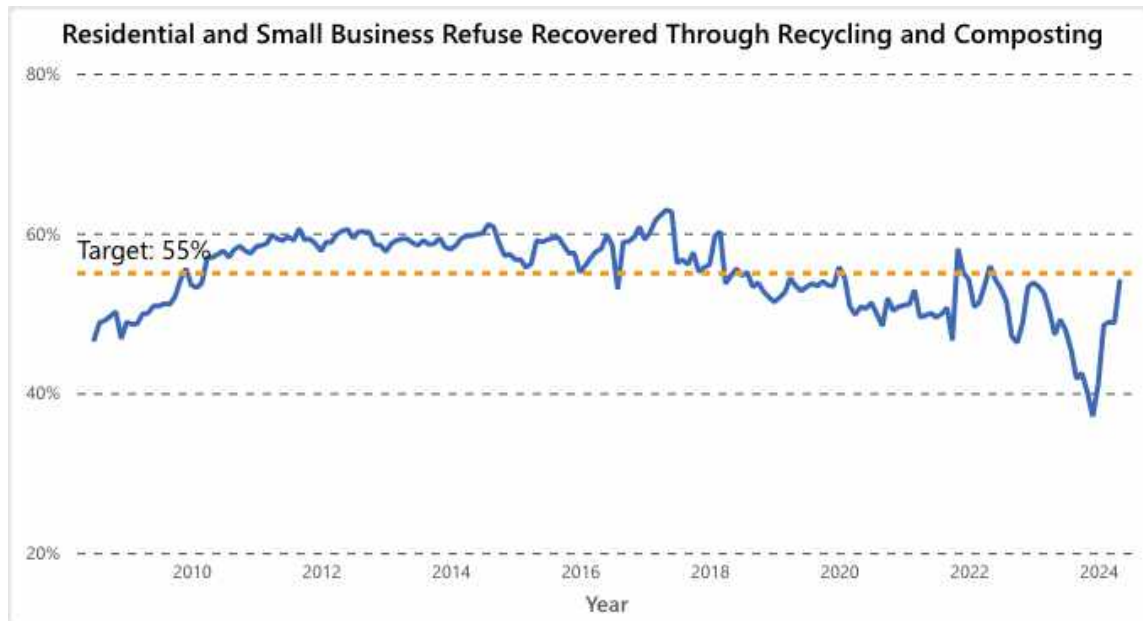


Fig 4. This line graph from sf.gov shows that recycling and composting (at least within residential and small businesses) have generally hovered at around 55-50%. While San Francisco may not have fully met its goal, this recycling/composting rate is still much higher than the national average (in 2017, the United States had a 35.2 recycling and composting rate).

San Francisco’s success is also attributed to its robust public education efforts. Programs like “Food to Flowers” educate young students about composting in their school cafeterias, fostering early adoption of sustainable practices. Additionally, the city’s comprehensive outreach includes multilingual support and community workshops, ensuring that all residents are informed about proper waste sorting and its benefits (SFE, 2021).

The city’s innovative programs extend to businesses as well. The Food Service Waste Reduction Ordinance, effective since 2007, prohibits the use of polystyrene foam to-go containers, mandating the use of compostable or recyclable alternatives. This ordinance reduces non-compostable waste and aligns with consumer preferences for environmentally friendly packaging, thus using social norms to encourage compliance (SF GSA, 2020).

Another notable initiative is San Francisco’s extensive composting program, which started in 1996 and has become the largest in the United States. The program collects

approximately 650 tons of organic waste daily from residents and businesses, converting it into high-quality compost for local farmers and vineyards. This effort exemplifies the circular economy approach, transforming waste into valuable resources, closing the loop, and minimizing environmental impact (Future of Food, 2021).

Moreover, the city's public-private partnership with Recology, the waste management company, has been crucial. Recology's innovative three-stream collection system and its role in processing waste into compost and recyclables have been central to the city's achievements. This collaboration ensures the infrastructure supports the behavioral nudges implemented through policy and education (ArchDaily, 2021).

San Francisco's approach to waste management illustrates the effective use of choice architecture in promoting sustainable practices. The city has significantly reduced its environmental footprint by making recycling and composting the default options, educating the public, and implementing supportive policies. These efforts demonstrate how strategic design and comprehensive planning can substantially improve waste management and sustainability.

Implications for Policy and Practice

Both government and organizational bodies can assist in reducing food waste through the means of choice architecture. The following sections will propose how these groups can utilize these methods.

Government Strategies

Governments can implement robust regulatory frameworks that make sustainable practices the default option, increasing social acceptance of the movement against food waste and making it easier to take action. For example, San Francisco's mandatory composting and recycling laws require residents and businesses to separate recyclables, compostables, and trash into distinct bins. This regulatory approach leverages the concept of defaults, making sustainable waste management practices more effortless and habitual for the public (S.F. Department of the Environment, 2021), increasing participation in combating this issue. Another effective policy is the introduction of waste reduction targets and incentives. Governments can set ambitious goals, such as Denmark's target to reduce food waste by 25% by 2025, supported by financial incentives for businesses and households that achieve significant waste reductions. These targets can be reinforced through public reporting and benchmarking, creating social norms around waste reduction.

Educational campaigns are also vital for informing the public about the importance of reducing food waste and how they can contribute. Governments can run nationwide campaigns similar to the U.K.'s "Love Food Hate Waste" initiative, which provides practical tools like portion calculators, meal planning guides, and storage tips. These campaigns can use framing to highlight the financial and environmental benefits of reducing food waste, thus influencing consumer behavior. Moreover, governments can integrate food waste education into school curriculums, fostering a culture of sustainability from a young age. Programs like San

Francisco's "Food to Flowers" educate students on composting and waste reduction, ensuring these practices become second nature, leaning into making sustainable practices a "default", and encouraging the prevention of food waste as a baseline behavior from a young age (SFE 2021).

Lastly, governments can partner with businesses and NGOs to implement comprehensive waste reduction programs. For instance, Denmark's collaboration with supermarkets to introduce clear labeling and price reductions for near-expiry products has been highly effective. Such partnerships can leverage the strengths of both sectors, combining regulatory oversight with innovative business practices to reduce food waste. Another example is the partnership between the City of New York and local nonprofits like City Harvest, which redirects surplus food from restaurants and grocery stores to food banks and shelters. This partnership reduces food waste and addresses food insecurity, demonstrating the multifaceted benefits of such collaborations.

Organizational Strategies

Retailers can play a crucial role in reducing food waste by adopting innovative supply chain practices. Implementing dynamic pricing strategies for near-expiry products, as seen in Denmark, can incentivize consumers to purchase items close to their use-by dates. Additionally, retailers can offer smaller portions of fresh produce and ready-made meals to match consumer needs more accurately, thereby reducing waste and providing economic benefits for actively reducing food waste (for both the consumer and the retailer).

Organizations can also optimize their supply chains by improving inventory management and forecasting. Advanced data analytics can help predict demand more accurately, reducing overproduction and waste. Collaboration with suppliers to implement "just-in-time" delivery systems can ensure that products arrive fresh and are consumed before they spoil (Kibert & Grosskopf, 2020).

Retailers can also redesign store layouts to promote sustainable purchasing behaviors. Placing perishable items like fruits and vegetables at the front of the store and eye level can encourage consumers to buy these items first. Additionally, clear and attractive labeling and reminders to check expiration dates can nudge consumers toward better purchasing decisions.

Organizations can reduce food waste by training employees on best practices for inventory management, food storage, and waste reduction. Engaging staff in sustainability initiatives and setting organizational goals for waste reduction can foster a culture of responsibility and innovation. For example, training restaurant staff to minimize food prep waste and optimize portion sizes can significantly reduce food waste (Gunders et al., 2017).

Organizations can engage consumers through loyalty programs that reward sustainable behavior. For instance, offering discounts or points for customers who purchase near-expiry products or bring their containers can promote waste reduction. Collecting consumer feedback on waste reduction initiatives can help organizations refine their strategies and address any barriers to sustainable behavior.

Conclusion

The findings from Denmark, the U.K., and San Francisco all provide significant insights into the effectiveness of choice architecture in reducing food waste. In Denmark, the “Stop Wasting Food” initiative has demonstrated that simple changes such as clear labeling and price reductions on near-expiry products can significantly reduce food waste, highlighting the power of economic incentives and visual nudges in influencing consumer behavior. In the U.K., the “Love Food Hate Waste” initiative has shown that providing consumers with practical tools and educational resources can effectively reduce household food waste, emphasizing the importance of consumer education and accessible resources (such as portion calculators and storage tips) in changing behavior. San Francisco’s comprehensive waste management success illustrates the effectiveness of regulatory frameworks and infrastructural support in promoting sustainable waste management practices. By making recycling and composting the default options, San Francisco has facilitated large-scale behavioral change, illuminating the role of policy and infrastructure in reducing waste.

Despite the promising findings, several limitations must be considered. The scope of these initiatives is primarily localized, raising questions about their generalizability to other regions with different cultural, economic, and infrastructural contexts. For example, the success of San Francisco’s waste management program is partly due to its specific regulatory environment and the strong public-private partnership with Recology, which may not be easily replicable elsewhere (Goldstein, 2019). However, more broad initiatives like those similar to “Love Food Hate Waste” have great potential to spread to other areas without much hassle.

Despite these concerns, the importance of continuing efforts to reduce food waste through innovative approaches cannot be overstated. Food waste contributes significantly to environmental degradation and economic inefficiency, making adopting effective strategies like choice architecture imperative. The initiatives in Denmark, the U.K., and San Francisco serve as valuable models, demonstrating that simple, well-designed interventions can substantially reduce food waste. By building on these successes and addressing the identified gaps, governments, organizations, and individuals can make significant strides towards a more sustainable future.

While the findings from these initiatives are promising, several areas require further investigation. Future research should explore these interventions’ long-term sustainability and adaptability to different cultural and economic contexts. Studies focusing on integrating choice architecture with technological innovations, such as mobile apps and digital nudges, could provide new insights into enhancing the effectiveness of waste reduction strategies. Additionally, examining the interplay between individual behaviors and systemic factors, such as food policies and supply chain logistics, will be crucial in developing comprehensive solutions to food waste (Kibert & Grosskopf, 2020; Gunders et al., 2017)

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Payday Lending CAN Be Beneficial to Consumers—with the Correct Policies

By Whitney Baron

Abstract

This paper evaluates policies to curb the exploitation of payday borrowers. Practices of the payday lending industry have long been controversial. While some consumers, policymakers, and lenders themselves argue that it is one of the more stable credit options, others feel that these loans often contain exploitative terms (such as triple-digit interest rates and unrealistically short-loan terms), making it an unreliable option for low-income consumers. In order to tackle the predatory characteristics of payday lending, state legislators have implemented varying regulations. Some states have banned payday lending completely, while others have experimented with a variety of policies such as interest rate caps and requiring lenders to log transactions in databases. Many of these restrictions have been effective in that consumers have reported satisfaction, illegal lending practices have become easier to track and put to an end, and the predatory loans have decreased. Through an analysis of payday lending data and existing laws, this paper breaks down the payday lending laws of four demographically diverse states: Missouri, South Dakota, Virginia, and New York. Additionally, this paper outlines the optimal payday lending policy, which is a medley of the four states examined. The paper proposes that the optimal policy consists of a loan cap of \$500, an APR cap of 36%, a policy of no additional fees, a maximum of 2 rollovers, minimum and maximum loan terms of 3 and 6 pay periods respectively, and enforcement of a statewide loan database.

I. Introduction

Over 12 million Americans borrow payday loans every year (Sultana, 2016), with an estimated 80% of them already in some form of debt (Bareham, 2023). These two statistics are not a coincidence. When money becomes too tight for low-income consumers, a common option is to take out a payday loan. Low levels of financial literacy and high levels of desperation make low-income consumers easy targets for unscrupulous lenders. The terms of payday loans are often predatory, with interest rates as high as 664% (Leonhardt, 2021), junk fees, and the use of abstruse terms in loan agreements. These loopholes and several others are what have allowed the payday lending industry to thrive.

This paper seeks to evaluate existing payday lending regulations and uncover what policies should be implemented to further curb the exploitation of payday borrowers. My results suggest a maximum loan amount, an APR cap, no additional fees, a rollover limit, minimum and maximum loan terms, and enforcement of a loan-logging database.

i) What is Payday Lending and What is its Reputation?

Payday lending is a short-term practice in which consumers, in need of money before their next payday, borrow that money from a lender. The borrower then repays that money to the lender when their next paycheck comes. Payday loans are meant to be small amounts of money

(no more than \$1,000), making it realistic for borrowers to pay back the money and to ensure that the loaned money is only used on necessities.

Payday loans enable consumers to acquire money immediately, often for necessities that they cannot afford before their next paycheck arrives. Because borrowers acquire the money so quickly, interest rates tend to be high. While the typical interest rate of a personal loan is 12.35% (Ceizyk, 2024), the average annual percentage rate (APR) of a payday loan is 391% (Jackson, 2024). This is nearly four times the principal amount, which is very difficult for most borrowers to repay. This is what makes payday lending appear so vicious: the combination of short loan terms and extremely high interest rates is not consumer-friendly.

While New York has banned the practice completely, Missouri allows lenders to charge interest rates as high as 443%. Other jurisdictions have struck a middle ground: Virginia and South Dakota have established APR caps, rollover restrictions, and more. Consumers from states with such policies—Virginia and South Dakota—have reported higher levels of satisfaction with their payday lending laws in comparison with Missouri and New York. This is why the majority of the terms in the policy proposal stem from the existing laws of these two states.

ii) Motivations of Lenders

For lenders, the idea of giving out loans in small amounts while also being able to charge high interest rates is appealing. This process is low-risk: they give a little bit and, through unregulated interest rates and fees, are often able to gain a lot more. In states with minimal regulations, lenders are free to charge giant interest rates—the maximum APR in Idaho is 652% (US State Loans, 2024)—while also setting very small loan term lengths. This allows lenders to acquire large amounts of money in little amounts of time, even if borrowers are swimming in debt. When states implement payday lending regulations, such as APR caps, lenders have left those states. When South Dakota imposed an APR cap of 36% (such rates formerly reached as high as 574%), over 100 payday lenders reportedly did not renew their licenses the following year and instead left the state (US State Loans, 2017). These lenders were likely angry that they could no longer impose such high interest rates and sought to lend in a state without a cap.

When states have imposed APR caps, lenders have also tried to work their way around them by forcing massive fees on their borrowers. In 2020, Virginia passed the Fairness in Lending Act which eliminated lenders' ability to enact balloon payments. Many lenders reportedly asked for an exemption from that law, which was not granted (Virginia Poverty Law Center, 2023).

It should be noted that not all payday lenders are predatory. Many responsible lenders make sure to review loan agreements with their borrowers and sometimes even offer resources to help consumers avoid debt traps. In fact, a survey by the George Washington University School of Business found that 76% of borrowers were satisfied with their experiences with payday lending companies (Summers, 2013). However, because the payday lending industry caters to a largely low-income, financially illiterate community, it is often easy for lenders to take advantage of their distressed borrowers and make them believe that they are being treated well.

iii) Loan Example

Payday loans look different depending on the state. Say a Missourian takes out a payday loan of \$500 to cover a medical bill. The loan term is 2 weeks (the equivalent of 1 typical pay period), and the lender charges an additional fee of \$80 payable when the loan matures with 0% interest. The true cost of the loan takes into account the stated interest rate and all other costs of credit. While there is no stated interest rate, there is a fee of \$80, which functions as interest. From an economic theory perspective, an interest rate is the cost of borrowing money, so the interest rate should cover these fees. So, what is the interest rate implied by the presence of this fee? The APR is calculated to be just over 416%. While an \$80 fee for a \$500 loan doesn't seem like an extraordinary cost, it actually represents 16% interest over 2 weeks ($80/500$). This is already a relatively high interest rate for any given loan over the course of a year, but this loan is only for 2 weeks. If this interest rate is annualized, the APR is $16\% \times 26 \text{ weeks} = 416\%$. This is an astronomical number. An estimated 75% of payday borrowers are considered to be low-income (Peterson, 2013), meaning that the majority of payday borrowers do not have access to such large amounts of money to repay their lenders. This is what makes payday lending so harmful to vulnerable consumers.

To provide context for the staggering level of interest on payday loans, compare the previously calculated APR to the average 30-year fixed mortgage in the United States. Bankrate, a financial service and data compiler, collected information regarding interest rates from hundreds of lenders across the country regarding interest rates. They concluded that the national average, as of August 2024, is 6.86% (Ostrowski, 2024). As is clear, a realistic payday loan could fetch an interest rate that is over 60 times higher than a typical mortgage interest rate.

iv) Ideal Policy Overview

The Payday Lending industry is capable of being consumer-friendly, with better policies in place. After analyzing the diverse policies of Missouri, South Dakota, Virginia, and New York, I have developed the ideal policy, one that combines the strengths of the four jurisdictions into one promising regulation. The policy includes **i)** a maximum loan amount of \$500 **ii)** an APR cap of 36% **iii)** a no additional fees policy **iv)** a maximum of two rollovers allowed **v)** a minimum loan term of 3 pay periods **vi)** a maximum loan term of 6 pay periods **vii)** a requirement for all lenders to log transactions in a statewide database.

v) Paper Roadmap

The rest of the paper is organized as follows. **Section II** includes an in-depth analysis of the payday lending laws of each of the four researched states: Missouri, South Dakota, Virginia, and New York. The section is divided up by state, giving each its own subsection. **Section III** is the proposal of the ideal payday lending policy, which was determined by looking at the most successful regulations of each of the four states. This section is divided up by each piece of the regulation, including **i)** loan amount cap **ii)** APR cap **iii)** fees **iv)** rollovers **v)** minimum loan

terms **vi**) maximum loan terms, and **iv**) statewide database. **Section IV** addresses the paper's limitations and implications for future studies. **Section V** concludes.

II. Comparing and Contrasting the Regulations of 4 States

The payday lending regulations of Missouri, South Dakota, Virginia, and New York were examined, each lying on a different end of the stringency spectrum. The demographics of each state are notably different. While Missouri and South Dakota tend to lean more politically conservative, Virginia and New York are more liberal. South Dakota has a population of under 1 million people, Missouri and Virginia each have around 6 and 8 million respectively, and New York has over 19 million people. Lastly, the geographic locations of the four states differ. South Dakota is located in north-central United States, Missouri is located in the midwest, Virginia is located in the southeast region, and New York is up in the northeast. These differing aspects factor into the regulations of each state and the impacts that they have had on consumers living there. The following information was found from UStatesLoans LLC, a payday lending analysis and education resource. With a database of dozens of the most popular payday lending companies, UStatesLoans seeks to provide sufficient, reliable information to consumers on the payday lending process and industry.

i) Missouri

On the most laissez-faire end of the spectrum is Missouri, a state that is nationally known for having some of the most lender-friendly payday lending laws. While the state has an APR cap, it is set at 443%. This means that the borrower must pay an annual rate that is over quadruple the principal amount, despite the fact that they're already struggling to make ends meet. Additionally, per-loan interest fees are capped at 75%. If a loan is \$500 (the maximum amount), the borrower could have to pay \$375 in interest alone. Loan terms in Missouri are also set at a minimum of 14 days. This is typically 1 pay period. Greedy lenders often take advantage of their capability to set a loan term at such a small amount of time, often causing major stress on borrowers to repay such huge chunks of their paychecks in so little time. While Missouri does make clear that only simple fees can be charged, the massive interest rates alone push borrowers into debt. Missouri also allows for borrowers to rollover 6 times. Rollovers occur when a borrower doesn't have sufficient funds to repay a loan, so they 'rollover' and are given more time to pay it back. This may sound appealing to a desperate borrower, but rolling over causes interest to compound. This only pushes the borrower into a deeper cycle of debt. Too many rollovers turn payday loans into long-term loans, which they are not supposed to be. Many Missourians have reported dissatisfaction with their state's calm regulations on payday lending by claiming to feel unclear about loan terms, manipulated by lenders, confused about interest, forced into rolling over, and extreme stress due to loan debt.

ii) South Dakota

South Dakota falls moderate in terms of payday lending strictness. The state has no stated minimum or maximum loan term limits; this can be dangerous by forcing borrowers into incredibly small loan terms that render them unable to repay the loan when it matures. South Dakota also uses vague terms in its legislation by stating that lenders should be licensed by the Division of Banking, implying that it may not be a requirement. The state does allow lenders to charge fees, but they cannot exceed 1.39% of the principal amount per pay period. South Dakota allows a maximum of 4 rollovers, which is two fewer than Missouri's stated 6. While this amount is more modest, it is still enough to allow interest rates to compound to scary levels for consumers. South Dakota did make major updates to its payday lending legislation in 2017. Most notably, the 574% APR cap was slashed to 36%. The impacts of the cap have been remarkable. A reported 121 angry lenders left the state since, presumably so they could find a new place to charge their giant interest rates. The closing of their payday storefronts has opened up spaces for amazing purposes including nonprofit organizations, new businesses (which have opened up more jobs), and other financial services including churches and credit unions. South Dakotans are reported to be thrilled with these new opportunities, feeling that these storefronts have been redeveloped for the better.

iii) Virginia

Virginia has some of the strictest payday lending laws (aside from an outright ban). Like South Dakota, Virginia has a maximum APR of 36% and 20% per loan. The state has also set a minimum loan term of 2 pay periods, ensuring that borrowers are not punished if they cannot repay a loan in full after just 1 pay period (the majority of borrowers can't, with interest rates that are still decently high). Virginia prohibits rollovers as well; this is significant compared to South Dakota and Missouri, which both allow multiple rollovers. Lenders in Virginia are also required to have a license and enter all of their loans into a statewide database. The database ensures that no terms are breached, a measure that the more lightly regulated states have not taken. In 2020, Virginia updated its lending policies to mend identified issues. This legislation, known as the Fairness in Lending Act, made the minimum loan length longer: 4 months. For employees paid bi-weekly, this is equivalent to 8 pay periods. This is a high minimum but decreases borrower's chances of being unable to repay the loans and therefore far less likely to rollover. Additionally, to close the junk fee loophole, all payday lending fees are capped at \$25 or 8% of the principal in this state. These added terms in conjunction with the existing ones have pleased Virginians as they have reported feeling that their privacy is respected and that short-term loans are accessible. Lenders who refused to accept the new terms left the state, which similarly occurred in South Dakota.

iv) New York

On the most stringent end comes New York, a state that has banned payday lending completely. The ban occurred in 2013, and the state cited several reasons for doing so. Three of

the most notable reasons were: a) borrowers easily get trapped into debt when loan terms are so short b) APRs are monstrously high and c) fees for borrowers unable to repay the huge sums of money are very high. Each of these reasons is an issue that Missouri, South Dakota, and Virginia have sought to fix to varying degrees, but New York believes that there are better forms of obtaining credit; these include working with community development credit unions, non-profit financial cooperatives, or social service agencies. The state of New York believes that these options are far more dedicated than payday lenders to help consumers handle their expenses in a non-exploitative way. The effects of this ban are significant in deciding what policy would be ideal for payday borrowers. It has been mainly found that the ban has pushed desperate consumers to shift toward other high-interest credit options—such as pawnshops—which are capable of being just as predatory. Additionally, New Yorkers and citizens of other states with payday lending bans have been found to be turning to lenders in other states, borrowing online, or interacting with lenders who are willing to break the laws (Bhutta, Goldin, and Homonoff, 2016). It can be concluded that while the ban may reduce payday lending itself, it does not solve the overarching problem of exploitative lending.

III. Policy Proposal

The payday lending policies of Missouri, South Dakota, Virginia, and New York vary in both their strictness and the impacts that they've had on borrowers. The policy I've developed stems from these four states, combining the best of each into one ideal policy. The optimal payday lending regulation would rely on having complete information of borrowers that we would never have, and would thus be essentially impossible to create. There are tradeoffs and externalities to each piece of law, including this one, which will be included.

i) Loan Amount Cap of \$500

The first piece of the policy will include a maximum loan amount of \$500. This amount ensures that borrowers can get money for their necessities but not in such huge sums of money that feel impossible to pay off. An amount this small immediately limits the chances of default or rollover. While some borrowers may need more than \$500 to cover their expenses, payday loans are meant to be short-term, meaning that borrowers in need of larger amounts of money should not look to payday loans. This loan cap is likely to turn many consumers away and toward other types of loans, but this cap will ensure that payday loans remain short-term and decrease the debt cycles that stem from payday lending. While some of these borrowers may be credit-rationed because they cannot get other types of loans, more harm than good would likely come about with a higher loan cap. Studies such as one from the FDIC have shown that the risk of bankruptcy is statistically significant when people take on payday loans compared to when they don't (Teuscher, 2009). If payday loans will have this increased-bankruptcy effect, lowering the amount of money that these borrowers can take out can mitigate this effect. Several states, including South Dakota and even Missouri, have reached a common ground of \$500 being a realistic loan amount cap.

ii) APR Cap of 36%

An APR cap of 36% is to be imposed. This is the number used in South Dakota and Virginia, which report to have saved \$81 million (Calhoun and Rios, 2020) and \$100 million (Martinez, 2020) in interest respectively since imposing this cap. A 36% APR establishes a “happy medium” between lender and borrower. On one hand, lenders can still acquire significant profit from this interest rate (most other types of loans have single-digit interest rates). On the other, this amount isn’t completely unrealistic for a borrower to repay. With a maximum loan amount of \$500, the highest amount of interest a borrower would have to pay on a single loan is $(0.36/26) \times 500 = \$6.92$ for a 2-week loan. This is a much more manageable amount to pay. And even if the borrower experiences a negative income shock, the unpaid balance will accrue interest at a much calmer rate. In 2020, a Nebraskan led an initiative to lower Nebraska’s payday lending APR to 36% (the existing law allowed lenders to charge over 400% APR); the vote passed with an 83% approval rate. Since then, citizens of all different backgrounds have supported the 36% cap, such as housing groups, military groups, and civil rights groups. Additionally, more and more states have imposed a 36% APR cap, including Illinois and Michigan (Center for Responsible Lending, 2023). Enforcing restrictions on interest rates may influence competition between lenders for the better by pushing them to better other aspects of their loan offers and appeal to borrowers. These include loan maturity, flexibility, and clarity.

iii) No Additional Fees

The ideal payday lending regulation would prevent additional fees from being imposed. The interest rate of 36% already enables lenders to make a significant profit per loan. Adding more fees on top of this puts borrowers in a stressful position by minimizing their abilities to repay the loans. Fees increase borrowers’ chances of default or rolling over, making the payday lending industry appear unappealing and exploitative. A guideline of no additional fees will ensure that lenders do not cut around the APR cap by imposing “junk fees” for more profit. Moreover, this piece of law will diminish the payday lending industry’s poor image of being risky. Knowing that there will be no surprise fees, borrowers will trust the practice more as payday lending will be more predictable. This attracts individuals who are trying to financially plan and budget.

iv) Maximum of 2 Rollovers

A maximum of 2 rollovers will be allowed. While rolling over can push borrowers into continued debt, it can sometimes help them cover the final few payments they need to cover and prevent default. 2 rollovers were decided after looking at rollover prevalence in Virginia, South Dakota, and Missouri. Virginia does not allow any rollovers. While this policy intends to prevent further debt, it doesn’t give borrowers any chances to make late repayments. South Dakota and Missouri allow 4 and 6 rollovers respectively, each appearing to be too many as interest can quickly compound with so many rollovers. 2 rollovers will allow for borrowers to have extra time if they need it. If a borrower experiences multiple negative income shocks, rolling over can

aid them by giving them extra time to sort out their payments. More than 2 rollovers would mean that borrowers will greatly struggle to repay their loans with compound interest, which subsequently means that lenders may never receive their full profits. Fewer than 2 rollovers, however, would make default much more prevalent, leading to diminished credit scores and overall decreased access to credit. The 2 allowed rollovers are a compromise between the borrower and the lender. A study at Vanderbilt University examined consumer reactions when allowed 1 or 2 rollovers vs 3 or more rollovers. The study concluded that, when consumers are allowed 3 or more rollovers, they are more likely to use payday lending and pawnshops as credit options. However, when consumers were allowed only 1 or 2 rollovers, they were found to gravitate more toward payday lending and away from pawnshops (Carter, 2012). This shows that fewer rollovers push consumers to rely solely on payday lending and make them feel less obligated to supplement pawnshops as credit options.

v) Minimum Loan Term of 3 Pay Periods

The ideal policy will have a minimum loan term of 3 pay periods. This means that borrowers will have more time to repay their loans, decreasing their financial stress. The typical pay period for a payday loan is 2 weeks (or 1 pay period). Research has found that this shockingly short amount of time is exactly what pushes consumers into debt traps (Montezemolo, 2013). 3 pay periods, which is on the longer side, will help curb this issue. It will also make rolling over far less likely, which is why a maximum of 2 rollovers are allowed. Fewer rollovers also mean fewer defaults, meaning that lenders can feel more confident they will get their money back. Longer loan terms also make payday lending more accessible to low-income borrowers who need more time to repay loans. 3 pay periods, however, still keep the loan short-term by definition.

vi) Maximum Loan Term of 6 Pay Periods

To ensure that the loans stay short-term, a maximum loan term of 6 pay periods will be imposed. Maximum loan terms are unclear in Virginia and South Dakota, so this piece of the policy will set in stone that there is a maximum amount of time that these loans can last. 6 pay periods will limit the amount of time a borrower is indebted while simultaneously limiting the amount of time a lender awaits their profit. A loan term cap limits interest from compounding to massive amounts as well as establishing transparency between borrower and lender. While some borrowers may still be stressed about repaying their loans in that period of time, longer loan terms can increase costs for lenders and cut majorly into their profits. A study at Vanderbilt Law School has even proven that extended loan terms do not improve the repayment behavior of consumers (Luce, 2023). To help distressed borrowers, the 2 rollovers previously implemented can help diminish the chances of default.

vii) Statewide Database

Lastly, lenders will be required to track all transactions in a statewide database to ensure that each loan properly follows each of the above pieces of the policy. This law only exists in Virginia out of the four examined states, but has yielded positive feedback from citizens who report feelings of transparency and financial safety with this law. A database ensures that loan terms are lawful and makes it easy to track the loan history of lenders. While maintaining a database may be costly, its positive impacts are promising to outweigh these extra costs. A legislative audit conducted in 2018 found that nearly 33% of payday lenders had been violating the state's payday lending regulations (Snyder, 2020). A statewide database would ensure such breaches of the law do not reoccur.

IV. Limitations and Future Implications

My research and proposal do have limitations. One of which is a consideration of only a handful of states (Missouri, South Dakota, Virginia, New York, and light research on Texas and Idaho). While I believe that these states gave me a broad view of the varying payday lending laws in the United States, I was not exposed to all existing laws that could have played a role in my proposed policy. Another limitation is brought up by the Lucas Critique, which states that econometric models of past data are insufficient and unreliable in evaluating macroeconomic policies. According to this theory, my proposed policy cannot be deemed “ideal” because it relies on evidence only from the past. Lastly, my proposal relies solely on theoretical data and lacks experimental data. This means that, while I have conducted extensive research on payday lending regulations, I have not actually implemented my ideal policy and evaluated its impacts or success.

There is certainly a lot left to research regarding this topic. It would be fascinating to assess the association between the implementation of these economic policies and the overall contentment of consumers. Economic growth has proven to be associated with general well-being and happiness (Yok-Yong Lee and Kim-Leng Goh, 2023). If my proposed policy or another with similar intentions (to improve consumer experiences with payday lending) was implemented, it would be intriguing to understand the overall happiness levels of consumers—perhaps by giving ratings of satisfaction on a scale of 1-10.

V. Conclusion

The payday lending industry, unfortunately, has a reputation for being risky, exploitative, and dangerous due to its unregulated terms and sometimes mal-intentioned lenders. Interest rates are too high, loan lengths are too short, and absence of necessary laws disables transparency between lender and borrower. This paper sought to investigate existing payday lending laws and develop the optimal payday lending policy with a focus on consumer well-being. After evaluation of academic journals, existing laws, and consumer satisfaction data, it was found that each examined state—Missouri, South Dakota, Virginia, and New York—has radically different views on which legislation works best. While some states are more lender-friendly with

triple-digit APR caps, other states have banned payday lending altogether in order to protect consumers. The ideal policy strikes a middle-ground between lender and consumer satisfaction. This includes a maximum loan amount of \$500, an APR cap of 36%, no additional fees, a rollover limit of 2, minimum and maximum loan terms of 3 and 6 pay periods respectively, and requiring lenders to track and report loan dealings into a database. These laws have the potential to improve the reputation of payday lending and enhance the social welfare of American borrowers. For too long, needy consumers have been trapped in debt cycles they cannot get out of through this lending practice. Take Arthur, a man who took out a payday loan for \$200. He continuously came up short on his repayments, and rolled over so many times that he'd accrued over \$5,000 of interest. If a rollover restriction or interest rate cap had been imposed, this wouldn't have been able to occur. Payday lending is capable of being a useful credit option for desperate consumers. Especially in areas where banks don't operate, payday lending is a primary form of credit for consumers. These individuals cannot continue taking out loans with such deceitful terms. With the correct laws, however, payday lending has the potential to be just what low-income borrowers need.

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Exploring the Therapeutic Potential of Lucid Dreaming: A Literature Review

By Victoria Shao

Abstract

Through the ability to consciously control dream content, Lucid Dreaming Therapy (LDT) presents a unique non-invasive approach to various psychological and physiological conditions. This literature review synthesizes findings from sources including books, theoretical reviews, opinion articles, and research papers, highlighting recent studies from reputable journals such as *Dreaming* and *Frontiers in Psychology*. The review explores effective lucid dreaming (LD) induction techniques like Mnemonic Induction of Lucid Dreams (MILD) and Reality Testing (RT), as well as both commonly used and developing LD detection methods. LDT has shown potential benefits in nightmare reduction, PTSD symptom alleviation, motor skill practice, and personal growth, among other areas. However, there are also significant concerns regarding possible side effects and whether LDT can be dangerous for certain groups of patients. By evaluating established techniques, examining the current effectiveness of LDT, and identifying potential areas for future research, this review contributes to a deeper understanding of LDT's therapeutic potential, ultimately highlighting a need for further rigorous investigation.

Keywords Lucid dreaming, Lucid Dreaming Therapy, Lucid Dream Induction, Nightmare Treatment, REM Sleep, Creativity, Mindfulness, Personal Growth, Motor Skills, Therapeutic Applications

Methodology

This paper references a total of 25 literary sources, including one book section, one theoretical review, one dictionary entry, two opinion articles, and 20 research papers. The literature reviewed was primarily gathered through Google Scholar, JSTOR, PubMed, and DOAJ searches. Keywords used in these searches included, but were not limited to, "lucid dreaming," "lucid dream therapy," "lucid dream induction techniques," "lucid dreaming and creativity," "clinical applications of lucid dreaming," and "lucid dreaming as nightmare treatment." A significant portion of the literature was sourced from the journals *Dreaming*, *Frontiers in Psychology*, and the *International Journal of Dream Research*, chosen for their reputable status and relevant research. With the exception of literature providing definitions or historical context, sources were restricted to being published in the past 20 years. To provide for a comprehensive and unbiased review, literature selection was conducted objectively and incorporated research with varying conclusions.

Introduction

Lucid dreaming (LD) was first defined by Van Eeden as a dreaming state in which "...the reintegration of the psychic functions is so complete that the sleeper remembers day-life and [their] own condition, reaches a state of perfect awareness, and is able to direct [their] attention,

and to attempt different acts of free volition” (142). Although various accounts of lucid dreaming preceded Van Eeden’s paper, he was the first to name and clearly define this phenomenon. The definition arose from an examination of his personal dream experiences, which he meticulously recounted in a dream journal. Over approximately 15 years, Van Eeden documented 352 lucid dreams and considered them the most intriguing of the seven dream types he identified in his study (142).

Lucid dreaming transcends the barrier between waking and dreaming states, capturing the interest of both researchers and popular media. It was notably depicted in the 2010 science fiction movie "Inception" and has inspired forums dedicated to exploring and discussing it (e.g., the subreddit r/LucidDreaming has over 550,000 members). LD is a REM sleep phenomenon that provides insight into consciousness and dreaming states, as lucid dreamers can often change their dreams to achieve specific purposes (Schädlich and Erlacher 134). In a survey of 301 lucid dreamers, 81.4% recalled using lucid dreaming for fun, 63.8% for changing nightmares, 29.9% for solving problems, 27.6% for applications of creativity, and 21.3% for practicing skills (Schädlich and Erlacher 136). These varied applications suggest that lucid dreaming can positively impact one's life and potentially be used as a powerful therapeutic tool.

Lucid Dreaming Therapy (LDT) teaches clients how to achieve lucidity within dreams and utilize this skill to control their dream content (Soffer-Dudek 2). It has emerged as a possible intervention for disorders such as depression, frequent nightmares, and PTSD, and as a method to improve mindfulness, problem-solving skills, and overall well-being. Due to its non-invasive nature and reliance on natural dream phenomena, LDT holds significant potential as a unique form of treatment. However, it is essential to analyze both the potential benefits and possible side effects of LDT. Many previous literature reviews on LD and its therapeutic benefits fail to properly address these risks. Therefore, in addition to illustrating LDT’s potential as an effective treatment, this paper also analyzes possible negative side effects of LD and proposes measures to overcome existing research limitations.

Induction Techniques

For LDT to be effective, reliable induction techniques must be employed. Widely adopted methods include Mnemonic Induction of Lucid Dreams (MILD), Senses Initiated Lucid Dreams (SSILD), Reality Testing (RT), and Wake Back to Bed (WBTB).

MILD involves creating the intention to become lucid in a dream through intense imagination and by repeating the phrase, “The next time I'm dreaming, I will remember that I'm dreaming” (Adventure-Heart 2). WBTB builds on this technique by instructing individuals to set an alarm a few hours before their intended wake-up time, and then focus on falling back asleep with the intention of having a lucid dream (Taitz, “Clinical” 168; Adventure-Heart 2). According to Adventure-Heart, SSILD is similar in that it requires waking up approximately five hours after falling asleep but involves cycling between focusing on the senses of sight, hearing, and touch, rather than repeating a phrase. On the other hand, RT entails habitually analyzing one’s surroundings for signs of dreaming throughout the day to increase awareness of reality and

induce lucidity during sleep. Less commonly researched techniques include employing external stimulation or using supplements to induce LD (Adventure-Heart 2-3).

Tailored programs for different therapeutic purposes could also enhance induction effectiveness. For example, Sackwild and Stumbry implemented a 12-step program in their study on using LD to reduce depression. This program involved working with a lucid dream coach, documenting depressive thought patterns, and practicing meditation, among other components (Sackwild and Stumbry 316-317). Future research should aim to investigate how such targeted programs can influence the effectiveness of LD induction.

Furthermore, Adventure-Heart conducted the International Lucid Dream Induction Study (ILDIS) to compare the viability of various LD induction techniques. From daily logbook surveys of 355 volunteers over two weeks, Adventure-Heart concluded that lucid dreaming rates were generally higher during the second week (6). This finding suggests that the full potential of LDT may remain unrealized without prolonged use of induction techniques, an important consideration for future studies.

Induction techniques are crucial for carrying out successful therapy and conducting reliable studies. If LD is not consistently induced, it becomes challenging to determine whether discrepancies in results are due to the lucid dreams themselves or the induction processes. Therefore, the development of LDT would benefit from further research into various induction methods—both existing and emerging—as well as the possibility of using tailored programs.

Detection and Tracking Techniques

Like induction techniques, reliable methods for detecting and tracking LD are essential for effective research. They are crucial for confirming the presence of lucidity in studies and monitoring therapy clients during treatment.

One of the earliest methods used for LD detection involved eye movement signals. LaBerge et al. performed a pivotal study in 1986 using an electrooculogram (EOG) to detect pre-agreed eye movements made by lucid dreamers, thus verifying the existence of LD and advancing its scientific study.

On the other hand, electroencephalograms (EEGs) have offered more in-depth knowledge beyond the mere detection of LD, revealing significant information about the brain's behavior during lucidity. LaBerge et al. examined physiological factors underlying dream lucidity by analyzing EEG activity during signal-verified lucid dreams. Their findings showed that mean values for lucid epochs during these lucid REM periods were significantly higher than those of non-lucid REM periods, indicating that physiological activation is necessary for reflective consciousness during dreaming (LaBerge et al. 253-255). More specifically, the brain appears to enter a hybrid state between REM sleep and wakefulness during LD, characterized by increased activity in areas associated with conscious perception, such as the frontal lobe (Voss et al.). Although these findings suggest that EEGs can assist in detecting lucidity while dreaming, discrepancies in specific data across different studies often arise. This may be due to individual differences among dreamers and variability between lucid dreams. Consequently, while EEGs

remain valuable research tools that offer significant insights, their potential to consistently and accurately detect LD is currently limited.

Neuroimaging also provides valuable data regarding the brain state during LD that can be used to help develop methods of detection and tracking. Dresler et al. used functional Magnetic Resonance Imaging (fMRI) to show that many brain areas associated with cognitive capabilities during wakefulness have increased activity during LD compared to normal REM sleep. Participants communicated lucidity through eye and hand signals while sleeping in an MRI scanner, revealing increased brain activity in the prefrontal cortex and precuneus, corroborating Voss et al.'s EEG findings.

However, LD detection is most commonly performed through self-reporting methods like surveying and journaling. Many studies, both recent and older, utilize self-reporting as a detection technique for LD (Adventure-Heart; Erlacher et al.; Harb et al.; Holzinger et al., “Studies”; Konkoly and Burke; Sackwild and Stumbrys; Schädlich and Erlacher; Schadow et al.; Stocks et al.; Stumbrys and Daniels; Stumbrys et al.; Taitz, “Learning”; Van Eeden). While self-reports can offer some insights that other methods currently cannot provide, such as detailed dream content, they are subject to memory errors and unintentional bias, making them imperfect.

The development of detection and tracking techniques is tied to the potential of LDT. For LDT to emerge as a widespread therapy, more reliable and detailed tracking techniques are necessary, just as with induction methods.

Potential Benefits and Applications of Lucid Dreaming Therapy

LDT involves the conscious manipulation of dreams to achieve therapeutic outcomes. LD is associated with a variety of psychological and physiological health benefits. However, determining the clinical utility of LDT to treat various conditions and improve quality of life requires rigorous investigation (Taitz, “Clinical” 179).

Nightmare Reduction

LDT has shown promise in reducing nightmares, which is one of the most direct benefits one might consider when discussing the advantages of controlling dream content. Nightmares are disturbing dreams that occur during REM sleep, often causing the dreamer to wake up feeling emotions like fear and sadness (APA Dictionary of Psychology, 2023). Spoormaker and van den Bout conducted an early pivotal study examining this area of potential. Participants with frequent nightmares were divided into three groups: those attending group LDT sessions, those in individual LDT sessions, and a waiting list control group. The results indicated that both LDT groups experienced a significant reduction in nightmares, while the control group did not. However, the primary therapeutic mechanism was unclear due to inconsistent induction techniques, with some participants experiencing fewer nightmares without achieving lucidity. Additionally, those in individual sessions saw greater improvement, suggesting the positive influence of personal or professional attention, and the study suffered from a small sample size and high dropout rate. But despite these shortcomings, the results of Spoormaker and van den

Bout's study were influential, as they suggested a correlation between LD and reduced nightmare frequency. This brought to attention the potential of LDT as a technique for nightmare reduction, inspiring a number of future studies that further investigated the correlation.

More recently, in 2015, Holzinger et al. carried out a study involving a larger group of subjects that assessed LDT's effectiveness as an alternative therapy. Participants were randomly sorted into two groups: one that underwent Gestalt therapy, a form of therapy involving the visualization of a changed dream plot and roleplays of these scenarios, and a group that underwent Gestalt therapy in conjunction with LDT. Both groups saw a significant reduction in nightmares after 10 weeks, but this decrease was more pronounced and happened sooner for the combined therapy group (Holzinger et al., "Studies" 5). These results highlight LDT's potential as a complementary therapy for nightmare reduction.

LDT is promising as a nightmare treatment and may be effective as an alternative therapy, but a major issue for current research is the blurred correlation between LD and nightmare reduction caused by undependable induction techniques. Thus, in order to broadly implement LDT for nightmare treatment, further work is needed to hone induction techniques used as part of the therapy, in addition to the implementation of large-scale studies that more rigorously assess LDT's efficacy and long-term effects.

Post-Traumatic Stress Disorder (PTSD) and Related Symptoms

Nightmares are prevalent in disorders such as PTSD, where repeated traumatic dreams disrupt sleep and hinder recovery (Taitz 173). Approximately 80% of PTSD patients suffer from distressing dreams that impact their daily functioning (Holzinger et al., "Cognitions" 2). Harb et al. found that a common treatment option for PTSD, IR (Image Rehearsal), which involves rescripting a nightmare while awake and "rehearsing" this new dream consistently, improves measures often associated with LD. In this study, a group of war veterans diagnosed with PTSD and suffering from recurrent nightmares underwent IR as part of their treatment. Despite the fact that LD was not encouraged or brought up to the group, after treatment, the veterans had greater control of dream content, which is characteristic of LD. This suggests that IR may owe some of its success in reducing nightmare distress to the enhancement of lucidity during dreaming, highlighting the potential of LD as a PTSD treatment option in the future that utilizes similar mechanisms.

In 2020, Holzinger et al. further examined LDT's impact on PTSD by conducting a study in which participants suffering from PTSD were split into a group that underwent LDT and one that did not. As measured by survey results, depression and anxiety levels significantly decreased for those undergoing LDT, although the PTSD profile itself showed minimal change (Holzinger et al., "Cognitions" 5). Given that depression and anxiety are common symptoms of PTSD, this study suggests that LDT could be used to target specific PTSD symptoms, meriting further research into its potential as a PTSD treatment.

Motor Skill Practice

Interestingly, LDT has also shown potential for improving motor skills. Erlacher and

Schredl conducted a field study where volunteers were tasked with attempting 20 tosses of a 10-cent coin into a cup. The volunteers were divided into 3 groups: a physical practice group, an LD practice group, and a control group (Erlacher and Schredl 160). When volunteers performed the task in the evening and then again the following morning, the physical practice group had the greatest improvement in accuracy, followed by those who claimed to successfully practice the task in a lucid dream (Erlacher and Schredl 161-163). These results can be attributed to the shared neural pathways between imagined and actual behaviors (Taitz, "Clinical" 177). Although research in this area is limited, these findings suggest possible uses of LDT to benefit motor skill development in sports, rehabilitation, and other areas.

Mental and Emotional Health

LD is also evidenced to have positive impacts on general mental and emotional health (Erlacher et al.). While LDT has significant potential to reduce nightmares and allow for motor skill practice through its influence on the dreaming state, it can also indirectly improve waking life. In 2020, Stocks et al. combined RT, WBTB, and MILD techniques to induce LD for 20 participants. These volunteers participated in a lucidity questionnaire and a mood-assessing survey each morning. Results indicated a positive correlation between lucidity and positive waking mood (Stocks et al. 14). A more extensive survey involving 386 participants supports these findings, with 90% of respondents reporting that they perceived some benefit to their mental and/or physical health through their ability to lucid dream (Erlacher et al.).

Moreover, LDT holds the potential to be a form of treatment for depression, through its contributions to mental health. Of 163 participants, mostly lucid dreamers experiencing depression, the majority agreed to statements that LD helped them when they were feeling "depressed or low" (Sackwild and Stumbrys 310). Six interviews were also conducted with successful lucid dreamers, providing qualitative evidence of LD's potential to alleviate symptoms of depression. For example, one interviewee stated that "lucid dreams could be so enjoyable even if I went to sleep crying... it's healing in itself but definitely an option for anybody ready to go the extra mile and stay nonmedicated" (311). Doll et al. similarly concluded from the survey results of 89 volunteers that frequent lucid dreamers had significantly better mental health than rare-lucid and non-lucid dreamers. However, both of these studies suggest a correlation between LD and improved mental health in dreamers who already possess the skill of lucidity. Although they suggest LDT as a potential therapy option, studies involving LDT as a clinical intervention would be necessary to strengthen the correlation. It should also be noted that despite notable research suggesting that LD mitigates depression, Taitz (2011) concluded the opposite: a positive correlation between the two (Taitz, "Learning"). A higher frequency of LD was correlated positively with depression in a sample of college students surveyed in the study. Thus, the risks of LD and LDT should be examined in conjunction with potential benefits to ensure a clear understanding of what the therapy entails.

Personal Growth, Mindfulness, and Creativity

LDT can also be used to enhance personal growth by improving mindfulness, creativity, and self-esteem, among other measures. Numerous studies in the past have suggested a correlation. Notably, Stumbrys and Daniels conducted an exploratory study revealing a unique application of LD to enhance creative problem-solving. Lucid dreamers and non-lucid-dreamers were both tasked with solving a logical puzzle and creating a metaphor before going to sleep, with the lucid dreamers being instructed to imagine a guide figure in their dreams to consult for help (Stumbrys and Daniels, 122-123). The successful lucid dreamers generally did better on the metaphor task, although there was no significant difference in results for the logical puzzle task (124-126). This suggests that LDT can potentially be used as a creativity enhancement.

However, four years later, Stumbrys et al. conducted a study in which they concluded that the positive relation between another measure, mindfulness, and dream lucidity was only present in those who reported experience with meditation. This suggests an unclear relationship in which positive effects of LDT could be due to a combination of natural predisposition and the positive impact of LD induction practices instead of lucidity in dreams itself. But recently, to address this, Konkoly and Burke assessed how much of the benefit arises from LD itself by comparing various measures of personal growth and psychological well-being between a group that received LDT, a group that took part in mindfulness practices without a focus on LD, and a control group. They discovered that successful lucid dreamers had a significantly more positive change in self-esteem and life satisfaction than unsuccessful lucid dreamers as well as a greater reduction in stress levels. This research heavily suggests that there is in fact a correlation between LD itself and positive measures like self-esteem that should be further explored.

Overall, LDT has shown promise in numerous areas, including nightmare reduction, PTSD symptom alleviation, motor skill practice, and personal growth. While exploratory studies and qualitative research indicate positive correlations, larger, clinically focused studies that go on for longer periods of time are necessary to confirm LDT's efficacy in all these areas.

Concerns and Cautions

Despite evidence of the positive effects of LD and the potential of LDT to offer psychological and physiological benefits, some researchers caution against its widespread use, due to potential negative side effects (Soffer-Dudek; Vallat and Ruby).

Soffer-Dudek advises against using LDT with psychotic clients, as LD may encourage hallucinations and an inward focus rather than engagement with external reality. The dissolution of boundaries between reality and dreaming implicated by lucidity in dreams theoretically relates to symptoms of psychosis and dissociation (Soffer-Dudek 2). Vallat and Ruby express a similar opinion, advising against the experimental use of LDT without adequately addressing these concerns and noting that both scientific and popular publications often fail to detail the potential side effects of LD induction (3).

Additionally, the hybrid state between dreaming and wakefulness reached during LD involves greater activation of brain areas typically associated with awareness and critical

thinking (Voss et al.; Dresler et al.). Normal sleep likely evolved to involve lower neural activation in these areas for a reason, so frequent LD may have unknown negative effects on sleep quality and health (Soffer-Dudek 2-3). Notably, regression analyses performed by Schadow et al. on data from surveys of both a student sample and a population-based sample revealed a positive relationship between poor sleep quality and LD frequency. However, this correlation may result from the side effects of unsuccessful LD induction attempts rather than LD itself. For instance, Adventure-Heart's international study in 2020 on various LD induction techniques found that participants experienced better sleep quality on nights when they successfully achieved lucidity compared to nights when they did not. Furthermore, numerous studies observed no correlation or a positive correlation between LD frequency and sleep quality (Adventure-Heart; Holzinger et al., "Cognitions"; Holzinger et al., "Studies"; Spoomaker and Van den Bout; Stocks et al.). Possibly, LD is in fact an advantage but currently is not a highly common skill within the population due to ongoing evolutionary factors.

Overall, if LDT is to fulfill its potential, further research needs to focus on assessing both suggested and unknown negative side effects of LD and addressing these risks.

Limitations

Current research on LDT has notable limitations. Although LDT has shown potential in many studies, the often unclear mechanism of improvement, small sample sizes, and imperfect induction and detection methods make it difficult to establish a direct correlation between LDT and the observed benefits. Additionally, lucid dreaming induction in studies faces the challenge of the fragile nature of lucidity, which often depends on various factors. For instance, Voss et al. were surprised to find that subjects who could achieve lucidity regularly at home had a far lower frequency of lucid dreams in the laboratory (1196). However, despite induction difficulties, LDT's apparent positive effects can offer valuable insights into general treatment approaches, whether the changes are directly caused by lucidity or the methods used to achieve it.

Another limitation is the lack of diversity among both lucid dream researchers and study participants, a homogeneity that encourages bias and limits representation (Ou 128-129). When analyzing the literature referenced in this review, the trend is similarly apparent. Study subjects were often recruited through universities and online forums, resulting in participants having similar educational backgrounds and, in many cases, a preexisting interest in dreaming research. Addressing this issue by targeting new demographics through partnerships with community centers and hospitals or by utilizing more diverse advertising channels, for example, could work to enhance the inclusivity and representativeness of future studies.

Conclusion

LDT is a developing therapy with many potential benefits, including helping with nightmares, mitigating PTSD symptoms, encouraging personal growth, enhancing creativity, and even allowing for motor task practice. However, more research is needed on induction and detection techniques to achieve clearer research results. The strength and validity of research are

often limited by the effectiveness of LD induction and detection techniques, warranting special attention to development in those areas. Furthermore, to be widely accepted as a reliable and safe form of therapy, the potential side effects and cautionary areas of LDT should continue to be targeted in LD research. Through the analysis of both recent and historical literature, this review concludes that LDT has significant potential, meriting greater attention and more rigorous research efforts to explore it.

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Predicting Short-Term Stock Price Actions Using Artificial Intelligence

By Sri Rithish Palani

Abstract

Predicting short-term price actions of stocks is a significant aspect of stock market investing. Numerous methods exist, but many lack efficiency and accuracy. With recent advancements in Artificial Intelligence (AI), research has explored its potential in predicting stock markets. However, limited research focuses specifically on short-term price action prediction. This paper discusses the methodology and findings of our AI models in predicting short-term price actions of stocks. We analyzed key metrics from a sample of 80 stocks using various AI models to assess their accuracy in predicting short-term stock prices. The results suggest that AI models can be effective in forecasting short-term stock movements, but their accuracy is highly dependent on the preprocessing techniques and the features used. Notably, the Orthogonal Matching Pursuit CV model achieved the highest accuracy, reaching up to 80%, particularly when previous quarter prices were included in the analysis.

Introduction

The stock market is a cornerstone of the global economy, offering companies a way to raise capital and investors the opportunity to buy and sell ownership stakes. Stock prices are driven by a complex mix of factors, including economic indicators, company performance, market sentiment, and geopolitical events. Investors are always on the lookout for methods to predict stock price movements, aiming to maximize returns and manage risks. Traditional approaches like technical analysis and fundamental analysis have been widely used. Technical analysis focuses on studying historical price charts and utilizing indicators like moving averages and the relative strength index (RSI) to forecast future price trends. However, these methods can often struggle to keep pace with the fast-evolving financial markets. While this method can be effective in stable market conditions, it may not account for sudden market shifts or anomalies. Fundamental analysis, by contrast, involves assessing a company's financial health through a detailed examination of its balance sheet, income statement, and cash flow statement. This approach aims to uncover the intrinsic value of a stock, providing a solid foundation for investment decisions. However, it can be time-consuming and may not quickly adapt to market changes driven by investor sentiment or external factors. This project aimed to leverage AI to predict short-term stock price movements, enhancing market dynamics understanding and generating monetary gains. Although stock prediction has been extensively explored, AI-based research has emerged only recently, focusing primarily on long-term predictions. The lack of research on AI for short-term predictions motivated our study. We analyzed current stock metrics and developed a novel metric, momentum, which calculates the average change of a stock metric over the past year. These metrics were incorporated into various AI models to identify the most effective approach.

The goal of predicting short-term stock price movements is not just a theoretical exercise but a practical necessity for investors seeking to maximize their returns. Traditional methods like technical analysis and fundamental analysis have their strengths, but they often struggle to keep up with the fast-paced changes in financial markets. By incorporating AI into these processes, we're introducing a new level of precision and adaptability in predicting stock prices. Our approach is rooted in the belief that AI can identify patterns and correlations that are too complex for human analysts to detect.

Methods

To achieve our objective, we compiled a dataset of 80 stocks, carefully selecting them to ensure a representative sample across various industries and sectors. This broad spectrum of data allows us to capture a wide range of market behaviors and company profiles, making our findings more applicable to different market conditions.

Our dataset includes the following columns:

- **Symbol:** The ticker symbol of the stock, which is a unique series of letters assigned to a security for trading purposes.
- **Description:** A brief description of the company, providing context for its market activities.
- **Industry:** The industry in which the company operates, helping to compare performance against industry peers.
- **Sector:** The broader sector classification of the company, such as Technology, Healthcare, etc.
- **Current Price:** The latest trading price of the stock, providing a snapshot of its current market value.
- **Price Momentum:** The rate of change in the stock price over a specified period, indicating the strength of the price trend.
- **Beta:** A measure of the stock's volatility relative to the overall market. A beta greater than 1 suggests higher volatility, while less than 1 suggests lower volatility.
- **Market Cap:** The total market value of the company's outstanding shares, used to classify the size of the company.
- **P/E (Price to Earnings Ratio):** A valuation ratio comparing the company's current share price to its per-share earnings, used to assess valuation.
- **P/E Momentum:** The rate of change in the P/E ratio over a specified period, providing insight into valuation trends.
- **P/B (Price to Book Ratio):** A ratio comparing the company's market value to its book value, indicating whether it's over or undervalued.
- **P/S (Price to Sales Ratio):** A ratio comparing the company's market value to its total sales, offering insight into valuation.
- **P/S Momentum:** Tracks changes in the P/S ratio over time, reflecting shifts in market valuation.

- **Net Income:** The company's total profit, indicating overall profitability.
- **Net Income Momentum:** Tracks changes in net income over time, showing profit trends.
- **Total Revenue Annual:** The total revenue generated by the company in a year, reflecting its scale of operations.
- **FCF (Free Cash Flow):** The cash generated after capital expenditures, indicating the company's financial health and ability to generate cash.
- **Dividend Yield:** The dividend expressed as a percentage of the stock price, reflecting the return on investment through dividends.
- **Total Current Assets Quarterly:** Total assets expected to be converted into cash within a quarter, indicating liquidity.
- **Total Current Liabilities Quarterly:** Total liabilities due within a quarter, showing short-term financial obligations.
- **Total Debt Quarterly:** The total amount of debt the company holds, indicating financial leverage.
- **EBITDA:** A measure of overall financial performance, indicating earnings before interest, taxes, depreciation, and amortization.

These metrics were chosen because they provide a comprehensive understanding of each company, covering aspects of profitability, valuation, market behavior, and financial health.

We organized this data into a spreadsheet, ensuring it was clean and free of inconsistencies. Using the Lazy Regressor extension, we tested various AI algorithms for accuracy. The Lazy Regressor was chosen for its ability to quickly and efficiently compare multiple machine learning models with minimal manual coding. This tool automates the process of training and evaluating models, allowing us to focus on analyzing results rather than on model implementation. Initial tests identified the Gradient Boosted Regressor as the best model. However, to improve accuracy, we added a previous quarter price column, providing a historical baseline for the models. Additionally, we refined the dataset by scaling large numbers, such as market capitalization, to ensure uniformity and improve model performance.

Results/Analysis

Firstly, we visualized our initial dataset using various graphs and charts, including correlation matrices, box and whisker plots, bar charts, and heat maps. These visualizations helped us gauge the correlation between different features in our data.

Initial Dataset Visualization:

- **Correlation Matrix:** This heat map shows the correlations between different features.

Figure 1



The correlation matrix revealed several significant relationships between features. For instance, market capitalization and total revenue showed a strong positive correlation, suggesting that larger companies tend to have higher revenues. Conversely, features like beta and dividend yield showed little to no correlation, indicating that these metrics may not be directly related in our dataset.

After understanding the data correlations, we created our features and target variables, preparing them for input into AI models. We split our data into training and testing sets to ensure efficient model performance.

Next, we used the Lazy Regressor extension to test multiple AI algorithms and determine the best model. Initially, the Gradient Boosted Regressor showed the best performance, so we subsequently applied it to our dataset, as well as other models like Logistic Regression, SVC, and XGBClassifier.

Initial Model Performance:

- **Gradient Boosted Regressor:** Mean Squared Error (MSE) ~ 6000
- **Logistic Regression, SVC, XGBClassifier:** MSE ~ 10,000

Gradient Boost regressor results

Symbol	currentPrice	Predicted Price
ASMLF	1039	340.485934
TMUS	180.01	228.862603
SCL	84.54	15.659611
NVO	143.24	436.503046
BE	14.89	77.654146
AMBP	3.91	26.026309
INTU	573.68	406.547432
COVTY	25.61	15.133065
SKFRY	21.77	12.482684
CSCO	45.93	207.693672
OGFGF	6.4	7.2844
NKE	97	76.091362
TREX	80.07	144.352632
GE	162.1	219.933662
XPRO	20.37	18.033478
NVDA	1207.5	854.086074
ERNXY	19.59	9.599931

The initial models demonstrated limited predictive accuracy, with the mean squared error (MSE) values being in the range of 10,000. To enhance accuracy, we incorporated a previous quarter price column into our dataset, providing a historical reference point crucial for forecasting future price movements. We then re-visualized this updated data and repeated the analysis process. This time, the Lazy Regressor tool identified OrthogonalMatchingPursuitCV as the most effective model, indicating improved accuracy with a lower MSE and higher correlation between predicted and actual stock prices.

Updated Dataset Visualization:

- **Correlation Matrix:** Shows updated feature correlations.

Figure 2



The updated correlation matrix highlighted some shifts in relationships between features, likely due to the inclusion of the previous quarter price. This historical data added another layer of complexity and depth to the dataset, enhancing the models' ability to detect trends.

Updated Model Performance:

- **OrthogonalMatchingPursuitCV:** MSE ~ 6000, Accuracy ~ 80%
- **Other models:** MSE ~ 10,000

OrthogonalMatchingPursuitCV results:

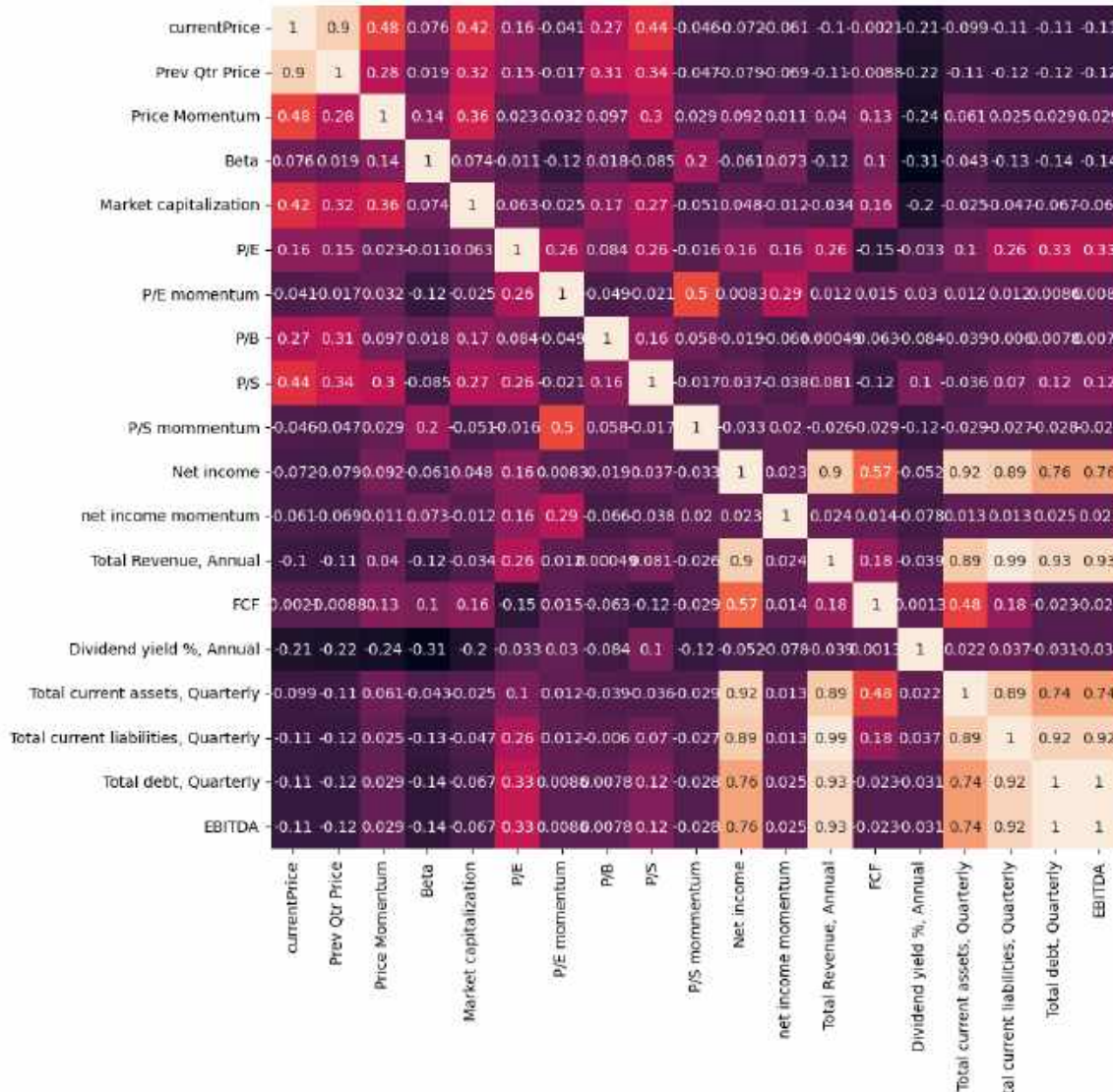
Symbol	Current Price	Predicted Price
ASMLF	1039	937.769188
TMUS	180.01	177.642815
SCL	84.54	144.793037
NVO	143.24	84.005725
BE	14.89	89.921674
AMBP	3.91	-11.905522
INTU	573.68	639.34006
COVTY	25.61	34.180276
SKFRY	21.77	9.564862
CSCO	45.93	61.717932
OGFGF	6.4	-5.304051
NKE	97	136.617333
TREX	80.07	78.779936
GE	162.1	97.320397
XPRO	20.37	26.683213
NVDA	1207.5	596.815002
ERNXY	19.59	18.567147

The addition of the previous quarter price column significantly improved our model's accuracy. Finally, we attempted to improve our dataset by scaling down columns with large numbers, such as market capitalization. We repeated the analysis, and Lazy Regressor suggested Kneighbors as the best model. However, this resulted in a decline in performance.

Scaled Dataset Visualization:

- **Correlation Matrix:** Shows scaled feature correlations.

Figure 3



Scaling the dataset altered the relationships between some features, as shown in the updated correlation matrix. For example, before scaling, market capitalization had a relatively strong positive correlation with total revenue. However, after scaling, this correlation weakened, likely due to the disproportionate scaling of market capitalization compared to other features. Similarly, the correlation between EBITDA and total debt increased post-scaling, indicating that the scaling process impacted the relative importance and relationships of these features within the dataset.

Scaled Dataset Model Performance:

- **Kneighbors:** MSE ~ 11,000, Accuracy ~ 60%
- **Other models:** MSE ~ 10,000

Kneighbors Results:

Symbol	currentPrice	Predicted Price
ASMLF	1039	552.1333333
TMUS	180.01	147.2311111
SCL	84.54	18.8344444
NVO	143.24	153.3844444
BE	14.89	23.30888889
AMBP	3.91	11.86888889
INTU	573.68	352.4177778
COVTY	25.61	25.81
SKFRY	21.77	19.82444444
CSCO	45.93	88.19888889
OGFGF	6.4	13.61333333
NKE	97	118.1944444
TREX	80.07	43.53222222
GE	162.1	98.23444444
XPRO	20.37	19.26555556
NVDA	1207.5	359.2066667
ERNXY	19.59	15.28222222

The decline in performance with the scaled dataset can be attributed to only partially scaling down some columns, suggesting that all columns should have been scaled to improve accuracy fully. This finding underscores the importance of consistent preprocessing steps across all features.

Next Steps

Our research on leveraging AI to predict short-term stock price movements has yielded insightful results, yet there remains ample room for improvement and further exploration. To enhance the performance of our models, we will undertake a more systematic approach to data normalization and standardization. By refining data preprocessing techniques, we aim to ensure that all features contribute optimally to the model's performance, addressing the mixed results observed when scaling specific columns.

Data Preprocessing and Feature Engineering

One of the primary areas for improvement is data preprocessing. Inconsistent scaling and normalization can lead to suboptimal model performance, as observed in our study. Future work will involve a more rigorous and systematic approach to data preprocessing. This includes ensuring that all numerical features are standardized and scaled appropriately. Additionally, we will explore advanced preprocessing techniques such as feature selection and dimensionality reduction to identify and retain only the most relevant features. Previous studies, including those by Han et al. (2011) and Kuhn and Johnson (2013), have underscored the critical importance of consistent data preprocessing in achieving accurate model predictions.

In addition to refining preprocessing techniques, we're planning to explore additional features that could further enhance our predictive power. This includes the incorporation of technical indicators such as moving averages, the Relative Strength Index (RSI), and the Moving Average Convergence Divergence (MACD), which are widely used in financial analysis. Moving averages help smooth out price data to reveal trends over specific periods, RSI measures the speed and change of price movements to identify overbought or oversold conditions, and MACD, a trend-following indicator, illustrates the relationship between two moving averages of a stock's price. Furthermore, sentiment analysis from news articles and social media will be integrated to capture market sentiment and investor behavior. Macroeconomic factors, such as interest rates, inflation, and Gross Domestic Product (GDP) growth, will also be considered to provide a more comprehensive picture of market dynamics.

Ensemble Methods and Advanced Models

To further improve model accuracy, we will experiment with ensemble methods such as stacking, bagging, and boosting, which combine the strengths of multiple AI models. Ensemble methods have been shown to enhance predictive performance by reducing overfitting and improving generalization. Techniques like Random Forests, Gradient Boosting Machines, and Voting Classifiers will be explored. We will also investigate the use of more advanced models, such as deep learning techniques including LSTM (Long Short-Term Memory) networks, which are well-suited for time-series prediction.

Incorporating Real-Time Data

Incorporating real-time data is another crucial step in our future work. Developing a pipeline that allows our models to receive and process real-time stock data will potentially improve prediction accuracy by providing more timely predictions. This involves setting up real-time data feeds and ensuring that our models can process and update predictions continuously. Alongside real-time data integration, we will focus on hyperparameter tuning and cross-validation to optimize model performance, utilizing techniques such as grid search and randomized search. Hyperparameter optimization is essential for fine-tuning model parameters to achieve the best possible performance.

Expanding the Dataset

We also plan to expand our dataset by increasing the sample size of stocks and incorporating data from different market conditions and time periods. This expansion will help generalize our findings and improve the robustness of our models. By including a diverse set of stocks from various sectors and market environments, we can ensure that our models are not biased towards specific market conditions. This will involve gathering historical data from multiple market cycles, including bull and bear markets, to train and test our models under different scenarios.

Additionally, we will consider a broader range of evaluation metrics, such as mean absolute error (MAE), R-squared, and directional accuracy, to gain a more comprehensive understanding of model performance. These metrics will provide a more nuanced view of model accuracy and reliability, helping us to identify areas for further improvement.

Automated Trading Strategies

Finally, we will explore the practical application of our models by developing automated trading strategies based on the predictions. This will involve backtesting and paper trading to evaluate the financial viability of AI-driven predictions. Backtesting will allow us to simulate trading strategies on historical data to assess their performance and risk. Paper trading, on the other hand, will enable us to test strategies in real-time without financial risk, providing valuable insights into their practical applicability.

By refining our methodologies, expanding our dataset, and integrating real-time data, we aim to develop more accurate and reliable AI models for short-term stock prediction. These efforts will contribute to the ongoing advancement of AI in financial markets, providing investors and researchers with powerful tools for decision-making and analysis. Our goal is to create a robust framework that can adapt to changing market conditions and deliver consistent, high-quality predictions, ultimately enhancing the capabilities of investors and researchers alike.

Conclusion

Our research demonstrates the potential of AI models to predict short-term stock price movements, albeit with varying degrees of success. The Gradient Boosted Regressor and Orthogonal Matching Pursuit CV models showed promise, with the latter achieving up to 80% accuracy following the inclusion of a previous quarter price column. However, challenges remain, particularly in data preprocessing and feature scaling.

The exploration of different AI models and the incorporation of additional features significantly improved prediction accuracy, highlighting the importance of comprehensive data analysis and model selection. Our findings pave the way for future research and enhancements in this domain.

Our ongoing work promises to contribute valuable insights to the field of financial prediction and AI, ultimately advancing the capabilities of investors and researchers alike.

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Review on the Impact of Diffuser Design on the Aerodynamic Performance of Cars

By Nirvaan Gupta

Abstract

After witnessing rapid growth of performance in cars over the last few decades, optimization of aerodynamics has emerged as a crucial factor in designing modern cars. Some modern aerodynamics solutions include the Mercedes IAA concept, with a drag coefficient as low as 0.19, which is unheard of in today's production cars. Furthermore, shape-morphing structures are being developed to fine-tune the aerodynamics not only in cars, but also in airplanes. Recently, diffuser design has emerged as a major factor in improving aerodynamics and, therefore, performance, of cars. Drag and lift coefficients are two of the most important factors heavily affected by the aerodynamic design. They are also considered key factors when judging performance of cars, specifically race cars. Despite this importance, there is a lack of a concise review study summarizing the recent advances in design of diffusers. This review paper reflects on recent advancements in the design of diffusers and the applications of such designs on cars' aerodynamics. In this review, first, we overview the essential concepts used in car aerodynamics. Next, we review the most recent literature investigating the impact of various parameters defining a diffuser design on the aerodynamic performance of cars. Specifically, the effect of the diffuser angle, length, and ride height of a car on the drag and lift coefficients are considered in this review. Towards the end, we overview the key opportunities and challenges for future innovations in this area. This review paper provides an initial guideline for understanding and optimizing the impact of different diffuser designs on cars' aerodynamic features.

Keywords Drag, downforce, aerodynamics, diffuser, lift, performance.

Introduction

Aerodynamics has a significant impact on the performance of cars, whether it be race cars or common production cars. While factors such as torque, horsepower, and weight are often considered of higher importance when designing cars, aerodynamics is given the least amount of attention. Aerodynamic design influences how efficiently a car moves through the air, affecting its ability to overcome the forces of air resistance and achieve higher speeds rapidly [1]. When a car accelerates, it must combat the forces of drag to move forward. Furthermore, to achieve better traction at the contact surfaces, which are the tires, the car must have a high magnitude of negative lift force, or "downforce". The greater downforce not only helps in acceleration but also provides significant gains in cornering speeds. This is clearly illustrated in a study by JA Dominy et al. (1984) as the lap time changes significantly under different downforce and drag coefficients (Fig. 1).

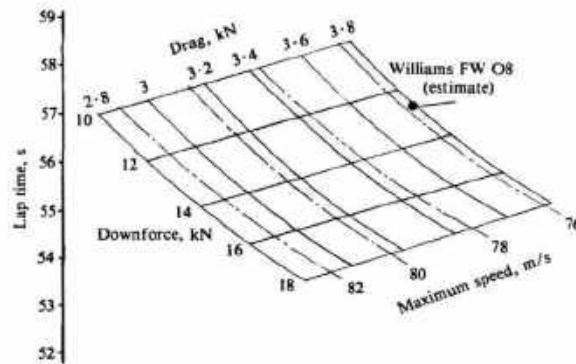


Figure 1. Variation of lap time with aerodynamic downforce and drag for a Formula 1 racing car- Williams FW O8, reprinted from Ref. [1].

A higher downforce combined with a low drag force can provide significant improvements in lap times (Fig. 1). Considering the importance of aerodynamics, the Chiron, renowned for its performance, underwent significant aerodynamic refinements for the Super Sport 300+ variant, specifically designed to break the revered 300 mph barrier, hitting a speed of 304.8 mph [2]. However, the regular Chiron has only managed to achieve a top speed of 261 mph [2], which is lacking in comparison to the Super Sport 300+. While both models feature very similar powertrains producing 1,500 horsepower in the Chiron's case and 1577 horsepower in the Super Sport 300+'s case, the Super Sport 300+ achieved its incredible top speed due to its streamlined shape that significantly reduced aerodynamic drag [3].

A massively critical component, which helps to determine the aerodynamic performance of a car, is the diffuser. These devices are usually found at the rear of a vehicle. They effectively manage the airflow beneath the car, resulting in improved stability, reduced drag, and increased downforce. This acceleration generates a low-pressure zone beneath the vehicle, which helps in sucking the car closer to the ground, hence increasing downforce. The diffuser is particularly useful for high-speed performance as it increases the vehicle's overall grip, stability, and cornering capabilities. Furthermore, by making air flow laminar, diffusers help reduce drag, allowing cars to accelerate quicker. One notable example showcasing the effectiveness of diffusers is found in Formula 1 race cars. These cars are at the epitome of motorsport, and the intricate diffuser systems play a pivotal role in maintaining stability during high-speed maneuvers, enabling better cornering and acceleration.



Figure 2. Image of a diffuser present on a Lamborghini Aventador SV, reprinted from Ref. [4].

Diffusers help make significant gains in drag coefficients as well as lift coefficients (note that for lift coefficients, a lesser value represents more downforce) [5]. They also serve as essential tools for enhancing a vehicle's aerodynamics by controlling airflow, managing turbulence, and optimizing downforce. They contribute significantly to improved stability, reduced drag, and enhanced overall performance, making them a cornerstone of modern vehicle design for both racing and road-going purposes. In this review paper, we explore the multiple facets of diffuser design. This is done by comprehending and collating information produced by recent research papers and providing an effective and concise outlook into the relatively unexplored design element in cars: diffusers. Additionally, aspects such as length, angle and the vertical fins in a diffuser shall be covered in this paper. This review will help researchers as an introductory guideline to enhance the aerodynamic design of the car.

Key Concepts

In this section, the details of key areas in the field of aerodynamics are briefly overviewed. These key concepts include drag force and downforce.

Drag Force

The drag force is the force experienced due to air resistance. For a car to accelerate or decelerate, it must overcome the resistive forces of drag as well as friction, according to Newton's Law. The aerodynamic drag experienced by a car at a specific velocity is determined through its frontal area and drag coefficient [6]. The formula for calculating drag force is as follows [6]:

$$F_d = \frac{1}{2}C_d A \rho v^2 \quad (1).$$

In equation (1), F_d represents drag force, C_d represents drag coefficient, A represents frontal area, ρ represents density of the fluid, and finally, v represents velocity of the body.

Typically, for a subcompact car, the frontal area is 1.80 m² and 2.00 m² for a compact car [7]. For SUVs, the frontal area is ~3.00 m² [7]. From this equation, the drag force is directly

proportional to the square of the velocity, which explains why acceleration decreases exponentially in cars as velocity increases, under the same engine power and torque. The drag coefficient of a car changes depending on the shape of the car and is a key area taken into consideration when designing and optimizing the aerodynamics of a car. The lowest drag coefficient currently obtained by a production car is 0.175 [8]. This number has been achieved by the car Lightyear 0. Most road cars have a drag coefficient between 0.3 and 0.4, with SUVs at the higher end of this range and sedans towards the lower end [9].

Downforce

Downforce, often called negative lift, is the force which pushes a car onto the ground [10, 11]. This force is experienced due to changes in pressure of the airflow surrounding the concerned body. A higher magnitude of downforce allows a car to go around corners at higher speeds. According to Ref. [10], downforce is the reverse of lift, the net result of the pressure difference between the air flowing underneath and above a front splitter, an entire car body, or a front or rear wing. The formula for lift force produced in context of a wing is as follows [11]:

$$F_l = \frac{1}{2}\rho AC_l v^2 \quad (2)$$

In equation (2), F_l represents lift force, C_l represents lift coefficient, A represents frontal area, ρ represents density of the fluid, and finally, v represents velocity of the body.

Introduction to Diffuser Design

Diffusers, along with front and rear wings, are one of the most important components on any type of car, especially, race cars and sports cars, when considering the impact on aerodynamic performance. Downforce can be increased by incurring a large increase in drag through modifications to the wings, and a similar increase in downforce can be achieved through the addition or modification in the design of the diffuser [12]. This is supported in a study by Toet, W. [12], which shows that the diffuser and floor contributes to more than 50% of downforce produced in 2009 F1 cars, while contributing to less than 15% of the drag. This is the premise around which the development of diffusers has gained significant importance over the last few decades.

According to Bernoulli's equation, a flat-bottomed race car produces downforce due to the pressure under the car (between the floor of the car and the asphalt of the track) being lower than the pressure above the car [13]. This is known as ground effect as the car effectively gets sucked towards the ground. However, the addition of a diffuser helps reduce the pressure under the car to a greater degree [13]. The extent of this pressure decrease is dependent on the design of the diffuser. This pressure decrease is crucial to enhance the ground effect and produce more downforce [13].

Various aspects of a diffuser affect the aerodynamic performance of a car (Figs. 3, 4). First, the slant angle of a diffuser (diffuser angle, angle Θ in Figure 3) is key in determining the

effect on aerodynamics. The slant angle is the angle between the ground and the slope of the diffuser (Fig. 3) [14]. Another important component is the length of the diffuser itself (Fig. 4) [15]. In the following sections, we study the specific impact of each of these design parameters on the aerodynamic performance of a car.

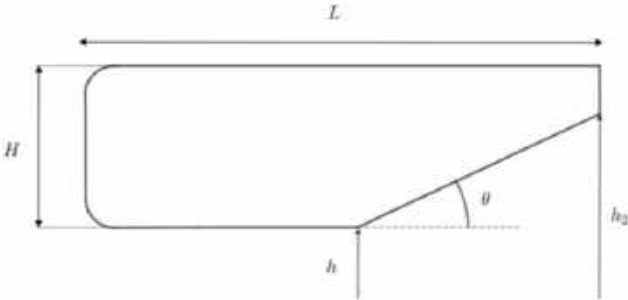


Figure 3. Diagram showing slant angle of a diffuser on an Ahmed body, reprinted from Ref. [14].

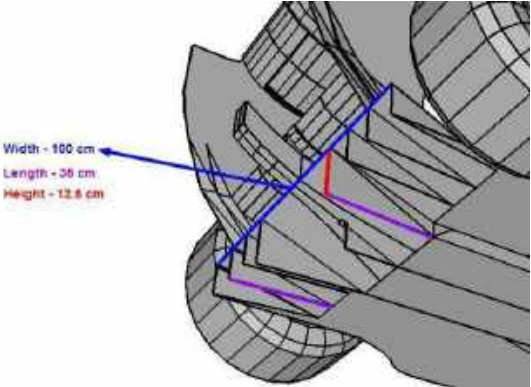


Figure 4. Diffuser Diagram, showing its dimensions, reprinted from Ref. [15].

Recent Research Progress in Diffuser Design

In the following sections, we will explore the impact of various parameters on the aerodynamic effect produced by the diffuser.

Slant Angle

The slant angle of a diffuser is crucial in determining the aerodynamic performance of a car [1]. With multiple efforts from various researchers over the last couple of decades, more definitive conclusions about how the slant angle affects the performance are being formed

[16,17]. In this section, the various studies providing insight into the effect of slant angle on aerodynamic performance shall be compared.

Xingjun Hu et al. (2011) conducted a study, which, using Computational Fluid Dynamics (CFD) simulations, showed how the slant angle affects the Cd and Cl. The model used for the CFD simulation was of a midsize sedan (Tables 1 and 2, Fig. 8).

Case name	Diffuser angle	Cd	Cl
Case one	0°	0.2841	0.3350
Case two	3°	0.2718	0.2791
Case three	6°	0.2487	0.2656
Case four (original model)	9.8°	0.2673	0.2633
Case five	12°	0.2822	0.2586

Table 1. The values of drag and lift coefficient obtained for a range of different diffuser angles. All factors except the diffuser angle remain the same. The table is reprinted from Ref. [16].

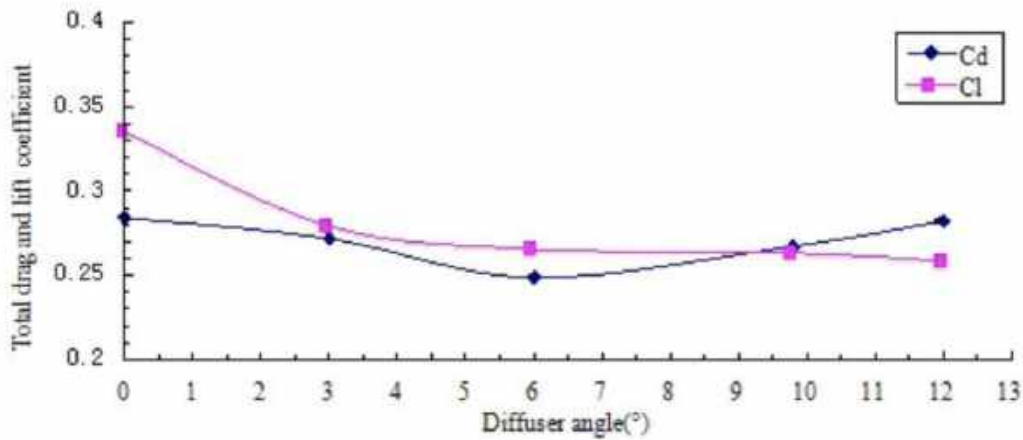


Figure 5. A table and a graph showing the relationship between diffuser angle and Cd and Cl, reprinted from Ref. [16].

Diffuser Angle (Degrees)	C _d	C _l
0	0%	0%
3	-4.33%	-16.7%
6	-8.50%	-4.84%
9.8	7.48%	-0.866%
12	5.57%	-1.79%

Table 2. Percentage difference between consecutive values of drag and lift coefficients obtained in Ref. [16].

In 2013, a similar study [17] was conducted, which also used CFD simulations. The dimensions of the height and length of the car were the same as the model used in Ref. [17], however, in this case a 2-dimensional (2D) model was used, which could be a limiting factor in this study. Furthermore, the researchers investigated the effect of diffuser angle solely on the drag coefficient, leaving out its implications on the lift coefficient [17]. The results obtained in Ref. [17] (Tables 3 and 4) were also varied from the ones obtained in Ref. [16], which may be a result of differing diffuser lengths or usage of a different model or mesh types. Notably, the general trend is largely similar, validating the reliability of both studies. Both studies show that there is a clear decrease (approximately 11% [16]) in the drag coefficient until a diffuser angle of 6 degrees. Then there is a gradual increase in the drag coefficients, which is caused due to the flow separation at larger angles. However, when it comes to the lift coefficient, it is always decreasing, with a drastic decrease from 0 to 3 degrees and then, a more gradual decrease when increasing diffuser angle. Thus, the downforce of a car increases as the diffuser angle increases at least in the domain of ≤ 12 degrees as the diffuser angle increases, according to both studies.

Case name	Diffuser angle	Drag Coefficient
Case one	0°	0.27060
Case two	3°	0.26933
Case three	6°	0.268582
Case four	9°	0.283298
Case five	12°	0.286455
Case six	15°	0.286644

Table 3. Drag coefficient observed using different diffuser angles, reprinted from Ref. [17].

Diffuser Angle	C_d
0	0%
3	-0.469%
6	-0.278%
9	5.48%
12	1.11%
15	0.0660%

Table 4. Percentage difference between consecutive values of drag coefficient obtained in Ref. [17].

Length of Diffuser

Along with the slant angle, the ratio of diffuser length to the car body length can also often be a major deciding factor in determining the aerodynamic performance of the car [1]. In a comprehensive study conducted by Huminic et al (2017), 4 values of this ratio were covered: 0.1, 0.2, 0.3, and 0.4 (note that a value of 0.1 means the diffuser covers 10% of the body's length and likewise). The model used for this study was a bluff body named an "Ahmed Body" [18]. The body was first devised by Ahmed et. al (1984), resembling the normal shape of a hatchback. Computational fluid dynamics were used to conduct this research, similar to [16] and [17]. Figures 6a and 6b clearly show this significant variation between length and coefficients of drag and lift, produced in this study.

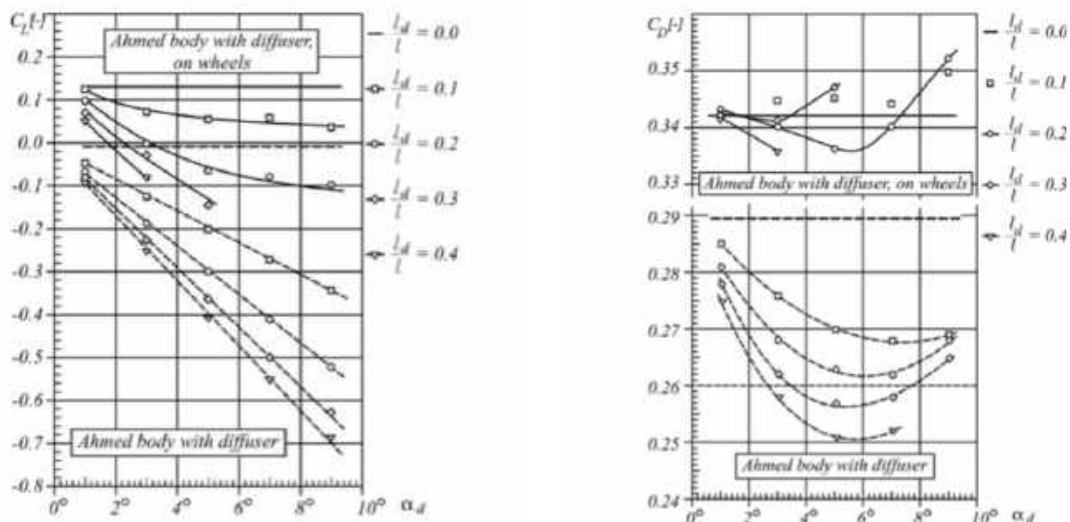


Figure 6. The relationship between diffuser angle, length and lift and drag coefficients produced. Left (6a) shows lift, right (6b) shows drag, reprinted from Ref. [5].

For the purpose of an accurate, and practical discussion, only the results from the Ahmed body on wheels shall be discussed. Firstly, the lift coefficients see a fairly constant trend of increasing downforce (decreasing lift coefficients) across a range of different diffuser angles, helping to strengthen the reliability of the assumption that, the longer the diffuser, the greater the downforce produced. On the other hand, the drag coefficient sees a highly incohesive and seemingly ambiguous trend. However, upon close examination, it can be observed that the lift coefficient tends to increase when the body goes from no diffuser to a diffuser length divided by body length of 0.1. However, after that point, a clear reduction is seen in the lift coefficient, meaning that more downforce can be produced, with maximum downforce being reached when the diffuser constitutes 40% of the body length. But this design is highly impractical to implement in most race cars, let alone normal production cars. According to Ref. [5], the optimum design would be to consider the ratio of the diffuser length to the car length (l_d/l) to be as much as 20% (0.2).

Ride Height

Ride height, even though it is not a design factor of the diffuser itself, but of the whole car, it nevertheless affects the interaction of the diffuser with airflow, which is the reason why its effects shall be discussed in the forthcoming paragraph. In a study conducted by Breslouer et al. (2008), the effects of different ride heights on the lift coefficient were explored experimentally [19]. Due to this study being conducted in a wind tunnel, the results are highly reliable, as compared to results in other studies that use computational fluid dynamics. The model used for this study is almost identical to the one used by Cooper (1988) [20]. In this, the diffuser angle can be switched between 0 and 9 degrees, with the diffuser length fixed at 25% of the body. Figure 7 shows the variation between lift coefficient and non-dimensional ride height.

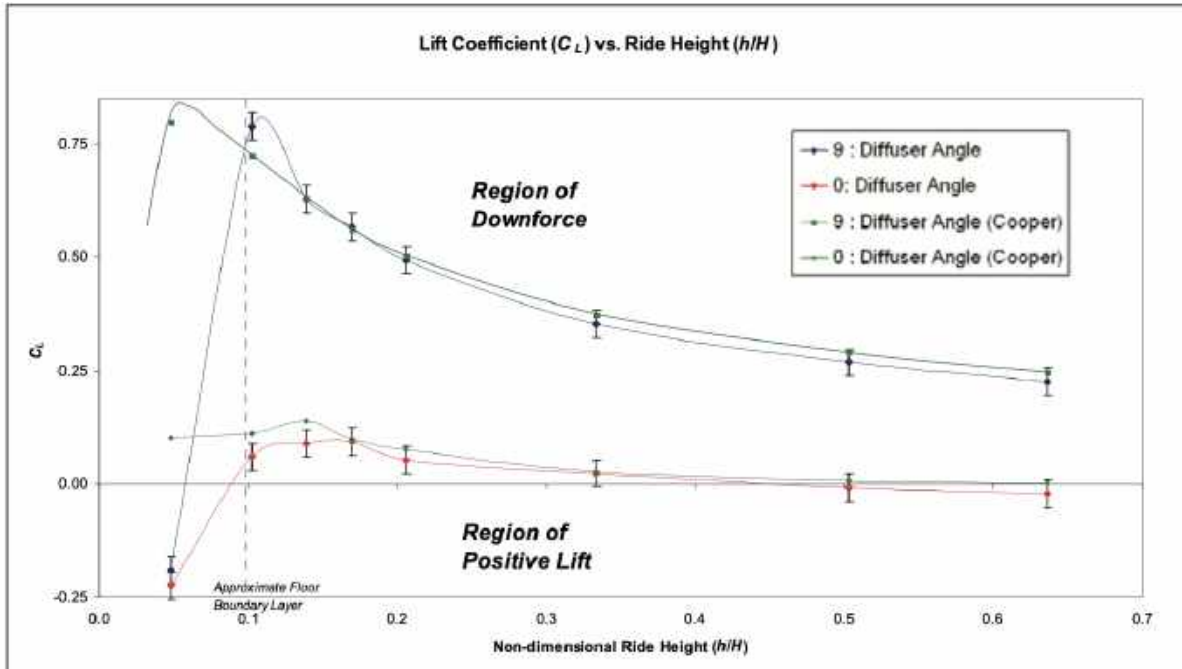


Figure 7. Relationship between ride height and lift coefficient of a car using two different diffuser angles and establishing a comparison with Cooper's results, reprinted from Ref. [19].

In this graph “h” corresponds to the ride height and “H” corresponds to the height of the model from the ground to the roof of the car. Generally, as h/H increases, the downforce decreases at an upward sloping rate, particularly for $h/H \geq 0.1$. Furthermore, the results obtained by Breslouer are largely similar to Cooper's results, with an anomaly being present when h/H is 0.05 [19]. Unlike Cooper's model, when going from $h/H = 0.05$ to 0.1, large increases in downforce are observed for Breslouer's model. A major shortcoming of Breslouer's study [19] is that it fails to examine the effects of ride height on the drag coefficient, which is a factor that must be considered when applying the appropriate ride height to any car.

Discussion

The importance of aerodynamics in cars cannot be understated due to its profound implications on various performance parameters of the car including its acceleration, top speed, stability, cornering speed and fuel economy. The drag and lift coefficients of a car are usually some of the most important target attributes aerodynamics departments of racing teams worldwide focus on, in order to maximize performance of their cars and achieve success. In production sports cars, these key factors are focused on to maximize driveability as well as performance. In normal sedans and SUVs, the drag coefficient especially draws a great amount of focus in order to maximize fuel consumption efficiency in the case of combustion engine cars and range for electric vehicles. In this study, we have reviewed the impact of diffuser design on performance of cars. We have reviewed some key concepts with regards to design parameters

and attributes of a typical diffuser. The design parameters studied include the angle of the diffuser, the length of the diffuser, and the ride height of the car and attributes also include the lift force and drag force of the car.

In the field of diffuser design, there is a significant potential of further research and innovative solutions for better aerodynamic performance. For instance, further research must be done to study the impact of vertical fins on a diffuser and how different designs of the vertical fins impact the aerodynamic performance. Furthermore, our current understanding of the impact of diffuser length on aerodynamic performance is limited and needs further exploration. While the angle of a diffuser has been extensively researched, it may be worth exploring this factor in conjunction with other factors and using more accurate methods, such as using a wind tunnel, as opposed to CFD. CFD simulations usually are limited in capturing the complex physics involved in the aerodynamics of a car, especially at a micro scale. The usage of active aerodynamic systems, in the context of diffusers, should also be a key area in which research must be done since these systems can be fine-tuned for different driving conditions. This review study can help as a guideline for initial design of a diffuser, with regard to aerodynamics of cars.

In this review study, the impact of vertical fins has not been studied, and that could be explored in future works to gain a more comprehensive idea of how a diffuser should be designed. Furthermore, we did not focus on how different car types such as SUVs, sedans and hatchback impact the diffuser design. These can be studied in future work.

Conclusion

By going through key factors with a significant impact on the aerodynamic performance of cars, we reviewed some of the most important research studies on the impact of diffuser design on aerodynamic performance. As reviewed in this paper, the literature demonstrated that a diffuser angle of approximately 6 degrees minimizes the drag coefficient while achieving a relatively lower value for the lift coefficient (0.2656) for a diffuser attached to a bluff body such as the Ahmed body. The effect can be enhanced with a diffuser length of approximately 20% of the car's total length, and a ride height of approximately 10% of the car's total height. This review paper can be used as a guideline aiding in the design of novel diffusers or optimizing typical diffusers in order to achieve enhanced aerodynamics. Future research work on advanced technologies such as active aerodynamic systems using wind tunnel testing would potentially be highly desirable, making more efficient cars.

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Navigating IBD: The Role of Environmental Stressors and Nutrition

By Nikhil Kannan

Abstract

IBD is a broad term that describes chronic inflammatory diseases that affect the GI tract. The primary disorders are Crohn's Disease (CD) and ulcerative colitis (UC). Broadly, differences between the two diseases depend on what part of the gut is inflamed; CD affects any segment of the GI tract, usually in the ileum, whereas ulcerative colitis inflammation is concentrated in the colon and rectum. Symptoms of both diseases include abdominal pain with diarrhea and systemic manifestations such as fatigue and fever. Although genetic predisposition is a major contributor to developing IBD, environmental factors (include diet and pollution) play significant roles. This article will discuss the symptoms, treatments, genetics, and environmental stressors related to IBD and what current therapeutic options are available to treat the diseases.

Introduction

Approximately 1.6 million Americans have Inflammatory Bowel Disease (IBD), accounting for 0.5% of the U.S. population. It affects all ages with approximately 80,000 children a year getting diagnosed alone (Rosenthal et al.). The disease can be broken down into two major types – Crohn's disease (CD) and ulcerative colitis (UC) – that largely differ depending on where in the intestine the inflammation is concentrated. CD affects all parts of the intestine, but primarily the ileal portion of the small intestine; UC primarily impacts the colon ("Crohn's Disease"). As a whole, both diseases are thought to be caused by numerous factors including dietary & environmental exposures, autoimmune reactions, and individuals with certain genetic backgrounds. As a society, attention to these diseases is imperative because of their role in causing secondary complications such as colorectal cancer. Many doctors believe that remission can help with this issue, but flares can occur with no probable cause (Brody). This article will focus on the symptoms of IBD, how current research is focused on trying to understand what environmental stressors are present & their varying effects on the gut, the impact of microbes (such as E. coli bacteria) on overall gut health, and how diet can contribute or alleviate symptoms.

Introduction to IBD

What is the gastrointestinal system?

Inflammatory Bowel Diseases impact the gastrointestinal tract, which is a complex set of organs composed of the mouth, pharynx (throat), esophagus, stomach, small intestine, large intestine, rectum, and anus. These organs make up the pathway that food and liquids take as they are swallowed, digested, absorbed as nutrients, and finally exit the body ("NCI Dictionary of Cancer Terms"). The vast majority of the GI tract is broken down into two major components:

the small intestine (which is further segmented into three regions: duodenum, jejunum, and ileum) and the colon (consisting of the proximal and distal colon) (Professional).

The gut acts as a barrier between the outside (lumen) and the inside of the body. In certain parts of the intestine, the lumen is home to trillions of microbes (e.g., bacteria and fungi) that normally live in symbiosis with the gut and produce important nutrients. To keep these microbes at equilibrium, the GI is also home to the majority of the immune system (Di Vincenzo et al.). Specialized immune cells help maintain a barrier between the microbes and the intestinal wall. The NIH states that they sense what microbes are present and produce substances that maintain separation including mucus, antimicrobial peptides, and antibodies (Di Vincenzo et al.). Both microbes and the immune system maintain homeostasis with each other, but imbalances can lead to gut inflammation which can cause secondary metabolic diseases (Di Vincenzo et al.).

What are the symptoms of the diseases?

IBD symptoms range from mild to severe (“Inflammatory Bowel Disease (Overview)”). These symptoms may include abdominal pain, diarrhea, constipation, bowel urgency, gas and bloating, loss of appetite, unexplained weight loss, mucus or blood in the stool, and an upset stomach. In more acute cases, symptoms can escalate to stunted growth, fatigue, fever, itchy red eyes, joint pain, nausea, vomiting, skin rashes, and vision problems, often occurring during periods of active illness. These symptoms fluctuate as inflammation may subside during phases of remission (“Inflammatory Bowel Disease (Overview)”) (“Inflammatory Bowel Disease (IBD) Basics”).



Comparisons between healthy and inflamed IBD guts
Secondary Complications such as colorectal cancer can occur when untreated

What are the secondary complications of the disease?

There are numerous secondary complications to IBD (**Figure 1**). The NIH reports Crohn's disease diagnoses often turn into colorectal cancer with rates of 2.9% at 10 years of age, 5.6% at 20 years of age, and 8.3% at 30 years of age (Kim and Chang). Other complications can include fistulas, abscesses, fissures, strictures, bowel perforations, increased risk of cancer, organ complications (kidney stones and the liver), and toxic megacolon ("Inflammatory Bowel Disease (Overview)").

Apart from complications in the bowel, IBD can induce other systemic damage such as anemia, malnutrition, and osteoporosis ("Inflammatory Bowel Disease (Overview)").

Recent research into this field explores that while Crohn's disease causes numerous forms of physical damage, it can lead to stress and mental health disorders (Stress and Mental Health Disorders - IBD Journey - Complications of IBD - Stress and Mental Health Disorders).

How is IBD diagnosed?

To determine which treatment is necessary, a diagnostic test for anemia or infection is performed. This approach entails a blood test or more commonly, a stool test. These tests show whether hidden blood (occult), excessive/reduced mucus, and/or parasites present in the stool. To confirm findings from the diagnostic test and to determine the severity of IBD, doctors may perform invasive procedures, such as endoscopies and colonoscopies. These exams allow gastroenterologists to view the entire colon by using a camera at the end of the GI tract. Less invasive exams can involve swallowing a capsule with a camera that sends images to the healthcare professional (Inflammatory Bowel Disease (IBD) - Diagnosis and Treatment - Mayo Clinic).

What are the current treatments of IBD?

The primary goal in treating IBD is to reduce inflammation in the gut. Targeting the immune system not only reduces symptoms, but also allows for longer periods of remission and a lower risk of secondary complications. Doctors employ two primary approaches: drug therapy (i.e., external medication) and surgery (i.e., removal of portions of the intestine) (Inflammatory Bowel Disease (IBD) - Diagnosis and Treatment - Mayo Clinic).

There are four main types of treatments used to manage IBD: anti-inflammatory drugs, steroids and other immune system suppressors such as biologics, and antibiotics. As a general rule, the medication prescribed depends on which area of the intestine is affected and the severity of the symptoms (Inflammatory Bowel Disease (IBD) - Diagnosis and Treatment - Mayo Clinic).

Anti-inflammatory drugs are usually the first option to treat mild-to-moderate ulcerative colitis. These include aminosalicylates such as mesalamine, balsalazide, and olsalazine. To speed up remission, short-term courses of corticosteroids may be used. These drugs are both anti-inflammatory and immunosuppressive (Inflammatory Bowel Disease (IBD) - Diagnosis and Treatment - Mayo Clinic).

Immunosuppressants work by lowering the immune response that triggers the chemicals which cause inflammation and injures the digestive tract lining. These include azathioprine and mercaptopurine, thiopurine, and methotrexate. Swallowable medications, known as “small molecules”, have been recently developed, such as tofacitinib, upadacitinib, and ozanimod (Inflammatory Bowel Disease (IBD) - Diagnosis and Treatment - Mayo Clinic).

Biologics are a newer category of therapies that target the proteins that cause inflammation. These treatments can be utilized through the vein as infusions or subcutaneous injections usually in the thigh. Commonly used biologics include infliximab, adalimumab, and golimumab, among others (Inflammatory Bowel Disease (IBD) - Diagnosis and Treatment - Mayo Clinic).

Antibiotics may be prescribed with other medications or with an active infection, including perianal Crohn's disease. Regularly used antibiotics include ciprofloxacin (Cipro) and metronidazole (Flagyl). Pain relievers, anti-diarrheal medications, enteral and parenteral nutrition, as well as vitamins and supplements can also help treat IBD (Inflammatory Bowel Disease (IBD) - Diagnosis and Treatment - Mayo Clinic).

In severe cases, medication is not efficacious, and surgery may be employed as an alternative. When treating ulcerative colitis with surgery, doctors may remove small portions of the bowel and rectum. Surgeons then create an internal pouch connected to the anus, which permits bowel movements in place of a bag. When internal pouches cannot be used, a permanent opening in your abdomen is created, known as a ileal stoma, where stool passes into an attached bag to be collected (Inflammatory Bowel Disease (IBD) - Diagnosis and Treatment - Mayo Clinic).

How does stress contribute to IBD?

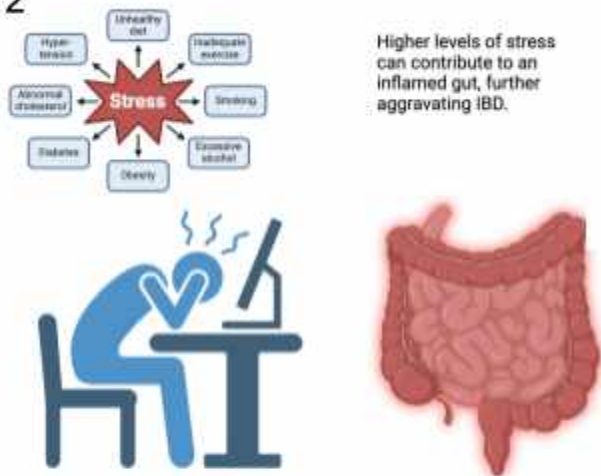
People with Crohn's and ulcerative colitis are experience higher rates of anxiety and depression (Mental Health and Wellbeing With Crohn's or Colitis). As described by the Crohn's & Colitis Foundation, personality changes can occur in IBD patients when the disease is active (60% to 80% of patients), as well as during remission (up to 30% of patients) (Stress and Mental Health Disorders - IBD Journey - Complications of IBD - Stress and Mental Health Disorders).

In a study conducted by the American Journal of Gastroenterology, researchers concluded that increased cortisol levels are present in those with Crohn's disease and patients in surgery, which can be related to severe gut inflammation (**Figure 2**) (“Importance of Serum Cortisol Levels in Inflammatory Bowel... : Official Journal of the American College of Gastroenterology | ACG”). These increased levels correlate with a higher release of glucocorticoids which happens during severe and acute diseases (“Physiology, Cortisol”).

Repeated psychological stress speeds up severity of IBD by changing the neuroendocrine-immune network and microbiome homeostasis ((Ge et al.). Stress has the ability to change gut microbiota and the way nerves experience senses, resulting in IBD-like symptoms (Ge et al.). IBD also causes anxiety and depression-like symptoms by over-activating brain immune regulation (Chaudhry et al.).

While there may not be a clear correlation between type A/B personalities and IBD, there have been studies relating other types of personalities with IBD (Eugenicos and Ferreira). The

Fig. 2



High levels of stress can lead to negative health consequences including worsening levels of inflammation in the gut.

NIH conducted another study that found a relationship between neuroticism, external thinking, and impulsive traits on the onset of IBD, which contributes to the development and quality of life of patients with IBD. However, a cause and effect relationship was not able to be established.

Is there a correlation between specific ages and IBD?

The lifespan is often categorized into five distinct stages of development: children, adolescents, young adults, middle aged adults, and seniors. These different stages are associated with different goals and characteristics which create distinct levels of stress.

Children have lower levels of stress as they attempt to blend in with the people around them (Bertani et al.). Children often eat unhealthy foods associated with the western diet. Nutritional factors such as a diet with increased glucose and trans fats have been correlated with IBD (Bertani et al.). The NIH states that this type of diet is associated with increased levels of proinflammatory cytokines, changed intestinal accessibility, and an altered intestinal microbiome makeup that creates inflammation in the gut (Singh et al.).

As people take on more responsibilities and move through major life milestones, teenagers develop a moderate to high level of stress that can impact their gut health. For those with IBD-related diseases, the symptoms may worsen simply because following their medication schedules may be difficult for them. Only 65% of these adolescents perfectly adhere to their medication prescriptions (Lu). It presents differently in teenagers because IBD can lead to growth failure and delayed puberty (Amaro and Chiarelli). Their BMI is also affected.

Young adults have the highest rate of developing IBD related mental health conditions, almost 15.2% developing conditions by age 18 (Cooney et al.). The disease is most active in this age group due to the high levels of stress they encounter. It can also be due to the unhealthy diet they follow from not having adequate food security, specifically due to income (Nguyen et al.).

Middle aged adults and seniors have very similar likelihoods of being diagnosed with IBD. The TIME magazine states that more than a quarter of people with IBD are “elderly” , a percentage that is expected to increase to 30% by 2030. Doctors are beginning to notice a third spike of IBD in this age group (Courage). Surgery can be a less helpful approach for elderly patients at higher risk for complications (“Management Considerations for the Older Adult With Inflammatory Bowel Disease”). They often have to get parts of their bowels resected and receive ostomy pouches (Chrobak-Bień et al.). There is also a higher percentage of patients with ulcerative colitis than Crohn’s disease (“Inflammatory Bowel Disease of the Elderly: A Wake-up Call”).

As individuals become older, chances of IBD increase as cells begin to break down and get weaker. (Ananthakrishnan). Additionally, there has been a noticeable overlap between the biology of IBD and aging. This can cause different outcomes in IBD as well.

The Gut Microbiome

Microbes live on various surfaces of the body and are most concentrated in our intestinal tract (**Figure 3**) (DeBruyn). In healthy contexts, these microbes are in a commensalistic relationship with the body and provide useful, beneficial functions for us (Olano et al.). For example, in the intestine, they can fight against pathogens by stopping their growth and boost the host immune system (Zheng et al.). Additionally, these “commensals” are capable of providing the body with specific vitamins and other nutrients that cannot be produced by human cells (Martín et al.). Three major phyla are in the gut: Firmicutes, Actinobacteria, and Bacteroides (Belizário and Napolitano).

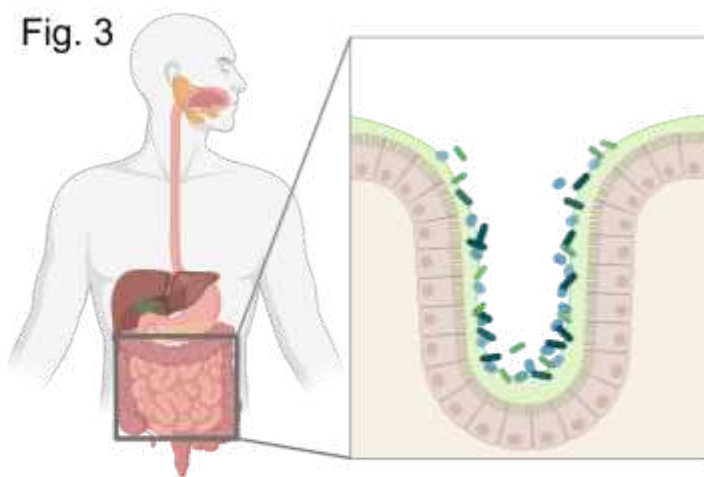


Fig. 3
The intestinal tract is home to a dense community of bacteria that live in the lumen of the gut.

Firmicutes are anaerobic spore-forming bacteria largely responsible for fermenting dietary fiber and interacting with the intestinal mucosa (Sun et al.). A high level of Firmicutes causes an unequal distribution of microbes within the gut. This is related to inflammation; as the number of Firmicutes increases to dangerous levels, it can worsen inflammation within the intestines (Magne et al.). Moderation of such bacteria can help keep the gut healthy.

Actinobacteria are gram positive, anaerobic bacteria. There are three main families of actinobacteria, but one most present in the human gut is Bifidobacteria (Bhatti et al.). Actinobacteria make secondary metabolites that have been shown to possess antibiotic, antifungal, and anticancer qualities (Actinobacteria (U.S. National Park Service)).

Bacteroides are anaerobic, gram-negative bacteria that make up almost 25% of the intestinal gut microbiome. They can cross-communicate with intestinal cells, affect the intestinal immune system, and produce molecules that can change the intestinal immune response (Binda et al.). They play two roles in gut inflammation and inflammatory bowel disease (IBD). While they generally help control immune responses and protect against inflammation, an inequality in Bacteroides can cause immune activation and worsen conditions like Crohn's disease and ulcerative colitis (Salyers and Shoemaker).

Role of the Gut Microbiome in IBD

When compared to healthy people, IBD patients generally have significant changes in their gut microbiome compositions (Ogunrinola et al.). These include less variety of microbes and an inequality in the levels between beneficial and pathogenic bacteria, a condition known as dysbiosis (Shan et al.). For example, one important study showed that compared to controls, IBD patients have lower numbers of the beneficial bacteria *Faecalibacterium prausnitzii* which are Firmicutes known for their anti-inflammatory properties (Martín, Rios-Covian, et al.). Conversely, many patients have increased burdens of potentially harmful bacteria, including Proteobacteria and Enterobacteriaceae – bacterial families linked with inflammation and epithelial barrier disruption (Hills et al.).

Dysbiosis can cause hyper-activation of the immune system (Zeng et al.). In a healthy state, good bacteria, keep gut homeostasis by producing SCFAs, which provide food for colon cells and mimic immune functions (Zhao et al.). Lowering their counts reduces SCFA production, which harms the gut's ability to regulate inflammation (Fusco et al.). Additionally, the overgrowth of pathogenic bacteria could produce harmful metabolites such as LPS, which activate the pro-inflammatory pathways of the immune system (Ney et al.). Imbalance can lead to gut permeability or "leaky gut," which can allow pathogenic bacteria and toxins to enter the intestinal lining and the bloodstream (He et al.). This triggers a chronic immune response, causing sustained inflammation and tissue damage, a characteristic of IBD (Chanchaonthana et al.). The changed microbiome in IBD patients affects several mechanisms which can cause inflammation (Santana et al.). The dysbiotic microbiome communicates with the mucosal immune system and changes the microbiome (Gyriki et al.). The communication can enable dendritic cells and macrophages to create pro-inflammatory cytokines, such as TNF-alpha and IL-6, which push the inflammatory response (Belkaid and Hand). The cytokines disrupt the intestinal barrier and progress the cycle of inflammation (Zhang and An).

Understanding of the relationship between the gut microbiota and IBD has opened avenues for treatment. Some of these strategies include the use of probiotic treatment, prebiotics, and dietary modifications.

Probiotics are a classification of live organisms that are small which have intended health benefits when consumed. Prebiotics are consumed by the human body's microflora. Prebiotics are in foods such as whole grains, bananas, soybeans, as well as others. Prebiotics are used with the intention of improving the balance of these microorganisms ("Probiotics and Prebiotics: What You Should Know").

A number of the many probiotics can be harnessed to repopulate beneficial bacteria to decrease inflammation, not only due to their use in the future but also because the present suggests. Consequently, the use of tailored probiotic treatment might also result in immune response modulation and gut barrier reinforcement (Ji et al.).

High-fiber and fermented foods may modify the growth of beneficial bacteria and their metabolic effects to enhance SCFA production, thus modulating a normally functioning balance among immune responses and gut barrier function (Portincasa et al.).

Several studies do support this type of treatment as an option to combine with other IBD therapies. Fecal microbiota transplantation is the process through which a fecal material from a healthy donor is transferred to a patient with IBD for the purpose of restoration of microbial balance (Basson et al.). Early intervention has shown a potential effect of radical improvement in gut microbiota composition and inflammation reduction, even though more investigations are necessary not only to unravel its long-term effects but also to clearly explain its optimal application.

The interplay of the gut microbiome with the immune system is core in IBD pathogenesis (Qiu et al.). This dysbiosis iterates immune deregulation, increasing inflammation and decreasing the gut barrier's function (Fakharian et al.). The fact that such targeted treatments for restoration of the microbial balance in IBD are already here points out to the enormous potential of microbiome-based therapy in improving patient outcomes.

Impact of the Genetic Makeup on IBD Presentation

Genetics plays a critical role in the development of IBD. Some major genes implicated in the development of the disease include the interleukin-23 receptor (IL-23R), the nucleotide-binding oligomerization domain-containing protein 2 (NOD2), and the human leukocyte antigen complex (Hadad et al.). These genes play a significant role in the body's immune response and often give rise to proinflammatory pathways.

One cytokine that affects how the mucosal immune response is modulated is IL-23 (Korta et al.). It is a member of the IL-12 family of cytokines and it promotes or sustains Th17 cells, which in turn release more cytokines like IL-17 and IL-22 (McGeachy et al.). Although the host is protected from infection by certain pathogens by IL-17 and IL-22, their dysregulation can trigger autoimmune reactions (Mills). The surface expression of T cells, NK cells, and dendritic cells is of IL-23R, the IL-23 receptor. It has been demonstrated that SNPs and gene mutations in the receptor enhance its activity, resulting in an increased signal through the IL-23 pathway and subsequently encouraging chronic inflammation (Sewell and Kaser).

When muramyl dipeptide, a byproduct of bacterial cell wall peptidoglycan, is recognized by NOD2, it acts as a pattern recognition receptor and triggers NF- κ B activation, which in turn

triggers a host immune response (Keestra-Gounder and Tsohis). More significantly, it plays a key role in identifying intracellular pathogenic organisms and preventing immune reactions directed against the commensal microbiota found in the intestines (Balasubramanian and Gao). There is a strong correlation between genetic variations of the NOD2 gene and Crohn's disease (Ashton et al.). The NOD2 protein is faulty as a result of frameshift mutations like 1007fs and missense mutations like R702W and G908R. This impairs cellular autophagy and the production of antimicrobial peptides (NOD2 Nucleotide Binding Oligomerization Domain Containing 2 [Homo Sapiens (Human)] - Gene - NCBI). This flaw causes immune cells to overreact against the normally benign gut microbiota, which results in persistent inflammation (Lauro et al.).

HLAs, or Human Leukocyte Antigens, are proteins located on the surface of almost all cells of the human body (Histocompatibility Antigen Test: MedlinePlus Medical Encyclopedia). They perform a vital role in immunity by allowing the immune system to distinguish “self” protein from foreign proteins (like viruses and bacteria) (HLA-B Gene: MedlinePlus Genetics). Mutations or variants of HLA genes consequently affect immune function and are involved in many autoimmune diseases (Cruz-Tapias et al.). These mutations can alter the presentation of antigens, consequently leading immune cells to wrongly attack one's own body tissues (Nordquist and Jamil). In terms of IBD, a class of HLA genes – HLA Class II – plays a major role in the development of the disease (Stokkers et al.). Knowing these mutations and their consequences helps in the diagnosis of treatment against autoimmune diseases.

Much of the genetic basis of IBD is known and therapies targeted to direct personalized strategies are increasingly being developed. Second variants at IL-23R, NOD2, and HLA modified the host immune response and, through that, did influence the pathogenesis of IBD (Hadad et al.). Results provided a molecular basis for mechanisms driving IBD and opened ground for further research and therapeutic innovation.

Demographics of patients with IBD

In the case of IBD, there are prevalence rate differences among various ethnic groups around the world. It has been noted in several studies that the highest cases of IBD are found in Caucasians (“Groundbreaking Study Led by the Crohn’s and Colitis Foundation Estimates Nearly 1 in 100 Americans Has Inflammatory Bowel Disease (IBD)”). The prevalence rate is approximately 0.3% to 0.5% in North America and Europe (Caviglia et al.). Hispanics have the second highest prevalence, which has been calculated at 0.1% to 0.3% (Aniwan et al.). Those with a family history of IBD are at much greater risk compared to others (“Family History Is Biggest Risk for Crohn’s and Colitis”). First-degree relatives of IBD patients are at an increased risk, by 10 to 15-fold, of developing IBD compared to the general population (American College of Surgeons Division of Education). This familial risk is greater in Caucasians for whom individual genetics studies have identified many risk alleles, including those in the IL-23R and NOD2 genes, that explain some of the elevated risk for the disease (Jarmakiewicz-Czaja et al.).

There are also geographic and socioeconomic factors that influence diagnosis of IBD. It is more prevalent in urbanized and developed regions; the prevalence of IBD in North America

is 0.25%-0.35%, while in Europe, it ranges between 0.3% and 0.5% (Caviglia et al.). Because of the factors such as pollution, antibiotic use, and diet that lead to inflammation, citizens of urban areas in Western countries have a higher risk (Vedamurthy and Ananthakrishnan). The Hygiene Hypothesis, which suggests that lower exposure to microbes in childhood contributes to an increased risk for autoimmune disorders like IBD, is also associated with the higher hygiene standards of urban living (Okada et al.).

More recent studies indicate an increasing incidence of IBD in previously low-risk areas, such as the eastern part of the world (Alatab et al.). In countries across Asia and Africa, there is a rising trend of IBD cases correlating with possible pollution and dietary changes (Hodges and Kelly). For instance, the prevalence of IBD in China and India have been increasing at about 10 to 15 percent yearly, showing the impact of urbanization and dietary influences from the west (Pandey et al.). Strikingly, one clear pattern shows, among other reasons, the big role that environmental and lifestyle changes play in the global spread of IBD (Abegunde et al.). The rising prevalence in non-Western countries points out a clear need for public health strategies to regard IBD as a global health concern (Kaplan and Windsor).

The Pollution, Hygiene, and IBD Link

Exposure to exogenous pollutants like sulfur dioxide and nitrogen dioxide has been linked to the course of IBD (Zaltman et al.). Sulfate and nitrate particles contribute to acid rain, which, when falling on the plants we eat, may then damage the gastrointestinal system (“Effects of Acid Rain | US EPA”). Apart from the effects on crop yields, acid rain could also affect the quality of the diet (Fatma and Ahmet). It introduces harmful substances into the diet that might upset the gut microbiota and hence be proinflammatory for the gut (Hills et al.). Additionally, exposure to residential SO₂ and NO₂ can lead to an increased incidence of IBD, since these gasses are capable of creating oxidative stress and inflammation in the gut lining, an event which could trigger or worsen IBD symptoms (Kaplan et al.).

The relationship between smoking, nicotine, and IBD is complex. Smoking, on the one hand, has been very well documented as a risk factor for the development of CD, while on the other hand, it seems to have a protective effect against UC (Berkowitz et al.). Smoking itself causes inflammation and oxidative stress, which aggravate symptoms in IBD patients and finally lead to the development of disease (AlQasrawi et al.). However, nicotine, a compound formed in tobacco composition, was shown to alleviate symptoms in some UC patients (Benisek). Studies show that nicotine probably induces the receptors on some types of immune cells, thereby reducing the production of pro-inflammatory cytokines. Thus, inflammation in the colon is reduced in subjects with the condition (Zhang et al.). Even in the light of these findings, nicotine cannot be seen as a potential therapy for IBD in view of the overall toxic effects of nicotine and its addiction potential (Guslandi). Chronic exposure to nicotine may induce cardiovascular disease, dependence, and multiple systemic toxicities, which makes nicotine an unlikely therapeutic option for IBD (Price and Martinez). Therefore, while nicotine has transient

beneficial effects on symptoms in UC, it is far outweighed by its negative effects, thus raising the need for safer treatment options.

The hygiene practices and use of antibiotics have a strong impact on the gut microbiome (Patangia et al.). Poor personal hygiene can contribute to frequent infections of pneumonia, urinary tract infections, and 'strep throat', each of which is normally treated with antibiotics (“Colds and Flu: Do You Need Antibiotics?”). While such antibiotics might be effective against infections, they have an antagonistic effect on the gut microbiota by killing the beneficial bacteria (Felman). Such a disruption could make the gut more compromised and therefore open to the development of inflammatory conditions like IBD (Shan et al.). Another theory is the hygiene hypothesis: the lingering creation of overly sterile environments, to which exposure in childhood can mean increased susceptibility to autoimmune diseases like IBD (Okada et al.). The reduced exposure to microorganisms during early life might avert the development of a healthier immune system and lead to hazardous immune responses (Stromberg). What this theory does stress is the need for balanced exposure to microbes for the healthy development of the immune system, and it does caution against excessive cleanliness.

In terms of the interplay between genetic and environmental risk factors, environmental factors—such as pollution, lifestyle habits like smoking, and hygiene practices—play a very big role in the prevalence and development of IBD. While SO₂ and NO₂ pollutants affect gastrointestinal health directly through diet and by inducing oxidative stress (Rio et al.), the complex role of smoking and nicotine in general has risks and benefits, mainly for UC (Guslandi). However, the health risks from nicotine make it unsuitable for treatment (Mishra et al.). The Hygiene Hypothesis and antibiotic use further underline this required balance in the gut microbiome to keep up good health (Langdon et al.)—this very balance that is important for preventing inflammatory conditions like IBD.

Diet and its link to IBD

Diet is a major determinant of risk and management of IBD (Hashash et al.). High intake of fruits, vegetables, and fiber-based diets reduces the risk of IBD through simple food elements and pro-health gut-related bioactive compounds provided by them (Campmans-Kuijpers and Dijkstra). High intake of saturated fats, red meat, animal fats, and processed foods, on the other hand, can predispose an individual to IBD due to their high levels of linoleic acid and other fats that might have proinflammatory effects in case the body does not absorb them well (Limdi). Refined foods have low satiety potential, and thus one can end up overeating. When they overeat, people can end up eating unhealthy foods or too much of one specific kind of harmful food leading to inflammation (Shapira).

Fiber forms an integral part of gut health (Fu et al.). Soluble fiber absorbs water in the intestines, making stool softer, while insoluble fiber gives bulk to the stool for its passage (Cdces). While insoluble fiber may cause irritation of the intestines, inadequate fiber causes bowel obstruction (Dresden). Gut bacteria ferment fiber into SCFA, such as butyrate, which as mentioned above, can promote anti-inflammatory responses (Ney et al.).

L-Carnitine is an amino acid rich in red meat. When ingested, the gut microbiota is capable of metabolizing L-carnitine into the metabolite TMAO, a molecule implicated in heightening cardiovascular disease risk (“Research Links Red Meat Intake, Gut Microbiome, and Cardiovascular Disease in Older Adults”). Studies have revealed that in IBD, choline levels are usually higher, but carnitine levels were similar. Additionally, decreased TMAO levels are seen in IBD compared to those without the disease, suggesting a new factor to diagnose patients effectively (“Trimethylamine-N-oxide: A Novel Biomarker for the... : Official Journal of the American College of Gastroenterology | ACG”).

High sugar intake, typical of Western diets, instigates drastic changes in the gut microbiome (Satokari). Based on a study conducted in mice, high-sugar diets thinned protective mucus in the intestines by reducing beneficial bacteria and increasing bad bacteria. These changes can lead to colitis and metabolic disorders by promoting inflammation and lowering the gut's ability to act against disease-causing pathogens (“High-sugar Diet Can Damage the Gut, Intensifying Risk for Colitis”). Additionally, glucose can induce loss of the beneficial Th17 immune cells (D. Zhang et al.).

Conclusion

IBD, both Crohn's and ulcerative colitis, is an important area of study because the prevalence of the diseases keeps increasing in people with significant deterioration in the quality of life. The estimation of approximately 1.6 million affected Americans and about 80,000 diagnosed children calls for a dire need to know means and ways of managing IBD (Rosenthal et al.). The condition has a complex etiology that incorporates dietary, environmental, autoimmune, and genetic aspects; hence, it requires continued research and public awareness.

The rising prevalence of IBD also points to a pressing need for research into environmental stressors and microbial influences on gut health. Indeed, current research is unraveling the contribution these elements make during the process of disease development and symptom severity. In addition, understanding the role that diet may play in either aggravating or relieving symptoms can help in devising more effective management strategies.

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Freedom of Speech and Social Media: Striking a Balance Between Misinformation and Censorship By Eddy Chen

Freedom of speech is one of the foundational principles of American democracy. Although the United States Supreme Court has issued a number of decisions regarding this issue, the line between what type of speech is protected under the First Amendment of the Constitution and what is not remains subject to debate. Over the last several years, this debate has been reinvigorated by the advent of the internet and social media, raising the critical question of whether the suppression of harmful ideas on social media and other online platforms is consistent with the First Amendment or even particularly effective at combating misinformation. Through an examination of key legal precedent and harmful social media posts, this essay will argue for a new standard to guide courts and social media platforms as they attempt to combat misinformation and protect free speech within the ethical gray areas of our ever-advancing technological world.

Not all potentially harmful speech raises a grave enough threat to justify a departure from the First Amendment's broad protections. The landmark 1969 Supreme Court case *Brandenburg v. Ohio* offers a useful test to determine which types of harmful speech circulating on social media today might not deserve protection under the First Amendment. In this case, the court asserted that freedoms of speech and press "do not permit a State to forbid advocacy of the use of force or of law violation except where such advocacy is directed to inciting or producing imminent lawless action and is likely to incite or produce such action" (*Brandenburg v. Ohio*).

The court's use of the word "imminent" is key to interpretation of this ruling. By its choice of this word, which is defined as "coming or likely to happen very soon," the court limited the type of speech that can be prohibited to that which is meant to precipitate "lawless action" in the very near future (Cambridge University Press & Assessment). The court later cited this ruling in the 1973 case *Hess v. Indiana*, in which it overturned the conviction of a man who, as the police were clearing the street during an anti-war protest, exclaimed, "We'll take the ... street again." In exonerating the appellant, the court cited the fact that, according to witnesses, he "did not appear to be exhorting the crowd to go back into the street" (*Hess v. Indiana*). In other words, although the man was advocating a particular action, his speech was not specifically meant to cause that action to occur in the imminent future. Thus, this speech was protected under the First Amendment.

This so-called *Brandenburg* rule could be applied directly to potentially harmful speech on social media platforms. For instance, under this rule, a post that provides the address of a particular individual's residence and exhorts people to immediately go and set fire to the house would be removed, as it is meant to incite lawless action—specifically, arson—in the immediate future. Furthermore, the fact that the post provides the address of the building in question increases the probability that the post would be "likely to incite or produce such action," in violation of the second criterion of the court's test in *Brandenburg*. On the other hand, a post that extols the pleasures of arson without specifying a particular time and target would not be

removed, as its invocation of lawless action is too vague and general to fall afoul of the Brandenburg rule.

While the standard Brandenburg test could be applied directly to posts on social media platforms, a better alternative would be to apply a modified version of it, one that focuses not on the promotion of unlawful actions per se but on the promotion of actions that are likely to cause physical harm to a person or group of people. Such a rule would, for instance, apply to certain social media posts that promote the ingestion of harmful products like bleach or hand sanitizer as a means of warding off or curing COVID-19, as many posts on social media platforms like YouTube and Twitter did during the pandemic (Coleman; Dickson). A post that urges people to immediately go to their pantries or medicine cabinets and drink the bleach or hand sanitizer that they find there would, under this rule, be removed even though the consumption of these products, while physically harmful and potentially lethal, is not strictly illegal. Conversely, a post that states that consuming these products is an effective way to cure the disease, without exhorting people to immediately find and ingest them, would not be removed under this rule, as it is not meant to incite imminent action.

One might reasonably raise the objection that it would be better to remove all social media posts extolling the supposed virtues of drinking bleach or hand sanitizer, whether they are meant to provoke imminent action or not, as any such post could potentially instigate the consumption of these toxic chemicals. Such a broad policy, however, would not only unduly undermine the free speech protections afforded by the First Amendment but would also eliminate important opportunities for people to learn that false statements, rumors, and conspiracy theories are, in fact, false. Regardless of whether social media posts on the subject exist, it is still likely that some people will believe that the ingestion of these chemicals is effective in curing COVID-19, possibly because they thought of the idea themselves or because they heard it from a friend, relative, or political figure (Rogers et al.) In situations like these, social media posts advocating this position could actually be helpful in disabusing people of this erroneous belief because they offer an opportunity for discussions in which the concept can be debunked.

This curative power of speech must be weighed against any efforts to restrict the flow of potentially harmful ideas. In an essay advocating for the protection of bigoted speech, for example, the American Civil Liberties Union (ACLU) states, “Where racist, misogynist, homophobic, and transphobic speech is concerned, the ACLU believes that more speech—not less—is the answer most consistent with our constitutional values,” and contends that “real social change comes from hard work to address the underlying causes of inequality and bigotry, not from purified discourse” (American Civil Liberties Union). A similar notion pertains to social media posts endorsing the consumption of bleach or hand sanitizer. Without such posts, which often trigger a plethora of replies in which people offer arguments against the ingestion of those poisonous compounds, many people who already believe that drinking those chemicals cures COVID-19 would never be exposed to those counterarguments and thus would not be disabused of this potentially harmful belief.

It is important to note that the concept of speech—which, in the case of social media, is most often understood to encompass both written words, as in a tweet, or spoken words, as in a YouTube video—also includes expressive conduct that does not involve the use of words at all and that such nonverbal, non written speech is also protected by the First Amendment. In the 1989 case *Texas v. Johnson*, the Supreme Court, asserting that the right to free speech “does not end at the spoken or written word,” ruled that “burning an American flag as a means of political protest” constitutes “symbolic speech protected by the First Amendment” (*Texas v. Johnson*). Similarly, in the 2003 case *Virginia v. Black*, the court stated that “the burning of a cross is symbolic expression” in that it “represents the message that the speaker wishes to communicate” (*Virginia v. Black*) while in the 1992 case *R.A.V. v. City of St. Paul*, the court contended that “[b]urning a cross at a political rally would almost certainly be protected expression” (*R.A.V. v. City of St. Paul*). Thus, posts that contain neither verbal nor spoken words—that, for instance, contain only images, either still or moving—should also be protected according to the modified Brandenburg rule described above. Indeed, a video of the burning of an American flag or of a cross should, if posted on social media, be afforded the same protections that the Supreme Court afforded those same actions in the physical world.

The debate over the boundaries of free speech in the context of the internet and social media remains complex and evolving. The principles established by the Supreme Court provide a useful framework for discerning between protected social media posts and those that should be removed due to their potential to incite imminent lawless action. Adapting these principles to the digital age, however, requires a nuanced approach. Modifying the Brandenburg rule to encompass speech that promotes physical harm, regardless of the legality of the actions endorsed, offers a balanced solution, one that protects free speech while addressing the real dangers posed by misinformation. Despite these dangers, free speech must be protected, and fostering an open dialogue, even about harmful ideas, plays a crucial role in the debunking of false beliefs—beliefs that, depending on their nature, have the potential to cause physical injury to an individual or existential harm to the democratic institutions on which this nation is based.

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Do We Have Any Good Reasons to Trust Our Moral Intuition? By Xirong Wu

We do not have any good reasons to trust our moral intuitions due to their susceptibility to emotional influence, and the suspect origin of human sentiment. Nevertheless, relying on moral intuition is unavoidable.

This argument will first explain how moral intuitions play into moral judgements, then present both psychological and philosophical evidence for their untrustworthy nature. Finally I will argue that incorporating rational deliberation into moral decision-making will mitigate and, in the long term, improve the moral intuitions we must rely upon.

Moral intuitions are deeply rooted within human's cognition and social interaction, therefore unavoidable. Psychologist Jonathan Haidt studied people's response to a scenario in which a pair of siblings, brother and sister, decided to make love. Haidt reported that most of the audience immediately judged that what the two siblings did was wrong given their own reasons. After emphasizing details in the scenario that suggested a fallacy in their reasons (the danger of inbreeding, for example, defeated by the fact that the brother and sister in the scenario used two forms of birth control), many were unable to offer further defense of their judgment but nonetheless believed their judgment to be correct (Singer, 337). Thus Haidt states elsewhere that "intuitions come first, strategic reasoning second" (Haidt, 14). Haidt argues that moral intuitions serve as a cornerstone to judgment and reasoning. The nature of moral intuition therefore shows that we have no choice about their involvement in our moral judgments.

In *A Treatise of Human Nature*, David Hume stated, "Reason is, and ought only to be the slave of the passions, and can never pretend to any other office than to serve and obey them." Hume considers passions a fundamental aspect of human psychology and motivation. They are the "original existences" that arise from our internal constitution and the interaction between our minds and externalities. This means that reason alone is not capable of motivating our moral judgements and actions. Rather, passion drives decisions and behaviors. While intuitions, rooted in passion, motivate moral action, what feels morally right or wrong can be inconsistent over time and in different situations. And due to the nature of human's ever changing emotion, this inconsistency will undermine the reliability of moral intuition as a stable influence and guide to moral judgements and decision-making. Considering Haidt's study above, the philosopher Peter Singer concluded that "it is the intuitive response that is responsible for the judgment these people reach, not the reasons they offer, for they stick to their immediate, intuitive judgment, even after they have withdrawn the reasons they initially offered for that judgment, and are unable to find better ones." This proves that humans tend to base judgments, decisions, and actions solely upon their moral intuitions.

Moral intuitions are further unreliable because of their susceptibility to emotional influence, leading to unstable judgments. We humans are emotional species, and many things come in impact of our emotions, most importantly, intuition. As intuition requires little to none rational analysis and logical thinking, it is solely based on either portrayals of what we've been educated or based on the situation and emotion of the person. In many situations, when a moral

dilemma introduces factors that underscore personal belief, one tends to have a stronger and typically more negative emotional response. Indeed, psychologist Joshua D. Greene studied this phenomena by conducting MRI scans while participants respond to the second version of the Trolley problem: whether or not to throw a stranger down a footbridge to prevent the trolley from killing five other people. The report reveals a presence of greater cognitive engagement among individuals balancing personal violations against moral theories (such as “minimize harm”), while those relying solely on intuitive judgments lack this cognitive activity (Greene 2001, (Greene 2001, 17) He explained in a different work, “Because people have a robust, negative emotional response to the personal violation proposed in the footbridge case, they immediately say that it’s wrong” (Greene, 178). In short, the emotional influence in moral intuitions leads to their instability, hence making moral intuitions unreliable in guiding moral judgments.

Therefore it is important to recognize common false notions within our moral intuitions as it impacts moral outcomes in humanity. Jonathan Haidt suggests a balanced approach to moral intuition by integrating it with rational deliberation. While moral intuitions are inevitable and provide an initial basis for moral decisions, Haidt advocates for using moral reasoning to complement and refine intuitions. Engaging in reasoned discourse and rational thinking helps mitigate the potential fallacies of intuitive judgments and enhances the trustworthiness of decision-making processes.

Take slavery as an example: for centuries, many cultures and regions around the world had accepted and practiced slavery and individuals within these societies often had strong moral intuitions that supported this. With these moral intuitions, people naturally viewed slavery as something justified, acceptable, and an irreplaceable factory for economic and social order. Now, we view slavery as something morally wrong, violating human rights and dignity without a doubt. The belief was reformed with the assistance of logical and rational reasoning until the current belief that slavery is morally wrong had become most people’s intuitive judgment.

This example proves that moral intuition can offer important initial insight into moral dilemmas, nevertheless, they cannot offer a trustworthy and decisive guide to moral truth. Although we lack compelling reasons to blindly trust moral intuitions, acknowledging their inevitability requires balancing their role with reasoned reflection. This approach enhances moral understanding and facilitates navigating the complexities of moral dilemmas effectively.

In conclusion, although moral intuitions are often deemed unreliable due to their susceptibility to emotional influence and inconsistent reasoning, they remain unavoidable in forming initial moral judgments. We need a more nuanced exploration of moral truth. An integration of rational thinking with intuitive judgment during moral decision-making enhances our understanding of complex situations and helps us avoid over-reliance on fallible intuitions.

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A Current Status of Menstrual Health Awareness Among Rural Communities in India By Disha Goswami

Abstract

Menstrual health in rural India is often an overlooked aspect of public health that significantly affects the health of menstruating individuals. The rural areas still lack hygienic menstrual products and inadequate sanitation facilities due to unaffordability and unavailability issues. Pervasive myths, misconceptions, and cultural stigmas still surround menstruation, further hindering the open discussion resulting in misinformation and poor practices. In this meta-analysis data from 13 studies has been combined to draw outcomes regarding the roots of poor Menstrual Health Management (MHM), its current status, and possible approaches to mitigate issues surrounding MHM. Increasing awareness regarding menstrual hygiene requires a multifaceted approach. First and foremost, curriculum-embedded education for both genders is essential to demystify this issue. Secondly, the involvement of governmental and non-governmental organizations for low-cost sanitary products, development of infrastructure, and better sanitation facilities. The third aspect is teacher training to promote healthy practices, and lastly, community-wide open discussion about menstrual health hygiene with dignity are crucial steps to increase menstrual health awareness in rural Indian communities.

Keywords Menarche, Puberty, Social, Cultural, Norms

Introduction

Menstruation Introduction

Menstruation is a physiological process involving the regular discharge of blood and mucosal tissue from the uterus lining through the vagina. It is an imperative phenomenon that begins during a girl's adolescence and continues through adulthood. Its primary role is supporting reproduction, so maintaining menstrual health and hygiene is crucial. The age of the beginning of menstruation, known as menarche, varies based on geographical location, age, activity, and several other factors, however, on average, it occurs between the ages of 8 and 16 with a median of around 13 [1]. A woman in a low-income country based on collected data on average menopause age is presumed to menstruate for approximately 1400 days in her lifetime [2].

Sociocultural Norms

Across the world, global menstruation has been regarded with a variety of social and cultural norms, which in turn impact the lives of girls and women. The sexual connotations of menstruation, along with being regarded as 'disgusting' make it a taboo topic for mothers to speak about with their daughters, and so the onset of menstruation is often fearful and shocking for young girls.

Without access to proper information about its management, these girls are often anxious to get their period. After menarche, they can also face social implications while menstruating such as exclusion, from everyday tasks including touching the water, cooking, cleaning, attending religious ceremonies, socializing, or sleeping in one's own homes or beds [2].

Generally, social restrictions vary across different Indian communities, however, based on a study done in Puducherry these include girls being asked to sleep separately (58.7%), and restricting religious events (44.6%) [3]. Another study conducted by Datta Meghe Medical College reported significant restrictions that were imposed on the girls during menstruation were not being allowed to attend religious functions (97.93% of respondents), as well as not being allowed to attend classes (65.86% of respondents) [6].

A study led by Muthusamy Sivakami in 2015 investigated facilities in schools in support of menstruating girls. Generally, only around half of respondents thought there were enough toilets in their school to deal with their menstruation, however, only 37% of girls stated that their school had toilets exclusively for them. 76% of girls in model schools vs 63% in regular schools stated that they were allowed to leave their class during accidental leaking/stains. Similarly, 73% of girls in model schools believed they had sufficient time during breaks to change their pads while only 55% in regular schools believed so. Percentages of access to washing facilities in general were low, with an average across both types of schools at 51% reporting they were present [5].

Current Status of Menstrual Hygiene Awareness

The current situations of the girls show that despite organizations; attempts to help certain targeted areas, there is still a widespread lack of awareness of menstrual hygiene practices, which results in a variety of both health and social effects.

Based on a study by the Department of Community Medicine, IGMCRI (June 2015-July 2015), Puducherry, 51.7% of female adolescent respondents were unaware of menstruation before menarche. 71.5% and 61.2% weren't aware of the cause of menstrual bleeding, or the source of menstrual bleeding correspondingly. 78.1% of respondents used only sanitary pads, while 21.9% used both old clothes and sanitary pads.

In terms of disposal, due to the lack of appropriate disposal options in their schools, girls tend to stay at home while menstruating. At home, however, based on a study conducted on menstrual waste disposal, results showed that 28% of pads were disposed along with routine waste, 28% were disposed in the open, 33% were buried in mud, and 28% were burned in the open [9].

Sometimes, girls don't even have access to toilets, which was investigated in one of the studies conducted to investigate differences in menstrual hygiene conditions based on socioeconomic backgrounds [7]. The outcome of this study deemed that around 8 out of 71 (11.2%) girls didn't have toilets at home and had only to access community toilets or else go elsewhere.

Health Implications due to lack of Menstrual Awareness

Most of the time, adolescent girls are unaware of the necessary hygiene requirements they should take to ensure appropriate menstrual hygiene. This could result in ill-health infections such as genital tract infections, urinary tract infections, and bad odor [3]. Potential long-term effects of poor menstrual hygiene include premature births, miscarriages, stillbirths, infertility problems, and carcinoma cervix (cervical cancer) as a complication of recurrent reproductive tract infections [4].

A study conducted by the Department of Community Medicine, Maulana Azad Medical College, Delhi, reported more than 50% of respondents suffering from dysmenorrhea (painful menstrual periods) during menstruation. In a similar case, due to reports of dysmenorrhea, around 80% of girls reported a decline in their academic performance, thereby showcasing the hindrances of academic focus or ability during periods due to being distracted by the pain. Around 20% of the girls stated that they did not consult anyone for help during their periods, not even their mothers [7]. In a similar study, an extremely high proportion of girls (88.4%) reported having at least one reproductive tract infection. Out of these 88.4% of girls, only 41.6% received treatment from any registered medical practitioner.

In conjunction with what has been previously mentioned, poor menstrual hygiene can not only exacerbate menstrual pain and discomfort, contributing to higher rates of dysmenorrhea and related absenteeism from school or work, but the psychological impact is also noteworthy, as girls and women may experience increased stress, anxiety, and embarrassment, further hindering their daily activities and social interactions. Not knowing of any diseases they may have, which is common across girls, will further lead to facing any harmful effects of not getting the appropriate treatment. In a study by Shri Arbindo Institute of Medical Sciences, 51/75 girls had PCOS unknowingly and were only found out after conducting the study. In cases of acute PCOS, not having access to good treatment options could hamper quality of life [10].

Menstrual Health Management (MHM)

There are quite a few studies focused on the ‘best’ absorbent used during menstruation. Here, the term ‘best’ was used very loosely, and each study had its definition of what is deemed as the best absorbent; however, the results were similar across various studies. All deemed that the use of sanitary pads was considered good menstrual health management. Rags or cloths, in comparison to sanitary pads, are said to be poor hygiene practices, however alright if washed hygienically and dried in the sun. A significant piece of data found in a study demonstrated that wearing rags washed in contaminated rivers was determined more unhygienic than wearing no absorbents at all and cleaning with the corner of a saree due to the high amount of pollutants present [8]. A cross-sectional study done by Sonali K Borkar et al from Community Medicine, Datta Meghe Medical College showed that the duration of the menstrual cycle ranged from 21-35 days in most of the girls (90.69%), and it was regular in 85.86% of girls. Around 73.79% of girls were using sanitary pads, while 26.21% of girls were using clothes. After conducting a statistical analysis of their results, they deemed that sanitary pads were used

significantly more in late adolescent girls than in early adolescent girls [6].

Significance of the Study

Thus, ensuring proper menstrual hygiene is crucial not only for preventing immediate health problems but also for promoting overall quality of life and well-being, as proven by the studies. This meta-analysis will provide a robust, comprehensive overview of the status of Menstrual Hygiene awareness in India by analyzing the data of recent research articles. This meta-analysis can help policy decisions, health education programs, and interventions aimed at improving menstrual hygiene management, especially in resource-limited settings.

METHOD / SEARCH STRATEGY

The search strategy was based on finding data collected by trusted organizations regarding menstrual health, Menstrual Health Management (MHM), and the effects of current lifestyle on the hygiene of adolescent girls. Three major sources used to find research studies were PubMed, NIH, and Research Gate, all of which are online databases. All of the studies selected dated back no less than 15 years ago, in order to get a wide spread of data to use while still being mindful of the possible alterations that could have significantly occurred during the period. Significant keywords were used while searching for research articles to help divide the review into parts; Hygiene data, health effects, and social effects.

Each of the eligible studies was found in peer-reviewed journals to ensure their credibility. All data was exclusively on studies derived from primary research to ensure the data reflected first-hand observations. To maintain the specificity of the review, studies concentrating on tampon use, prevalent in more developed regions of India, were deliberately excluded. This decision was made to concentrate on the use of sanitary pads and their substitutes, such as rags and toilet paper, which are more common in rural areas. Studies that focused on the use of tampons in more developed regions in India were excluded from the search to base the study on the use of pads and pad substitutes in more rural areas across India.

To find reliable data, the credibility of the research institution, the lead investigator, and the credibility of the data itself were checked before using it to conclude the review. Each of the data collected was to be from districts in India. Following this, the data from each of the studies was tabulated and compared based on the following parameters; sample size, general menstrual data collected, the practice being investigated, and study outcome data.

Results

Survey articles were used to conclude menstrual health hygiene among girls in rural India. The categories of the 13 surveys used for this meta-analysis were: not aware of menstruation, unaware of the cause of menstruation before menarche, sleeping separately during menstruation, restricted from religious events, not allowed to attend classes, sanitary pad users compared to users of both sanitary pad and clothes, proper disposal of a sanitary pad in dustbin vs buried in mud, didn't have a toilet at home, suffering from dysmenorrhea, the decline in

academic performance due to dysmenorrhea, reproductive tract infection vs received treatment for reproductive tract infection. These surveys reported that 97.93% of girls were not allowed to attend religious functions, 71.5% were not aware of menstruation before menarche, 61.2% were unaware of the cause of menstruation, and 65.86% were not allowed to attend classes. 58.7% were asked to sleep separately during menstruation. 78.1% use sanitary pads only while 21.9% use both sanitary pads and cloth. 28% of pads were disposed along with routine waste, 28% were disposed in the open, 33% were buried in mud, and 28% were burned in the open. 11.2% of girls do not have a toilet at home. A survey reported that 50% of girls suffer from dysmenorrhea out of which 80% experience a decline in academic performance. Another survey reported 88.4% of girls have at least one incident of reproductive tract infection out of which only 41.6% received treatment. 20% of the girls never received any consultation during their period.

Discussion

Older women, schoolteachers, and health workers get uncomfortable discussing the topic due to stigma and the prevailing sociocultural norms and practices. Right now, taking action such as implementing MHM embedded curriculum as a part of what is taught in school to both girls and boys can help. Teaching boys increases male sensitization, and therefore on a community level fosters a more accepting community and urges girls not to be afraid of asking for help or speaking up about any issues. It also secures the idea that girls will now know what is happening in their bodies and reduce their panic when getting their periods: being more aware of the purpose behind puberty and menstruation. This approach drives away from the idea of just managing it at menses and rather prepares the girls for the onset of menstruation.

Initiatives are already in place around the world to promote good hygiene practices. Menstrual leaves can be administered in cases where the school doesn't have the appropriate resources to support girls on their periods, or in severe cases of dysmenorrhea (or other menstruation-related issues). With the assistance of non-governmental organizations, menstrual hygiene products, even the most basic ones can be provided to girls and reduce their dependency on old rags, and cloths. Moreover, the government should exempt basic sanitary pads & menstrual health products from the tax. Currently, religious marital signifiers such as bangles and sindoor are already exempted from tax, along with contraceptives while pads are not. Removing the tax will promote the use of hygienic products, therefore promoting hygienic practices [12].

Since there is a lot of misconception regarding menstrual health currently, only bolstered by the taboo surrounding the topic, teachers themselves lack scientific awareness of menstrual health issues and how to teach their students appropriately. Furthermore, the lack of female teachers in particular schools serves as another obstacle due to being quite an uncomfortable topic for male teachers to teach. Male teachers also don't have any personal experience, so aren't as equipped to answer questions. In non-English-medium schools, which are quite popular among schools in rural India, having to teach in Hindi means requiring the use of vernacular terms for the reproductive organs, which often makes it embarrassing for both the students and teachers while learning.

In addition to male sensitization, reducing stigma can also be done through conducting workshops that allow both health professionals and female role models to diffuse teachings about good menstrual hygiene practices. Workshops should extend to both children and their parents, especially their mothers, to create a safe space at home, and to reduce extra pressures they incur from parents not to ask their menstrual health queries and issues. Simply providing the resources won't do much unless the taboo around the subject is reduced. There is also a distinct gap between parents' and teachers' expectations regarding who will introduce these topics to adolescents, and therefore workshops being done by non-governmental organizations (NGOs) are attempting to bridge this gap through workshops [11]. Similarly, schools can begin integrating milder versions of the subject into their curriculum to avoid being laughed at during class and introduce the subject in earlier grades.

Conclusion

Though there have been advancements with MHM in India, there are still several challenges faced by rural girls when it comes to hygiene practices. It is crucial to ensure the awareness of good hygiene practices, however, each of the studies explored in this review has reinforced that menstrual health awareness is currently subpar and requires refinement to prevent the risk of diseases due to poor MHM.

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Optimal Use of AI in Telehealth And How They Are Implemented In Mental Health Applications By Sidharth Deepak

Abstract

AI has been used in many fields in healthcare, and telehealth is no exception. AI has shown that it can be revolutionary in telehealth with its rapidly evolving manner and ability to analyze large data sets. This paper aims to dive deep into how AI can be implemented in telehealth, especially in mental health. It discusses various ways in which AI can be implemented, including symptom checkers, imaging analysis, and virtual assistants. A literature review is the main component and methodology of the paper's research and its findings. It also includes results obtained by companies that have already found use for AI in their applications. The objective of this paper was to find out the optimal role of AI in telehealth and mental health, highlighting both its uses and ethical concerns when it comes to implementing them.

Introduction

Telehealth is the technique of delivering remote medical consultations, tests, and surgeries while also encouraging interprofessional cooperation in the healthcare business (Amjad et. al. 6655). The COVID-19 pandemic has catapulted the healthcare environment into rapid development. The need for rigorous review mechanisms grows as they become more integrated into the global healthcare system. The COVID-19 pandemic was a watershed moment in the advancement of telehealth and AI-powered telemedicine technology, transforming the landscape of healthcare delivery (Burrell 721). AI in telemedicine has the potential to improve the implementation of the healthcare continuum significantly. They can encourage and enable increased access to integrated healthcare at all stages of a citizen's life. Chronic illness treatment requires interdisciplinary, ongoing, and coordinated care. Remote care can provide consistent communication and relationships across many aspects of healthcare delivery. AI may help meet this requirement by creating an intelligent information and communication environment in which health professionals can engage and provide a knowledge base for patient management (Fernandes 10). Mental health is a condition of mental well-being that allows individuals to cope with life's stressors, achieve their potential, study and work effectively, and contribute to their community (WHO). In 2019, 970 million individuals worldwide had a mental condition, with anxiety and depression being the most prevalent (WHO). Despite this, many individuals ignore the urgency of addressing this societal issue. AI technology in the healthcare system is ubiquitous, but the field of mental health is gradually expanding, and it is assisting mental healthcare in various ways. Practitioners rely on patient-centric information gleaned via narrative encounters and observation of patient behaviors and emotions. AI has the potential to transform the whole diagnostic process for mentally ill people and aid in the understanding of mental disease (Avasthi 90). Traditional approaches to mental health diagnosis and treatment can encounter financial, accessibility, and stigmatizing barriers. These hurdles have encouraged the development of novel solutions, including incorporating artificial intelligence (AI) into the

mental health field. AI, with its powers in data analysis, pattern recognition, and automation, has the potential to alter how mental health issues are identified, managed, and treated (Shah 74). Integrating AI into the telehealth and mental health areas raises several ethical problems. These considerations cast doubt on the future of AI's application in telemedicine and mental health, as well as data privacy and security throughout healthcare itself. Artificial intelligence (AI) has the potential to significantly impact healthcare delivery, particularly in telemedicine and mental health. This study aims to examine the unique capabilities of AI in these domains, such as remote patient monitoring and chatbots for mental health support. By comparing these functionalities to those offered by existing healthcare organizations, the research will identify areas where AI can provide distinct advantages. Furthermore, the study will explore the ethical considerations surrounding AI development in healthcare. This is crucial for ensuring responsible implementation that prioritizes patient well-being and data privacy. By critically evaluating both the potential and limitations of AI, the research will shed light on its most appropriate applications within telemedicine and mental health.

Methodology

Systematic Literature Review (SLR) was used for the paper's research, as it is reliable since all the papers have already been peer-reviewed. The main database used was Google Scholar to collect the papers. Google Scholar was used since it provides peer-reviewed papers that are trustworthy. To collect the papers, the following keywords were used: "AI in telehealth," "AI in mental health," "AI in telemedicine," "Machine Learning in Telehealth," "Machine Learning in Mental Health," and "Chatbots in Telemedicine." A total of 10 papers were selected based on. The papers were selected from a time frame between 2021 and 2024. The selection criteria were based on the relevance of the papers' content to the objectives of this paper. The papers were searched for methods of how AI is being implemented in telehealth and mental health to understand both the use cases of AI. The papers were also searched for the effectiveness and accuracy of AI in diagnosis compared to different AI techniques used and a direct comparison to the accuracy and effectiveness of a physician's diagnosis. This allows us to clear the air on the most effective way to implement AI and the best methods of AI processing that can be used. Another part of this research consists of studying and analyzing how companies have implemented AI into their facilities and the results and research behind the implementation. For this, we have selected 4 different AI companies that implement AI in various ways. We have chosen companies that focus on telehealth or remote health and companies that provide their results and research behind the development of their AI. This allows their results to be used in assessing the current effectiveness of AI and how it can evolve from this point. It also allows us to compare and contrast the given results with those of the research papers, allowing us to validate the results of these startups. This validation can be crucial in coming to a feasible conclusion about the effectiveness of AI and its optimal role in telehealth.

Literature Review

Why telehealth is the perfect playground for AI advancements

AI is an ideal fit for telehealth for numerous reasons. AI's ability to process and analyze large data sets efficiently and accurately can significantly increase the efficiency of current healthcare and telehealth services. Furthermore, since the training of AI mainly involves pattern recognition, AI can only get more accurate with each patient it analyzes, which, in the case of physicians, can reach a plateau. Secondly, due to AI's efficiency in learning and utilizing information, along with the rapid development of machine learning, AI can keep up with the speed of development in the telehealth sector, which is so rapid that it may soon be hard for physicians to keep up to date and adapt accordingly.

Uses of AI in telehealth

Medical history is arguably the most important part of a diagnosis, accounting for 76% of the medical diagnosis and being of more importance than a physical examination. Due to AI's accuracy and its ability to analyze large amounts of data meticulously, it can be used in analyzing medical records and the histories of patients, combining this analysis with the symptoms given by them to provide a diagnosis and potential treatment. This can be done remotely since it does not require any physical examinations or scans. This can also prevent potential errors or factors that a physician may have overlooked. Furthermore, it can increase the efficiency at which medical records are analyzed (Amjad et. al 6655; Burell 721). Moreover, AI can be used for early detection and diagnosis. This can be crucial to the patient's outcome, as the treatment can be carried out before the condition worsens or becomes critical. AI can also be implemented in the form of chatbots and virtual assistants. They can be used to provide basic medical advice and answer basic questions. They can also help increase patient engagement and allow for better-personalized care by scheduling appointments and setting reminders throughout the day to take any prescriptions. This can increase efficiency since staff do not need to book appointments. It can also reduce the number of appointments, as basic medical questions and dilemmas can be taken care of (Amjad et. al 6655; Daniel 1) . AI can be used in medical imaging analysis. It can analyze CT scans, MRIs, and X-rays to diagnose the patient. This can increase accuracy as AI spots inconsistencies or vital data that may have been overlooked (Burrel 721). However, this does require an in-person visit, which directly opposes the objectives of telehealth. But, as technology is evolving, these could be done remotely using wearable devices. Speaking of which, alongside the development of AI, the development of wearable devices and monitors is also essential for telehealth, as they can provide accurate vitals needed for diagnosis. Suppose wearable devices develop slower than AI does. In that case, the lack of accuracy could become a factor that hinders the diagnosis by both the physician and the AI algorithm. AI can also use cameras to read vitals such as respiration rate, heart rate, patient sentiment, and oxygen saturation levels. This is done by analyzing subtle changes in skin tone caused by moving blood. This can be crucial for development since it can increase the accessibility of healthcare since a

stable camera and internet connection are all that are required for a basic diagnosis. This reduces the need for a patient to visit the hospital or buy additional devices unless it is required for their specific treatment (Wang 202). Machine learning algorithms can analyze and diagnose diseases in large populations. This can be done due to AI's ability to access and analyze large data sets efficiently. It can be used to predict which populations are susceptible to the disease and potentially when an outbreak can occur (Amjad et. al 6655; Daniel 1). AI algorithms can be used to provide more personalized care for patients. This can be done as AI can take a patient's cultural, religious, lifestyle, and other potential complications, such as allergies to medicine, into consideration while planning out a treatment plan for them. They can alter the fundamental treatment plan to fit the needs of the patient, thus allowing more personalization (Daniel 1). AI can be used to monitor a patient's recovery after a treatment plan or surgery. This can be done with the use of wearable devices that are controlled and monitored by the patient's smartphone. This allows the patient to track their progress and recovery, reducing the number of in-person and via Internet meetings. This can greatly reduce expenses for the patient and will not take up a significant amount of their time (Amjad et. al 6655).

Limitations of AI

The abundance of benefits and potential of AI is not without its limitations and problems while implementing and developing it. One of the major hindrances to the development of AI and telehealth is the expenses that come along with the tools needed for development and integration, despite the efforts to work towards cost-effective models. There are also concerns and limitations due to the speed and stability of the connections required for fast and quality data transmission, which is one of the fundamental factors for the efficient implementation of telehealth and AI. Due to this, there might be a reliance on expensive and robust infrastructure, which can decrease the accessibility of telehealth, especially in rural or underserved areas. Due to the cost and time needed for the development of AI and telehealth, facilities may be reluctant to implement the technology needed, which can have a negative impact on patient care quality. Even though AI and telehealth have the potential to increase accessibility, it can also have the opposite effect. There are multiple kinds of populations in the world, some are ready to embrace the advancements of technology, while others are not. Due to this, it is important to take measurements that do not widen this gap (Amjad et. al 6655).

Application of AI in Mental health Diagnosis

The most common assessment tool for mental health is the Symptom Checklist 90-Revised (SCL-90-R). It includes 90 questions that are to be answered by the patient. It is used to assess 10 main mental illnesses, including somatization, obsessive-compulsive disorder, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, psychoticism, sleep, appetite, and feelings of guilt. Despite the abundance of tools used to assess mental health disorders, mental health professionals still find it difficult to diagnose patients accurately and efficiently. Psikometrist was a Decision Support System (DSS) developed that

uses AI to analyze the responses of users. The data was first collected using a web portal. This data consists of the responses of users to the SCL-90-R test. A Networked Pattern Recognition (NEPAR) algorithm was used to lower the number of questions on the SCL-90-R. The number of questions was chiseled down from 90 to 28. AI and Machine Learning (ML) algorithms were trained on the responses to the 28 questions and three centrality measures. Their objective was to calculate the likelihood that a particular patient has a certain type of mental health disorder. Results show that, though there is a 9% reduction in performance, the SCL-28-AI can diagnose the 10 primary mental disorders without a significant reduction in accuracy. Furthermore, the reduced number of questions will allow for a much higher response rate, and the likelihood of a patient completing the test will also be higher. Overall, this digital method of testing can reduce costs and the time taken by patients. These results also show the ability of AI to accurately and efficiently analyze and draw conclusions from a large set of data, which is crucial for its development in this rapidly developing field (Tuntun et. al. 1276).

What is being done already

AI has already found use in multiple healthcare companies. For example, Shen.ai uses cameras present in one's device to record and monitor their face and a contactless optical technique for recording blood pulsations in the skin vasculature to measure heart rate (HR), heart rate variability (HRV), as well as breathing rate (BR). The Shen.AI Vitals product satisfies the ANSI/AAMI/IEC 60601-2-27:2011 (R2016) standards for ECG devices with its high accuracy in HR measurement. The average values and quasi-instantaneous values across 10-second or 4-second intervals exhibit 99.9% accuracy, according to the results. 56% of the findings for the SDNN indicator fall below 10% of the observed value, with a median absolute error of 3.0 ms. With a median of absolute errors of 0.2 and 69% of results with an error below 10%, the lnRMSSD indicator has the highest measurement accuracy. The device tends to underestimate high BR values, but overall it shows good accuracy in measuring BR (almost 97% with an error ≤ 5 bpm). However, all physiological parameters show reduced measurement accuracy when utilizing laptop cameras.

Another example is binah.ai. Binah employs cameras and technology akin to that of Shen.ai. The photoplethysmography (PPG) signal obtained from facial skin tissue (remote PPG, or rPPG) is used by the Binah.ai algorithm. The algorithm takes face video images, generates an rPPG signal, evaluates the information, and gives the user real-time measures of their vital signs. For both Android and iOS operating systems, the respiratory rate recorded by Binah's SDK was reliable, extremely accurate, and within the accuracy target ($AE \leq 3$ rpm in $>93\%$) of the measurements. The HRV measured by Binah's SDK was found to be robust, highly accurate, and within the accuracy target ($AE \leq 25$ ms in $>96\%$) of the measurements for both Android and iOS operating systems. The pulse rate measured by Binah's SDK was found to be robust, highly accurate, and within the accuracy target ($AE \leq 3$ bpm in 95%) of the measurements for both Android and iOS operating systems.

Another startup that has a different approach to telehealth is VOS.health. VOS.Health is a mobile app that aims to provide its users with all the necessary tools to improve their lives and mental health. With the help of various journaling and self-monitoring approaches, users of the program can monitor their well-being and receive comprehensive data and analytics. The VOS.Health platform employs machine learning (ML) and artificial intelligence (AI) to give users reliable, evidence-based statistics and the ability to modify their lifestyles based on smart tech suggestions. The company's research demonstrates that patients exhibited a moderate level of persistent adherence to the web-based intervention. Compared to the baseline, Positive Affect Journalism (PAJ) was linked to improved well-being and a reduction in mental anguish. In comparison to normal care, PAJ was also linked to decreased anxiety and depression symptoms after one month, as well as increased resilience after the first and second months.

Health, Powered by Ada, is another application. Ada's AI-driven platform offers real-time, tailored symptom evaluations. After a user describes their symptoms, Ada poses a series of inquiries while sorting through hundreds of potential causes and countless symptom combinations. 33 doctors completed a total of 132 vignettes (mean 8.8 (SD 7.1) years of rheumatic professional experience). Based on the top diagnosis, Ada's diagnostic accuracy (IRD) was substantially greater (70 vs. 54%, $p = 0.002$) when compared to doctors. Ada reported an accurate diagnosis as the top diagnostic and among the top 3 diagnoses more frequently than doctors (54 vs. 32%, $p < 0.001$). The recommendation of the proper diagnostic or IRD status was unrelated to work experience. Physicians' diagnosis accuracy was less accurate when limited to symptom-related medical history and basic health information than when using an AI-based symptom checker. These findings demonstrate the value of symptom checkers early in the patient journey and the necessity of having access to adequate and comprehensive patient data to make an accurate diagnosis. Additionally, this study comprised 49 patients in total (30/49, 61% of whom were women; mean age 33.41, SD 12.79 years). In 51% (25/49; 95% CI 37.5-64.4) of the instances for all patients, the interview-based diagnoses matched the ADA's first condition proposal, and in 69% (34/49; 95% CI 55.4-80.6) of the cases, they matched one of the first five condition suggestions. The accuracy of the ADA's initial condition recommendation within the primary disorder categories was determined by a face-to-face assessment rather than one based on an app. Additionally, results point to the possibility that a commonly used symptom checker for formal mental illness diagnosis might offer therapists a list of suggested conditions with a moderate-to-good degree of accuracy. valued in larger samples and concerning other diagnostic tools.

Ethical concerns

Even though AI has been and will continue to be revolutionary in the fields of telehealth and mental health, there are many ethical concerns regarding the use of AI. The main and arguably most important concern is data sharing. AI improves through pattern recognition and analyzing large databases to detect patterns and anomalies. Due to this, there is concern about where this large amount of data will be stored, who has access to it, and how long it will be used.

It also sheds light on the importance and concern for the security of data; for example, how safe are these data leaks or data loss? There is also a concern that AI can reduce the accessibility of AI to people living in rural areas. If AI is rapidly developing, the technology and hardware required to maintain and support this evolution would have to be more robust, likely increasing its cost and making it harder for people living in rural areas to obtain proper remote healthcare. There are also privacy issues regarding telehealth and telehealth as a whole. Since these appointments are done through video conferences and online sharing of data, the software used to conduct these meetings is prone to cyber threats. Hackers could listen in on conversations or even intercept data such as medical records or patient histories during its transmission (Amjad et. al 6655).. This may also raise questions about data sharing between different healthcare facilities. For the best outcome possible, healthcare facilities may collaborate with their peers to speed up the development of AI by sharing information with their findings. This may cause some dilemmas among people since data-sharing may breach some walls of privacy. Due to this, training programs should include ways to responsibly, legally, and ethically use AI in telehealth. Even though technology in this field is evolving, the same cannot be said for the education. There remains a growing gap between the technology and AI used currently and the ones that are part of the education of a medical professional. Medical education systems should show a willingness to include up-to-date AI algorithms and technology in their courses, along with teaching the correct, legal, and ethical way to include them in practice. This will increase the number and willingness of future physicians to use this technology. which can lead to better patient outcomes and greater efficiency. It could also tackle some ethical issues related to implementing AI, resulting in better data privacy and more strict data-sharing policies (Fernandes 10). To ensure patient cooperation and avoid a lack of knowledge for the patient, an electronic document should be used to confirm the patient's informed consent and willingness to use AI in their treatment. There is also a degree of malpractice when it comes to the implementation of AI. Practitioners could potentially access the database of the AI, which could be a great threat to the privacy of data. Since AI is developed using pattern recognition, developers and healthcare facilities should try to avoid as many biases as possible to reduce the accuracy of the diagnosis. This will make the diagnosis fair and balanced, regardless of the demographic to be assessed. There is also significance for the explainability and transparency of AI. This will be a challenge since some AIs have a black box nature. However, this allows more trust to be formed between patients and their respective healthcare facilities. For example, the healthcare facility should be able to explain why their AI concluded on a particular diagnosis. Even though AI is accurate in diagnosing mental disorders, there are exceptions where it is wrong when analyzing and diagnosing more complex mental health issues. Since emotions have a significant role in mental health, medical records, and symptoms may not be enough to diagnose a patient; rather, there may be a connection between the patient and physician that helps them better understand the problem at hand. AI cannot form this type of connection, so there must be more caution when implementing AI in the mental health field for the best possible patient outcome.

Conclusion

To summarize, AI can be revolutionary within the telehealth and mental health fields if implemented while taking proper ethical care while doing so. AI can transform the accuracy and efficiency at which telehealth is performing now with symptom checkers and analysis algorithms that can detect health problems using medical records and wearable devices to monitor vitals. AI can also be used to complete tasks not related to direct healthcare, like scheduling appointments, streamlining staff, and auto-documentation overall, making healthcare more efficient. Virtual assistants can be used to schedule appointments, give basic medical advice, do follow-ups, and set reminders for medicine. Having said this, many ethical and legal factors should be considered when implementing AI. It requires strict and robust equipment while remaining cost-friendly to ensure data and privacy are kept safe while keeping its primary goal: accessibility. Education about the latest advancements and technology must be implemented to provide the best outcome for patients and the physicians of the future. So, AI should be a tool that physicians can utilize for the best patient outcome, rather than being a complete replacement for them.

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How Neural Plasticity Influences Empathy Development and the Neural Mechanisms That Can Enhance Empathetic Capacities By Amelia Martinez

Abstract

While numerous studies have demonstrated the evolutionary advantages of empathy in society, significant gaps persist in our understanding of empathy's molecular basis and how specific brain activities correlate with empathetic behaviors. Empathy comprises two dimensions: cognitive empathy, which involves perspective-taking, and emotional empathy, which involves compassion (Bernhardt & Singer, 2012; Beadle & de la Vega, 2009; de Waal & Preston, 2017). These dimensions enable individuals to vicariously experience others' emotional states, fostering prosocial behaviors and social bonds. This literature review examines methodologies such as neuroimaging studies, genetic analysis, and behavioral assessments to understand neural mechanisms underlying empathy and their modulation by social and environmental factors. This paper examines the role of the Mirror Neuron System, the inferior frontal gyrus and inferior parietal lobule. It investigates genetic influences on empathy, including the impact of variations in the oxytocin receptor gene, and considers the influence of early-life maternal care and socialization processes on empathy development, alongside the impact of stress and social context.

The main findings highlight the role of the anterior insula (AI) and the anterior cingulate cortex (ACC), revealing significant sex differences in empathetic responses. Initial findings suggest that sustained empathy training leads to brain changes, enhancing empathetic capacities with significant changes in key biomarkers like brain-derived neurotrophic factor (BDNF) and oxytocin. These results underscore the importance of neural plasticity in empathy development and suggest potential interventions to enhance empathy through targeted training programs. By bridging the gap between neuroanatomy and practical applications, this paper proposes targeted interventions to enhance empathetic capacities and promote prosocial behaviors, highlighting the significance of a multi-disciplinary approach in elucidating the complex interplay between neural plasticity, genetic factors and empathy. This paper aims to investigate the role of neural plasticity in the development and enhancement of empathy, elucidating the neural mechanisms underlying empathetic responses.

Introduction

In the past decade, much research has focused on understanding and sharing the feelings of others, a phenomenon known as empathy. Empathy encompasses both cognitive empathy (perspective-taking) and emotional empathy (compassion towards others) (Bernhardt & Singer, 2012; Beadle & de la Vega, 2009; de Waal & Preston, 2017). This ability allows individuals to vicariously experience another's affective state, often leading to caring and concern for others, which plays a significant role in social interactions and emotional experiences (Lamm et al., 2011; Decety, 2015). Technological advancements and widespread media have further amplified people's capacity to be affected by others' emotions, promoting parasocial behaviors such as

helping and consolation (Decety et al., 2016). Parasocial behaviors refer to one-sided emotional relationships that individuals form with media figures, which can evoke real emotional responses and influence behavior, similar to direct social interactions (Giles, 2002).

Despite these advances, it remains unclear why evolutionary theories suggest that emotions like empathy are innate and provide evolutionary advantages. Empathy is biologically based, with variations due to genetic and environmental factors (Jones & Gagnon, 2006). Its evolutionary roots highlight its role in guiding behavior and fostering social connections essential for survival and reproduction (Decety, 2015). Research demonstrates that empathy encompasses a range of emotions beyond pain, including social exclusion, disgust, and anxiety. Studies have shown activation in the anterior insula (AI) and anterior cingulate cortex/mid-cingulate cortex (ACC/MCC) when individuals observe or imagine these emotional states in others (Bernhardt & Singer, 2012). Empathy builds on basic forms of effective communication, social attachment, and parental care, facilitating social communication, moral reasoning, and prosocial behavior (Decety, 2011).

The purpose of this study is to examine how neural plasticity, the brain's ability to reorganize itself by forming new neural connections throughout life, is fundamental in developing and enhancing empathy. Neural plasticity enables adaptation to new social experiences and learning, highlighting the importance of this mechanism in the context of empathy (de Waal & Preston, 2017; Marthur et al., 2010; Decety & Jackson, 2004). This research will also explore the neural bases and mechanisms underlying empathy, the influence of social and environmental factors and potential interventions to enhance empathic capacities.

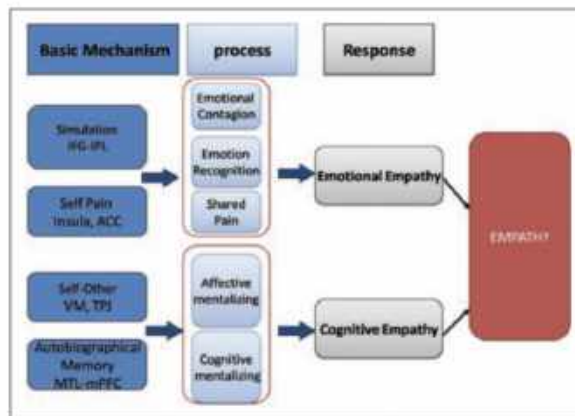


Figure 1. This diagram shows the mechanisms, processes, and responses in cognitive and emotional empathy. Cognitive empathy involves affective and cognitive mentalizing using the VM, TPJ, and MTL-mPFC. Emotional empathy involves emotional contagion, emotion recognition, and shared pain using the IFG, IPL, AI, and ACC. These processes lead to the empathetic response (Shamay-Tsoory, 2011).

The neural basis of empathy involves overlapping networks that process first-hand experiences of sensory and affective states, such as pain and pleasure (Marsh, 2018). These networks include regions like the anterior insula and mid-anterior cingulate cortex, which are activated both during personal experiences and when observing others' experiences (Marsh, 2018; Decety & Lamm, 2006). Functional magnetic resonance imaging (fMRI) have shown that these areas are not only activated by the perception of pain in others, but also by positive emotions, suggesting a broad role in emotional empathy (Lamm et al., 2007). Additionally, empathy involves neural circuits including the anterior insula, anterior cingulate cortex, and prefrontal cortex, which are consistently activated when individuals perceive the emotional states of others (Jones & Gagnon, 2006).

When observing empathic responses to others' distress, the anterior insula (AI) and anterior medial cingulate cortex (aMCC), core regions of the empathy for pain network (Fan et al., 2011; Lamm et al., 2011) are activated. These regions are activated during both first-hand and observed pain experiences, suggesting shared representations for firsthand and vicarious experiences of affective states (Decety & Echols, 2010; Bernhardt & Singer, 2012). Observing others in pain can motivate helping behavior and is often experienced as unpleasant for observers themselves, involving the AI, ACC, and MCC (Bernhardt & Singer, 2012).

Empathy for pain engages both lower-order (automatic, sensory) and higher-order (cognitive, affective) neural processes (see Figure 1), allowing for flexible empathetic responses depending on the context and individual differences (Levy et al., 2019; Bernhardt & Singer, 2012). The neural mechanisms underlying empathy involve a range of brain structures, including the cortex (insula, ACC, orbitofrontal cortex), midbrain (periaqueductal gray), brainstem, ANS, HPA axis, and endocrine systems (Decety, 2011; see Figure 1). The AI and MCC play key roles in processing both experienced and observed pain (Marsh, 2018). This article seeks to better understand the connection between neural plasticity and empathy. Ultimately, this study argues that harnessing the brain's neural plasticity through targeted interventions not only deepens our understanding of empathy's biological foundations but also offers a powerful tool for enhancing empathic capacities, with profound implications for improving social cohesion and promoting prosocial behavior on a global scale. By examining the anatomy and physiology underlying these neural processes, we can gain a deeper insight into how specific brain structures and systems contribute to the generation and regulation of empathic responses.

Anatomy and Physiology

The prefrontal cortex integrates cognitive and emotional processes crucial for empathy, with different regions involved in maintaining and manipulating memories, selecting appropriate responses, and inhibiting actions (Jones & Gagnon, 2006). The temporal lobes process sensory information and emotional memories essential for empathy and their interaction with other brain regions supports the empathetic process (Jones & Gagnon, 2006). The ANS plays a role in emotional responses, with the sympathetic system initiating alert responses and the parasympathetic system regulating arousal, both working together to facilitate prosocial

behaviors (Jones & Gagnon, 2006).

The AI and ACC/MCC are involved in a multitude of sensory, affective, cognitive, and motivational processes, contributing to the generation of subjective experiences and adaptive responses to affective states in both self and others (Bernhardt & Singer, 2012; See Figure 2). The AI is crucial for processing the emotional aspects of pain and other affective states by integrating interoceptive information and generating subjective feelings of pain, thus guiding prosocial behavior (Decety, 2011). The ACC is activated by the perception of others' emotional states and is involved in processing both firsthand experiences and empathetic responses to others' pain, playing a critical role in emotional regulation and empathy (Decety, 2015).

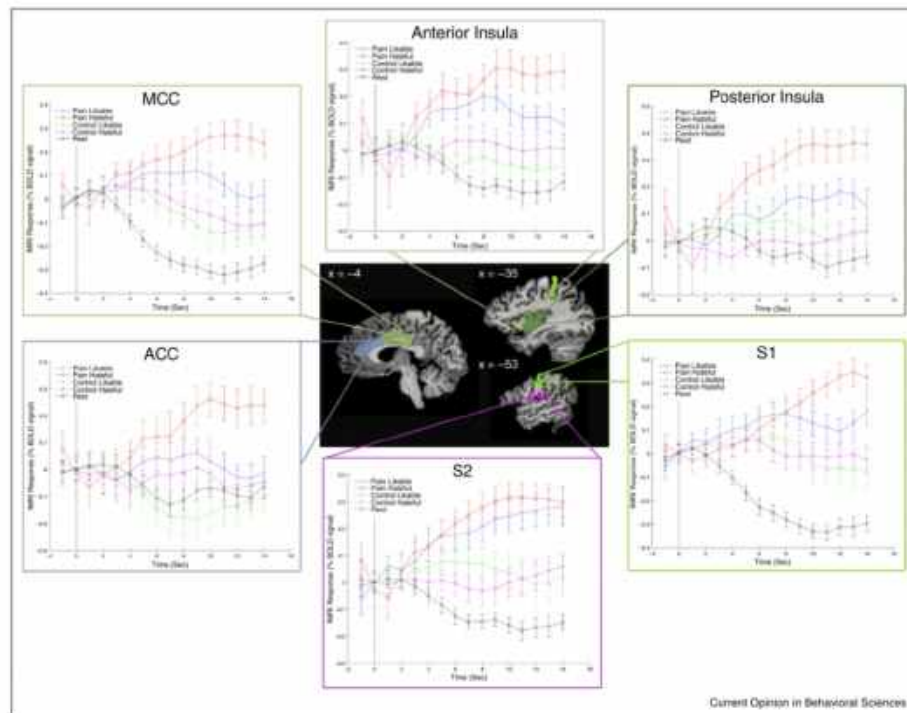


Figure 2. The figure shows the neural responses in empathy-related regions (ACC, AI, posterior insula, and somatosensory cortices S1 and S2) when participants viewed others in pain. There is greater activity in these regions for hateful targets in pain compared to likable ones, indicating heightened emotional empathy (Decety, 2015).

The AI's dense connections with prefrontal, temporal-limbic, and subcortical regions suggest its role in integrating sensation, affect, and cognition. Functional connectivity patterns indicate a central role in interoceptive and affective information integration (Bernhardt & Singer, 2012). The limbic system, including the amygdala and hippocampus, is crucial for emotional processing and empathy, interacting with cortical regions to regulate emotions during empathetic experiences (Jones & Gagnon, 2006). Additionally, the AI and ACC contain Von Economo neurons which are thought to play a role in empathy, social awareness, and self-control by allowing fast integration of affective states, motivation, control, and behavior in dynamic contexts (Bernhardt & Singer, 2012). These insights into the anatomy and physiology of empathy set the stage for a deeper exploration of the specific neural circuits involved in empathetic responses, particularly in the context of pain.

Neural Circuits for Empathy:

The neural circuits involved in empathy for pain encompass various brain regions and structures essential for processing both firsthand and vicarious pain experiences. These circuits include the supplementary motor area (SMA), which is involved in planning and coordinating movements; the dorsal anterior cingulate cortex (ACC) and anterior medial cingulate cortex (aMCC), which are associated with emotional regulation and the perception of pain; the anterior insula (AI), which integrates emotional and bodily states; the amygdala, which processes emotions and fear; and the periaqueductal gray (PAG), which plays a role in pain modulation and defensive behaviors.

These neural circuits form connections between the brainstem, amygdala, basal ganglia, ACC, insula, and orbitofrontal cortex. They are conserved across many species, underscoring their fundamental role in social behavior (Decety, 2015). Emotional empathy involves a network that includes the inferior frontal gyrus (IFG) and the inferior parietal lobule (IPL), necessary for emotion recognition and emotional contagion (Shamay-Tsoory, 2010). This network also includes shared neural structures involved in the firsthand experience of affective states, including the AI and ACC/aMCC, which respond to others' distress and pain, further emphasizing the complex interplay of these regions in empathy (Decety, 2011). These intricate neural networks underscore the complexity of emotional empathy and set the stage for discussing the dual systems of empathy, highlighting the distinctions and interactions between emotional and cognitive empathy.

Dual Systems of Empathy

Empathy involves two distinct systems: an emotional system for emotional empathy and a cognitive system for cognitive empathy (Shamay-Tsoory, 2010). Emotional empathy, supported by the AI and ACC, encompasses affective sharing, where perceiving another person's emotional state automatically activates a similar state in the observer through bottom-up processes. Bottom-up processes refer to the automatic and unconscious activation of emotional responses, starting from basic sensory input when observing someone else's emotions, leading to a shared emotional experience (Tousignant et al., 2016; Hein & Singer, 2008). This mechanism is vital for interpersonal communication and social bonding, as it allows for sharing another's emotional state without confusion between self and other (Decety, 2015). Cognitive empathy involves understanding others' perspectives and mental states through perspective-taking (Marsh, 2018). These separate yet interrelated processes highlight that empathy is not a single phenomenon but comprises multiple dissociable processes (Marsh, 2018; see Figure 3). Understanding the neural basis of cognitive empathy helps explain how neural plasticity contributes to empathy enhancement. The brain's ability to adapt and reorganize is crucial for developing the complex social cognitive abilities underlying empathy.

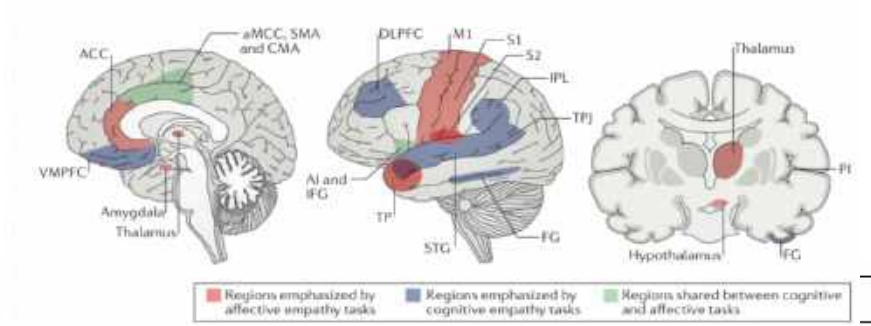


Figure 3. The image illustrates the neural regions involved in human empathy, highlighting the different brain areas associated with affective and cognitive empathy tasks. Affective empathy, which involves the direct perception of others' emotions or pain, engages regions such as the anterior cingulate cortex (ACC), amygdala, thalamus, and hypothalamus. These areas are shown in red and are activated by bottom-up processes. Cognitive empathy, which involves perspective-taking and higher-level understanding of others' mental states, engages the dorsolateral prefrontal cortex (DLPFC), inferior parietal lobule (IPL), temporoparietal junction (TPJ), and superior temporal gyrus (STG), shown in blue and associated with top-down processes. Regions activated by both affective and cognitive tasks, such as the anterior insula (AI) and anterior middle cingulate cortex (aMCC), are shown in green (de Waal, 2017).

Neurochemical mechanism	Oxytocin	Dopamine
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Table I. Comparison of Emotional and Cognitive Empathy (Tsoory, 2011)

Cognitive Empathy and Brain Regions:

Cognitive empathy, also known as mentalizing or perspective-taking, involves the ventromedial prefrontal cortex (vmPFC), temporoparietal junction (TPJ), and medial temporal lobe (MTL). These regions are necessary for self-reflection and understanding others' mental states, allowing individuals to infer intentions, desires, and beliefs (Shamay-Tsoory, 2010; Saxe & Kanwisher, 2003; Frith & Frith, 2006). This ability relies on advanced cognitive processing and neural plasticity (Decety, 2015). The medial prefrontal cortex (MPFC) is particularly responsive when individuals identify with others who are similar to themselves, and different patterns of MPFC activity are observed in individuals with varying perspective-taking abilities (Mitchell et al., 2006; Vogeley & Fink, 2003; see Figure 4). These neural mechanisms are crucial for predicting others' behavior based on their thoughts and feelings and are essential for complex social interactions (Marsh, 2018; Decety, 2015).

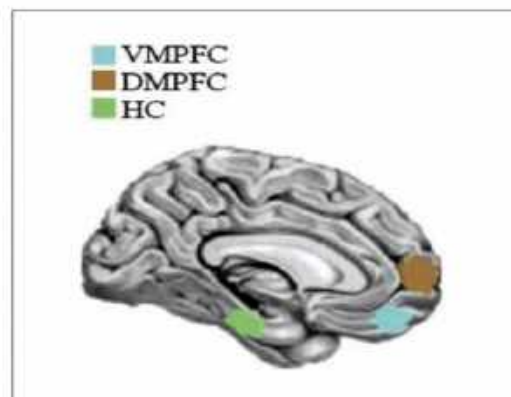


Figure 4. The cognitive empathy network (Tsoory, 2011)

Oxytocin and Emotional Empathy

Administration of oxytocin has been shown to increase emotional empathy but not cognitive empathy, indicating a role for the oxytocinergic system in modulating emotional empathy and highlighting the neurochemical basis for variations in empathic responses (Hurlemann et al., 2010; Bernhardt & Singer, 2012). Oxytocin, a neuropeptide regulating social attachment, facilitates maternal behavior, increases positive social behaviors, and reduces activity in the hypothalamic-pituitary-adrenal (HPA) axis, modulating stress responses and enhancing social trust (Decety, 2011). It reduces amygdala activation and modulates coupling with brainstem regions involved in automatic fear reactivity, with genetic variations in the oxytocin receptor gene (rs53576) relating to differences in empathy and stress reactivity (Decety, 2011).

Oxytocin plays a significant role in modulating empathy by reducing neural activity in the pain circuitry when individuals observe others in pain, thereby enhancing social bonding and prosocial behaviors (Marsh, 2018). It can also promote group bias and in-group favoritism, facilitating both positive and negative social interactions (Decety, 2015). Oxytocin's ability to reduce stress hormones like cortisol supports empathetic behavior, as lower stress levels enable individuals to engage more deeply with others' emotional states (Bartz & Hollander, 2006; Heinrichs & Domes, 2008). It facilitates altruistic behavior by promoting trust and reciprocity, increasing generosity and cooperative behaviors in social settings (Zak et al., 2005; Kosfeld et al., 2005). Furthermore, it enhances social cognition by improving emotion recognition, particularly in the eye region, and promotes the recognition of positive emotional expressions, which are crucial for empathy and social bonds (Guastella et al., 2008; Marsh et al., 2010; Domes et al., 2007).

Oxytocin enhances the ability to take on others' perspectives, leading to more accurate empathy (Wispé, 1986; Davis, 2005). Enhanced eye contact, associated with better empathetic accuracy, is another effect of oxytocin (Guastella et al., 2008; Bartz et al., 2010). Empathy involves both emotional and cognitive components, which can be enhanced through neural plasticity, with changes in brain function due to learning and experience improving both aspects of empathy (Decety et al., 2010; Eisenberg, 2000). Oxytocin's effects on empathy are context-dependent, enhancing empathetic responses in familiar and trusting environments but having less effect in competitive or uncertain situations (Declerck et al., 2010; Shamay-Tsoory et al., 2009). Individual differences, such as genetic variations and early life experiences, also modulate how oxytocin affects empathetic behavior (Rodrigues et al., 2009; Carter, 2003). However, oxytocin can sometimes intensify anxiety towards unforeseen threats, suggesting its effects on empathy are not straightforward and highlighting the hormone's impact on stress and anxiety levels (Grillon et al., 2012; Hurlemann et al., 2010).

This complexity suggests that researchers and clinicians must exercise caution when developing training programs designed to improve empathy, especially those that might involve oxytocin administration. Understanding the contexts in which oxytocin enhances empathy, as well as the potential for increased anxiety in certain situations, is crucial for designing

interventions that maximize benefits while minimizing risks. Exploring the intricate relationship between oxytocin and emotional empathy provides a foundation for understanding the neural underpinnings of empathy, paving the way to investigate the role of the Mirror Neuron System (MNS) in motor empathy and emotional contagion.

Mirror Neuron System (MNS):

The Inferior Parietal Lobule (IPL) and Inferior Frontal Gyrus (IFG) are crucial components of the Mirror Neuron System (MNS). The IPL is involved in the integration of sensory information and plays a role in body awareness and the coordination of complex movements. It supports the ability to understand others' actions by mapping observed actions onto one's motor representations (Rizzolatti & Craighero, 2004). The IFG, part of the frontal lobe, is critical for language processing, imitation, and motor planning. It enables the understanding and imitation of observed behaviors by mirroring the observed action within the brain (Iacoboni, 2009). These regions facilitate motor empathy and emotional contagion by firing both when an action is performed and when it is observed in others, creating a shared neural representation of the experience. This mirroring mechanism allows individuals to understand and share others' experiences, providing a neural basis for empathy (Rizzolatti et al., 2009; Gallese, 2003).

The Mirror Neuron System (MNS), particularly in the inferior frontal gyrus (IFG) and inferior parietal lobule (IPL), supports motor empathy, imitation, and emotional contagion by firing both when an action is performed and when it is observed in others (Rizzolatti et al., 2009; Bernhardt & Singer, 2012). Mirror neurons play a significant role in empathy by mirroring the actions and emotions of others, allowing individuals to understand and share others' experiences (Rizzolatti, 2005; Gallese et al., 1996). This mirroring mechanism provides a neural basis for understanding and imitating others' actions and emotions, creating a shared neural representation by simulating their experiences in the observer's brain (Gallese, 2003; Rizzolatti & Craighero, 2004; Iacoboni, 2009). Observing affective states in others activates brain networks involved in the firsthand experience of these states indicating that empathy is based on shared neural networks (Bernhardt & Singer, 2012). This shared activation, particularly in the AI and ACC, supports the idea that empathy relies on overlapping neural circuits that are engaged both when experiencing and observing emotions. This connection between MNS and regions like the AI and ACC highlights the complex interplay of neural circuits that underpin empathic processes.

Understanding these neural mechanisms is crucial for exploring how empathy manifests in behavior and experiences. To delve deeper into this connection, various experimental designs have been employed to understand the connection between the neuroanatomy involved in empathy and the acts of empathy themselves. Neuroimaging studies, for instance, reveal the activation of specific brain regions during empathic responses. (Decety, 2015) These studies often involve tasks where participants observe others in pain or distress, allowing researchers to track neural activation patterns. For example, studies (fMRI) have demonstrated that observing someone in pain activates the same brain regions involved in experiencing pain firsthand, such as

the AI and ACC (Marsh, 2018). This shared activation supports the idea that empathy relies on shared neural circuits. Behavioral experiments have also shown that individuals with higher empathic concern exhibit more significant neural responses in these regions when witnessing others' suffering (Bernhardt & Singer, 2011).

Comparing and contrasting the results from different studies reveals a consistent involvement of MNS, AI, and ACC in empathetic processes, but there are variations in how these regions are engaged depending on the context and individual differences. To advance the field, future research should focus on longitudinal studies to understand the long-term effects of empathy training and interventions. Additionally, more studies are needed to explore the genetic and environmental factors influencing neural plasticity and empathy. By understanding the underlying neural mechanisms and their modulation through experience and training, we could develop effective strategies to promote empathy and reduce social biases. These practices could also be included in the practice of Emotional Contagion. By examining emotional contagion and its underlying neural mechanisms, we can gain deeper insights into how automatic and involuntary empathic responses contribute to social cohesion and explore potential interventional strategies to enhance empathic abilities.

Emotional Contagion and Simulation

Emotional contagion involves the perception-action mechanism, where observing a behavior activates neural representations for that behavior, aligning with simulation theory and suggesting that social information processing involves matching neural states (Gallese, 2007). It is the tendency to automatically adopt the emotional state of another person through mimicry, synchronizing affective expressions, vocalizations, postures, and movements (Bernhardt & Singer, 2012; Decety, 2011). In the studies conducted by Bernhardt and Singer (2012) and Decety (2011), researchers used a variety of methodologies to investigate the neural basis of emotional contagion. Studies (fMRI) was employed to observe brain activity in participants as they were exposed to different emotional stimuli. Participants were shown videos or images of individuals expressing various emotions, such as happiness, sadness, anger, and fear. Neural activity was recorded, particularly focusing on regions like the insula and anterior cingulate cortex (ACC).

Observations following this methodology revealed that when participants were exposed to emotional stimuli, there was significant activation in the insula and ACC, indicating that these regions are involved in both the perception and internalization of observed emotions. This activation was found to be stronger when participants viewed emotions that they could relate to or had experienced themselves, suggesting that personal experience modulates the strength of emotional contagion. Furthermore, the studies showed that participants who scored higher on empathy questionnaires exhibited greater neural activation in these regions, implying that individual differences in empathic ability influence the degree of emotional contagion.

In addition to neuroimaging, some studies used behavioral assessments to measure the degree of emotional contagion. Participants' facial expressions, body language, and physiological

responses (e.g., heart rate, skin conductance) were monitored to determine how closely they mirrored the emotions of the observed individuals. Questionnaires and self-report measures were also utilized to gauge participants' empathic tendencies and their subjective emotional experiences during the tasks.

These methodologies revealed that emotional contagion is a basic form of empathy, where individuals unconsciously mimic another's emotional expressions, leading to shared emotional experiences. This process is supported by neural circuits involving the insula and ACC, which are also involved in direct emotional experiences (Hatfield, Cacioppo, & Rapson, 1994; Singer et al., 2004; see Figure 5). Emotional contagion occurs when individuals unconsciously mimic others' emotions. This process activates neural pathways similar to those used in direct emotional experiences, suggesting that empathy can be an automatic and involuntary process. These neural mechanisms likely evolved to promote social cohesion (Decety & Jackson, 2004). The central question this article seeks to address is: How do the neural mechanisms underlying emotional contagion facilitate automatic and involuntary empathic responses, and what implications do these findings have for understanding social cohesion and empathy training? Specifically, this research aims to explore the extent to which emotional contagion relies on shared neural circuits, how these circuits are modulated by individual differences and environmental factors, and how interventions can enhance empathic abilities to foster more cohesive social interactions. To fully comprehend how empathic responses can be enhanced and directed, it is essential to explore the top-down modulation of empathy, considering how contextual and interpersonal variables influence empathic processes and neural activations. The following sections will explain how interventional strategies could be used to do so.

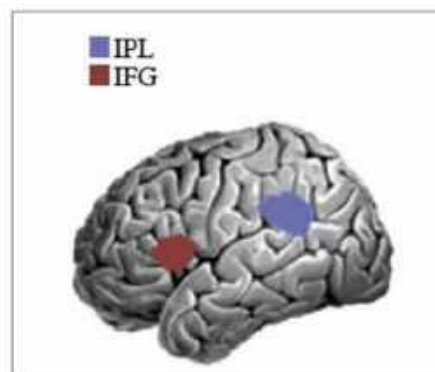


Figure 5. The emotional contagion network (Tsoory, 2011)

Top-Down Modulation of Empathy:

Empathic responses can be modulated by top-down processes such as contextual and interpersonal variables, including race, professional training, personal characteristics like alexithymia, contextual appraisal, perceived fairness, and group membership (Xu et al., 2009; Decety et al., 2010; Bernhardt & Singer, 2012). Factors like perceived fairness, group

membership, and previous interactions can significantly influence neural activations associated with empathy (Decety, 2011). By examining the influence of top-down processes on empathy, we gain valuable insights into how cognitive mechanisms like Theory of Mind (ToM) enable us to understand others' mental states and enhance our empathic abilities through complex neural processing.

Theory of Mind (ToM):

Theory of Mind (ToM), or mentalizing, involves understanding others' thoughts, intentions, and emotions by inferring and representing their beliefs and desires. (Frith and Singer, 2008) Key brain regions for ToM include the medial prefrontal cortex (mPFC), ventromedial prefrontal cortex (vmPFC), superior temporal sulcus (STS), temporoparietal junction (TPJ), temporal poles (TP), and posterior cingulate cortex (PCC) (Frith & Singer, 2008; Bernhardt & Singer, 2012). Cognitive empathy, or ToM, requires complex neural processing in the prefrontal cortex and develops through neural plasticity as individuals gain social experiences and knowledge (Frith & Frith, 2006; Saxe & Kanwisher, 2003). Understanding the neural basis of Theory of Mind (ToM) and its development through social experiences and neural plasticity provides a crucial foundation for exploring the relationship between empathy and moral behavior, highlighting how empathic processes motivate altruistic actions and shape moral judgments.

Empathy and Moral Behavior

In addition, empathy is linked to moral behavior and altruism, motivating prosocial actions such as helping others in distress, and is considered a key enabling process for altruism (Decety, 2011).

It is foundational to moral sensitivity and understanding why harming others is wrong. Dysfunction in empathy-related neural circuits leads to impaired moral judgment, as seen in individuals with psychopathic traits (Decety, 2015). Altruistic behavior is often driven by empathic concern, supported by neural networks involved in reward processing and goal-directed action, highlighting the motivational aspects of empathy (Marsh, 2018). Neural studies indicate that empathy and altruism share overlapping circuits, particularly in the medial prefrontal cortex and the temporoparietal junction, suggesting that empathic responses can drive altruistic behavior by activating neural pathways associated with prosocial motivations (Marsh, 2016; Zaki & Mitchell, 2013). Moral judgments involve empathic processes, with the prefrontal cortex and the temporoparietal junction playing key roles in integrating empathic responses into moral reasoning. This integration allows individuals to weigh the emotional and cognitive aspects of moral dilemmas, thereby promoting prosocial behavior (Cushman, Young, & Hauser, 2006; Greene et al., 2001). Investigating the impact of empathy on moral behavior and its neural underpinnings provides essential insights into how empathic processes can be disrupted in various psychopathologies and neurodevelopmental disorders, emphasizing the importance of understanding these mechanisms to improve diagnosis and treatment strategies.

Empathy in Psychopathology and with Neurodevelopmental Disorders

Individuals with psychopathic traits often show reduced activation in neural circuits associated with empathy, particularly the amygdala and the ventromedial prefrontal cortex, suggesting specific impairments in the neural mechanisms underlying empathic responses (Blair, 2005; Decety, Skelly, & Kiehl, 2013). Conditions like Attention-deficit/hyperactivity disorder (ADHD) and conduct disorder exhibit varied neurophysiological responses, indicating the need for further research to understand these relationships and the specific brain regions involved (Jones & Gagnon, 2006). Neurodegenerative diseases, such as Alzheimer's and Parkinson's, can lead to declines in empathy due to the progressive loss of neural plasticity and brain function in regions critical for empathy, such as the prefrontal cortex and amygdala (Rankin et al., 2006; Perry et al., 2001). This decline impacts emotional regulation and social cognition, further affecting empathic abilities (Marsh, 2018). In addition, the decline can be quantified by neuroimaging. Research indicates that overactivity in the amygdala is associated with depression and anxiety disorders. This heightened activity can lead to increased emotional responses and difficulty regulating emotions, which are key symptoms of these conditions. Additionally, studies have found that when depression and anxiety co-occur, the amygdala may actually enlarge, in contrast to the typical shrinkage observed in other brain areas like the hippocampus during chronic depression. This enlargement and overactivity suggest that the amygdala plays a crucial role in the emotional dysregulation seen in these mental health disorders (Huang S, Liu W, Qin X et al., 2022). These insights into the neuroimaging of empathy and its connection to psychopathology underscore the importance of understanding the dynamic and adaptive nature of empathy-related neural networks, setting the stage for examining how sex differences influence these processes.

Neuroimaging Studies:

Functional neuroimaging studies show that the same neural circuits involved in direct pain experiences are activated during empathy for pain. These regions include the anterior insula (AI) and anterior cingulate cortex (ACC), which are critical for processing the affective and motivational aspects of pain (Decety, 2011). Additionally, key brain regions involved in empathy, such as the insula, ACC, and prefrontal cortex, have been identified, highlighting the dynamic nature of empathy-related neural networks that adapt through plasticity (Decety & Lamm, 2006; Fan et al., 2011). Plasticity is also affected by gender. Examining the interplay between neuroimaging findings and sex differences in empathy provides a comprehensive understanding of the factors influencing empathic responses, leading to an exploration of how early parental care shapes empathy development in children.

Sex Differences in Empathy

Women generally exhibit higher levels of empathy than men, reflected in greater activity in brain regions associated with empathy, such as the inferior frontal cortex (Cheng et al., 2009). These sex differences may influence how empathy affects performance, with women potentially

more susceptible to empathy-induced performance changes (Schulte-Rüther et al., 2008). However, there are controversies about the impact of sex on empathy-like behavior, with some studies suggesting that males and females may exhibit different levels of empathy (Bartal et al., 2011). The difference of empathy levels in children may be brought on by early parental care. By understanding the profound impact of maternal care and early experiences on the development of empathy, we can explore how these foundational elements interact with genetic and environmental factors to shape empathic abilities throughout life. Research indicates that socialization processes play a significant role in the development of empathy, with differences in how boys and girls are raised contributing to varying levels of empathy (Hoffman, 1977). Boys often face social norms that discourage the expression of emotions, leading to unmet emotional needs and lower empathy levels (Way et al., 2014). Understanding these gender-specific socialization patterns is crucial for addressing empathy disparities and promoting emotional well-being across sexes.

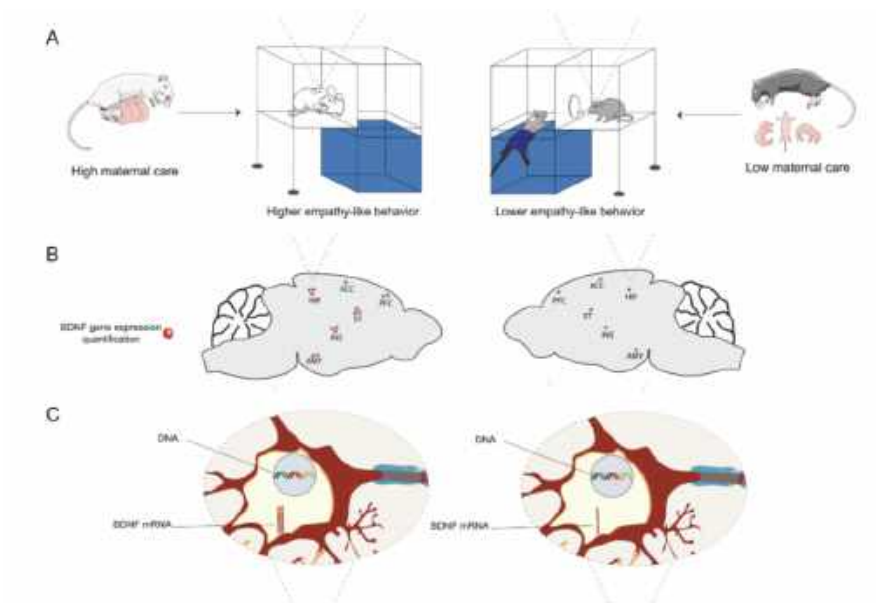
Maternal Care and Empathy / Early Development of Empathy in Infants

Early-life maternal care significantly shapes the development of empathy-like behavior in adulthood, enhancing helping behavior and influencing gene expression related to empathy, such as brain-derived neurotrophic factor (BDNF) in various brain regions (Asadi et al., 2021; Francis et al., 1999; Bowlby, 1969; see Scheme 6). Maternal care and other early experiences influence brain plasticity, crucially shaping empathy-related neural circuits and impacting emotional and social behaviors later in life (Francis et al., 1999; Bowlby, 1969; see Scheme 6). Interventions targeting childhood experiences could potentially enhance empathic capacities by fostering positive neural adaptations (Saxe, Carey, & Kanwisher, 2004).

Empathetic reactions emerge early in life and are heavily influenced by interpersonal and contextual factors, impacting behavior and cognition and demonstrating the flexibility and adaptability of empathetic responses (Decety, 2015). Differences in brain function between children and adults affect emotional processing and empathy, with the left frontal region, implicated in empathy, showing a slow developmental course, highlighting the importance of early experiences (Jones & Gagnon, 2006). There is modest evidence for the genetic basis of empathy, with studies on twins showing heritability of prosocial behaviors and suggesting genetic and environmental influences on empathic reasoning, which is also associated with fewer behavioral problems (Jones & Gagnon, 2006). Humans are biologically prepared for social interaction, as evidenced by newborns' emotional responses to social stimuli. This behavioral preparedness is linked to physiological processes and individual differences in response styles (Jones & Gagnon, 2006).

Emotional contagion develops earlier in infants, whereas cognitive perspective-taking abilities mature later in cognitive development stages (de Waal, 2008). The plasticity of neural circuits in early childhood significantly influences the development of empathic abilities, suggesting that experiences during critical periods can mold these circuits (Decety & Svetlova, 2012; Saxe, Carey, & Kanwisher, 2004). Recognizing the intricate relationship between stress

and empathy allows us to better understand the protective role empathy plays in social interactions and the neural mechanisms that underlie these processes, paving the way to explore how acute stress can sometimes enhance prosocial behaviors.



Scheme 6. (a) A schematic illustration of the behavioral task, where offspring were categorized into high maternal care (HMC) and low maternal care (LMC) groups based on observed maternal care patterns. The task then assessed the empathy-like behavior of these groups. (b) A comparison of BDNF gene expression in specific brain regions, including the hippocampus (HIP), anterior cingulate cortex (ACC), prefrontal cortex (PFC), insula (INS), superior temporal (ST), and amygdala (AMY), between the HMC and LMC groups. (c) Results showed that the HMC group had higher BDNF gene expression and demonstrated greater empathy-like behavior compared to the LMC group (Asadi et al., 2021).

Impact of Stress on Empathy

Stress can impair empathy by disrupting the neural circuits involved in emotional regulation and social processing, with chronic stress reducing brain plasticity and making it harder for individuals to engage in empathetic behaviors (Preston & de Waal, 2002; Sapolsky, 2004). However, sharing a threatening situation with someone in a similar emotional state can buffer individuals from heightened stress levels, underscoring the protective role of empathy in social interactions (Decety, 2015). Individual differences in empathy are influenced by structural variations in the brain, such as differences in the insula and somatosensory cortex, which affect how people perceive and respond to others' emotions (Marsh, 2018). Acute stress can increase neural responses to empathy for pain, potentially enhancing prosocial behavior and promoting social bonding and support in stressful situations, highlighting the complex interplay between stress and empathy (Marsh, 2018; McEwen, 2007). Understanding the profound influence of social environment and context on empathy underscores the importance of considering these factors in promoting prosocial behavior, setting the stage for exploring the neural mechanisms behind empathy and social cognition.

Influence of Social Environment / Social Context

The social environment plays a crucial role in shaping empathy through neural plasticity, with positive social interactions enhancing empathy by strengthening the neural networks involved in social cognition, while negative experiences can weaken these connections (Decety & Jackson, 2004; Hein & Singer, 2008). Empathy is influenced by social context, especially group membership, which can lead to biases in empathetic responses. These biases can be mitigated through behavioral interventions that promote empathy and reduce prejudice (Decety, 2015).

Social context, such as group membership and social status, can modulate empathy by influencing neural responses in regions like the temporoparietal junction (Marsh, 2018). These contextual factors can either enhance or inhibit empathetic responses. Social hierarchies also modulate empathic responses, with dominant individuals often exhibiting reduced neural activation in response to others' pain. This modulation is thought to be mediated by top-down cognitive processes that alter emotional responses based on social context (Feng et al., 2016; Zaki, 2014). Research consistently shows that empathic concern is a strong predictor of helping behavior. This is because perspective-taking, a key component of empathy, enhances an individual's sense of connection to others, thereby increasing the likelihood that they will offer assistance to those in need. This relationship between empathy and prosocial behavior is crucial for social cohesion (Decety, 2015). Empathic concern, or prosocial motivation, is driven by networks that include the ventral tegmental area, subgenual anterior cingulate cortex, and striatum, regions associated with goal-directed behavior and the motivation to help others (Marsh, 2018).

Empathy often involves coactivations in networks associated with social cognition, depending on the specific situation and information available. For example, empathy for social exclusion activates similar brain areas as physical pain (Bernhardt & Singer, 2012). Observing socially desirable others being rewarded activates the ventral striatum, a region involved in reward processing. The perceived similarity between the target and observer correlates with increased activity in the ventral ACC, mediating an effect of self-relevance in vicarious reward (Bernhardt & Singer, 2012). These findings on empathy training and enhancement underscore the potential for targeted interventions to significantly improve empathic capacities, paving the way for future research on their broader applications and benefits.

Empathy Training and Enhancement

Empathy can be enhanced through training programs that leverage neural plasticity, leading to structural and functional changes in the brain, thereby improving individuals' capacity for empathy (Klimecki et al., 2013; Singer & Engert, 2019). These programs demonstrate that empathy mechanisms are flexible and amenable to behavioral interventions that promote prosocial behaviors and reduce biases (Decety, 2015; Marsh, 2018). Training programs that increase activity in key brain regions, such as the anterior insula, highlight the potential for enhancing empathetic abilities through neural plasticity (Marsh, 2018). Compassion-based

interventions, like loving-kindness meditation, can increase cortical thickness in the anterior insula and enhance empathetic responses, showing that targeted practices can foster empathy (Marsh, 2018). Compassion training has been shown to boost functional neural plasticity in regions related to empathy, such as the insula and prefrontal cortex, leading to long-term changes in brain function and structure (Klimecki et al., 2013; Valk et al., 2017). Understanding the genetic influences on empathy provides valuable insights into the hereditary aspects of empathetic behaviors, setting the stage for exploring how genetic and environmental factors interact to shape empathy.

Genetic Influences on Empathy

Genetic factors contribute to individual differences in empathy by influencing brain structure and function (Plomin et al., 1997). Genes related to neural plasticity, especially those in neurotransmitter systems, can affect empathetic behaviors (Ebstein et al., 2010). Variations in the oxytocin receptor gene have been linked to differences in empathic abilities and neural activity, suggesting hereditary neural mechanisms underpinning empathy (Rodrigues et al., 2009; Gong et al., 2017). Twin studies show heritability of prosocial behaviors, supporting a genetic basis for empathy and its association with fewer behavioral problems, indicating both genetic and environmental influences (Jones & Gagnon, 2006).

Individual Differences in Empathy

Individual differences in empathy are influenced by brain structure variations, such as in the insula and somatosensory cortex, affecting emotional perception and response (Marsh, 2018). Brain injuries and psychological impairments have highlighted neurophysiological underpinnings of these differences, with specific brain regions playing crucial roles in emotional processing (Jones & Gagnon, 2006). Differences in empathy modulate neural activity during empathy tasks, with greater medial prefrontal cortex (MPFC) activity are observed when individuals take the similar perspectives of others (Lamm et al., 2007b).

Perspective-taking, or mentalizing, is a top-down cognitive process that involves understanding others' emotions and mental states through brain regions such as the ventromedial prefrontal cortex (vmPFC), superior temporal sulcus (STS), temporoparietal junction (TPJ), and posterior cingulate cortex (PCC) (Tousignant et al., 2016; Decety, 2011). These insights into individual differences in empathy highlight the importance of understanding the underlying neurophysiological and cognitive processes.

Neural Response to Emotional Saliency / Empathy for In-group vs. Out-group Members

Regions such as the anterior insula (AI) and anterior cingulate cortex (ACC) exhibit greater activity when individuals observe pain in in-group members compared to out-group members, emphasizing emotional saliency in empathetic processing (Decety, 2015). Empathic responses are typically stronger towards in-group members, with heightened neural activation in the ACC and AI. Interventions promoting positive intergroup interactions can mitigate this bias,

enhancing neural plasticity and empathy towards out-group members (Hein et al., 2016; Cao et al., 2015).

Empathy for in-group members engages distinct neural mechanisms compared to out-group empathy, with increased activation in the medial prefrontal cortex (MPFC) when perceiving the suffering of in-group members (Mathur et al., 2010). Greater empathy for in-group members correlates with stronger identification with the group and enhanced MPFC activity, particularly among different racial groups (Knowles & Peng, 2005; Phinney, 1996). Neural responses during empathy are influenced by perceived similarity to the target, with increased MPFC activity associated with greater empathy and altruistic motivation (Mitchell et al., 2006; Mobbs et al., 2009). Extraordinary empathy and altruistic motivation towards in-group members are linked more strongly to cognitive than affective empathy components, reflected by MPFC activity rather than ACC and AI activity (Mathur et al., 2010). In-group favoritism in empathy is characterized by higher MPFC activity and behavioral measures of empathy and altruism, underscoring the role of cognitive empathy processes in group bias (Mathur et al., 2010). Understanding how emotion regulation modulates empathic responses provides valuable insights into enhancing empathy through targeted interventions.

Effectives Strategies for Cultivating Empathy

Empathy, the ability to understand and share the feelings of others, is a critical skill that can be cultivated through various interventions in educational settings, professional environments, and everyday interactions. One effective approach is communication skills training, which focuses on improving key abilities such as active listening, reflective communication, and recognizing emotional cues. Research shows that such training significantly increases empathy by teaching individuals to engage more deeply with others, creating an environment where empathy can thrive (Butow et al., 2007; Kataoka et al., 2018). Perspective-taking exercises are another powerful strategy. These exercises encourage individuals to put themselves in others' shoes, enhancing their ability to understand and relate to different experiences and emotions. This method has proven effective across various contexts, from education to workplace training programs (Arthur et al., 2017; Lobchuk et al., 2016).

Experiential learning through simulations also plays a crucial role in empathy development. Simulations immerse participants in scenarios where they adopt different roles, such as patients or individuals facing challenging life situations. These exercises allow participants to experience the emotions and challenges of others firsthand, deepening their empathetic understanding (Everson et al., 2015; Cho & Kim, 2024). Reflective writing and exposure to narratives are additional tools that foster empathy. Reflective writing prompts individuals to analyze their interactions and emotions, leading to greater self-awareness and empathy. Similarly, exposure to personal stories through video recordings or live interviews offers a window into the lived experiences of others, enhancing the listener's empathetic response (Moniz et al., 2015; Heidke et al., 2018).

Role-modeling and scenario-based learning are also effective interventions. Instructors or leaders who demonstrate empathetic behaviors can significantly influence others to adopt similar practices. Scenario-based learning, which involves structured and realistic simulations, has been shown to be more effective than simple role-playing exercises, as it engages participants emotionally and cognitively, fostering deeper empathy (Tavakol et al., 2012; Cho & Kim, 2024). Finally, mindfulness-based training offers a valuable approach to empathy enhancement. Mindfulness practices help individuals become more aware of and regulate their own emotions, which in turn improves their ability to empathize with others (Shapiro et al., 1998).

Conclusion and future directions

While significant progress has been made in understanding the neural foundations and developmental pathways of empathy, several key areas still require further investigation. However, several critical areas warrant further exploration. Klimecki et al. (2013) underscored the need for longitudinal studies to uncover the enduring impacts of compassion training. Shamay-Tsoory (2010) highlighted gaps in distinguishing between the neural mechanisms of emotional and cognitive empathy. Bernhardt and Singer (2012) called for deeper investigations into the development of shared neural networks over time. Decety (2011) advocated for research into how higher cognitive functions, like language, augment empathy. Tousignant, Eugène, and Jackson (2016) stressed understanding the interaction of empathy-related neural correlates across developmental stages. Behm (2021) pointed out the lack of research on long-term performance changes induced by empathy exercises. Asadi (2021) identified the need to explore how brain-derived neurotrophic factor (BDNF) influences empathy-related brain regions. De Waal (2017), Decety (2017), and Marsh (2018) called for comprehensive investigations into how neural plasticity shapes empathy. Jones and Gagnon (2006) emphasized understanding how neural plasticity mechanisms influence individual differences in empathetic responses. Lara (2017) noted gaps in understanding the interplay between neuroplasticity and variations in empathetic responses. Mathur et al. (2010) highlighted the necessity to clarify the influences of genetic versus perceived similarity on neural responses during empathy.

The literature suggests that there is a biological connection with empathy, indicating a link with biomarker activity and neuroplasticity. To further elucidate this connection, researchers could design studies that monitor changes in biomarkers or genetic expression over time while participants engage in empathy-related behavioral tasks. For instance, longitudinal studies could observe how sustained empathy training affects neural plasticity and biomarker expression, such as levels of brain-derived neurotrophic factor (BDNF). Implementing empathy-enhancing interventions (e.g., compassion meditation, perspective-taking exercises) and measuring the corresponding changes in biomarkers like oxytocin, cortisol, and inflammatory markers could provide valuable insights. Genetic analysis can investigate the relationship between genetic variations (e.g. oxytocin receptor genes) and empathic behavior, examining how these variations influence neural responses and empathy-related biomarkers.

Additionally, using neuroimaging techniques like functional MRI (fMRI) and positron

emission tomography (PET) to observe real-time changes in brain activity can help correlate shifts in biomarker levels during empathy tasks. Developmental studies focusing on children at different stages can explore how early-life experiences and parental care impact the neural and genetic bases of empathy, tracking changes in biomarkers like BDNF and hormonal levels over time.

By linking behavioral studies with biomarkers and genetic analysis, researchers can better understand the biological underpinnings of empathy and how they are influenced by environmental factors and interventions. Moving forward, this multidisciplinary approach can serve as a blueprint for future research and intervention programs aimed at cultivating empathy on a societal scale. By harnessing the power of neural plasticity, we can not only enhance individual empathetic abilities but also foster a more cohesive and compassionate global community, ultimately contributing to social harmony and reducing conflicts rooted in a lack of understanding and empathy.

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My Journey with a Rare Congenital Condition and the Importance of Awareness **By Lyla Deysel**

As a young girl, ballet was my passion, an art form that motivated me to dedicate myself. But as I progressed, I began to notice unique limitations in my movements. My right leg, despite rigorous practice, couldn't execute certain steps with the same grace and precision as my peers. I couldn't balance correctly or point my toes like the rest of my friends. It wasn't just a lack of flexibility or strength, something deeper was at play: I was born with a rare condition called tibial hemimelia. Although I always knew there was something different about my leg, my ballet classes represented the first time I truly understood my limitations. This realization was both confusing and disheartening. I felt a mix of frustration and sadness, wondering why my body didn't respond the way I wanted it to. My instructors, noticing my struggles, were supportive but puzzled. They encouraged me to keep trying, yet I tried to remind them that there were some things I couldn't do. As they struggled to understand, I grew more frustrated as time went on - not just with them but with myself. My love for and enjoyment of ballet was not enough to completely overcome the obstacle caused by my condition. And despite the support of my teachers, I felt isolated. I felt like an outsider in the world I loved so much. Looking back on this experience, I feel both sad and determined. Sadness for the lack of understanding I experienced as a 6 year old and determination to raise awareness about my condition to show others with physical limitations that they are not defined by their impairments. My journey with tibial hemimelia, a rare congenital condition, has shaped my life in profound ways.

Tibial hemimelia is a condition characterized by the deformity, underdevelopment, or absence of the tibia, one of the bones in the lower leg. To deepen my own understanding of this condition, I spoke with my surgeon, Dr. Robert Rozbruch, Chief of the Limb Lengthening and Complex Reconstruction Service at the Hospital for Special Surgery, who emphasized its rarity. "Tibial hemimelia is the rarest among the lower leg congenital conditions that we see...it's estimated to be one in a million." For me, it manifested as a shortened tibia, causing instability and limited range of ankle motion. Today, tibial hemimelia is split into 5 types, via a categorization called the Paley Classification, ranging from mild deformities to severe cases in which the tibia is completely missing. Treatments typically involve a combination of surgical interventions and physical therapy. Some patients may require limb lengthening procedures, while others might need reconstructive surgeries. Dr Rozbruch highlighted the fact that limb lengthening, developed in the late 80s, has been a huge stepping stone in being able to address conditions like tibial hemimelia. "The big advances in the congenital limb deformities have been with the advent of the ability to lengthen limbs because... until we knew how to lengthen bones... it was nearly impossible to reconstruct." Despite these advancements, a critical issue remains: the long-term outcomes of these interventions are still not well-documented, leaving both patients and clinicians with uncertainties regarding the best way to mitigate the physical, and thus social, impacts of tibial hemimelia. Additionally, despite the evolution of surgical treatments, there is much that remains to be understood about the root cause of the disorder - the

genetics. Dr. Rozbruch highlighted just how far we have to go. “What we still need to understand are the genetics of this condition and conditions like it. How to understand which gene in particular is affected and how we can intervene at the genetic level.” Understanding the genetic basis of tibial hemimelia and other congenital conditions would potentially allow researchers and clinicians to develop gene-specific therapies that could correct or mitigate these disorders at their sources.

Now as I reflect on my journey with my condition, and my well-intentioned ballet teacher’s difficulty to understand it, these experiences have shown me the importance of increasing societal awareness and scientific understanding of tibial hemimelia. In writing this article, I hope not only to raise this awareness but also to highlight the need for increased research and better documentation of long-term outcomes, which can lead to more effective treatment strategies. Organizations like the Limb Lengthening and Complex Reconstruction Society are accepting donations that can support research related to limb lengthening and reconstruction. The Pediatric Orthopaedic Society of North America is also accepting donations that will support research and treatment advancements for various pediatric orthopedic conditions, including congenital limb deformities. Gaining a deeper understanding of the ways in which my condition has affected my life and the lives of others has allowed me to recognize a broader challenge: we can’t empathize with what we don’t know. When society recognizes and understands rare conditions like tibial hemimelia, it can lead to better support systems and more effective treatment protocols for patients. By increasing public awareness and supporting research organizations that are paving the way forward, we can bridge this gap and build a more compassionate and inclusive environment for those with rare conditions.

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The Role of Biomarkers After Mild Traumatic Brain Injury

By Nishika Mada

Abstract

This paper aims to compare the circumstances and the presence of the different biomarkers, including to see which ones are most effective when looking for brain degeneration. This will also cover the other sources in the literature review to analyze the attempt to add to the research. One central point covered was the difference between a student-athlete who has received concussions and a senior citizen who has been diagnosed with Alzheimer's disease. To achieve this, a fundamental review of the role of Tau in these neurodegenerative diseases will be given. Then, from there, the rest of the article will cover the different biomarkers that help identify trauma to the brain.

Introduction

A common injury in most high school sports is concussion, also recognized as mild traumatic brain injury (MTBI). A TBI can be characterized as a brain dysfunction that is commonly caused by a violent incident of trauma to the head, which promotes the deposition of the protein tau in the brain and is associated with an increase of tau in the blood, which is used as a blood biomarker in the study of concussion(Olczak et al.,2019). Tau could also be classified as a significant microtubule-associated protein (MAP) of a typical mature neuron and a fluid neurodegeneration biomarker(Schraen-Maschke et al., 2008). An excess of Tau can sometimes be used to identify a concussion, however, to identify a concussion, Sport Concussion Assessment Tool 5 (SCAT 5) tests can be utilized. TBIs can cause temporary problems, including headaches, fluid accumulation, vision problems, depression, anxiety, attention disorders, and moodiness(Pavlovic et al., 2019). If not taken care of efficiently, these symptoms can permanently damage the brain. Tau contributes to the worsening of neurodegenerative diseases by forming neurofibrillary tangles that disrupt neural communication and cause extreme neurodegenerative disorders (Wolfe, 2012). These blood biomarkers can be signs of severe neurological damage following an injury on the field. Through this, it was found that athletes who were part of the National Football League had a higher Tau level than individuals who had never received a concussion (Batty et al., 2022). Medical professionals can identify such an impact on the brain after noting the presence of such blood biomarkers. With chemical imbalances in the brain, Tau becomes hyperphosphorylated and toxic through an imbalance of different protein kinases and phosphatases(Rawat et al., 2022). Neurodegenerative diseases are usually caused by a surplus of toxic Tau in the brain, which can prove fatal due to the quick degeneration of the brain, leading to conditions such as Alzheimer's. Moderate head injury was proven to cause a higher risk of Alzheimer's disease or Dementia(Gottlieb 2000). The purpose of the review included the overall evaluation of the extent to which these neurodegenerative diseases would affect patients, who already had Tau accumulation due to chemical changes, rather than over time.

Tau Protein

There are many ways of measuring Tau, including Cerebro Spinal Fluid Tau [CSF Tau] and Plasma Tau. One could measure Plasma tau through a blood sample, and CSF Tau through cerebrospinal fluid samples, using positron emission technology (PET). PET can be a significant resource in exploring the pathology of CTE in terms of Tau (Ayubcha et al., 2020). While these proteins may have different properties, they still serve the same purpose: to cause brain degeneration. One example is that Plasma Tau is connected to cognition in Alzheimer's disease, unlike CSF Tau (Fossati et al., 2019). They appear to complement each other. However, further research is necessary. The Tau Protein's presence in the brain can indicate postconcussive syndrome and cognitive deficits (Schraen-Maschke 2008).

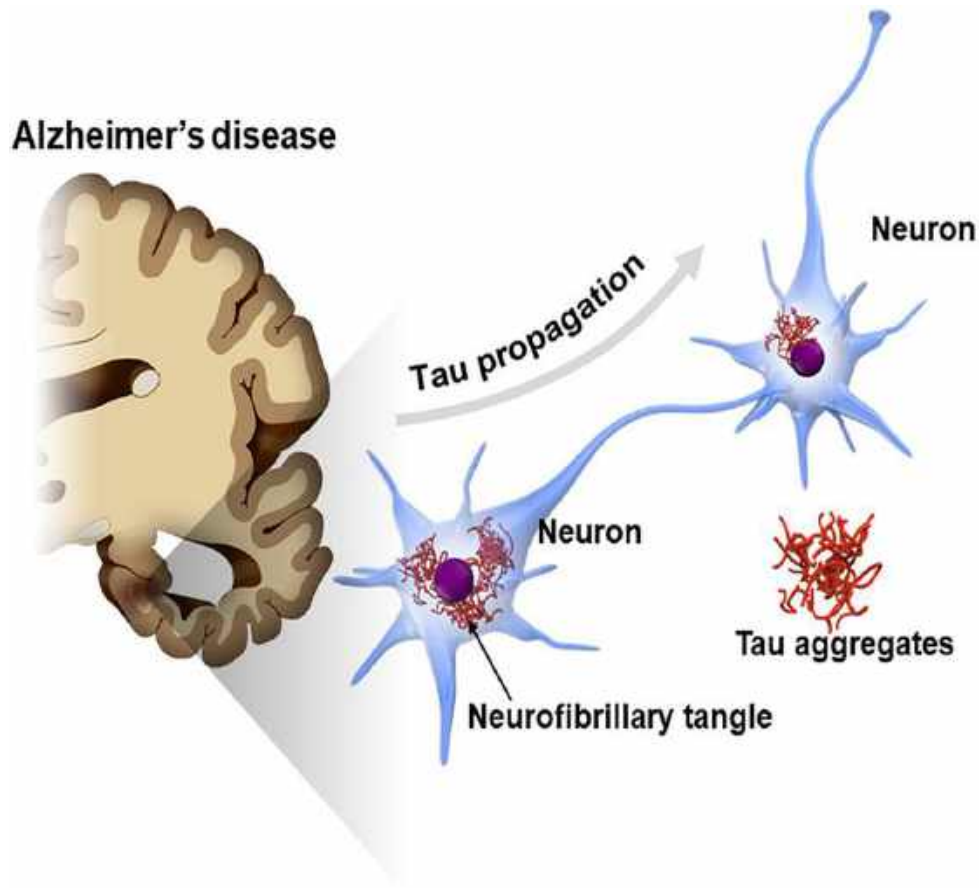


Figure 1. The process of tau propagation. From Smith et al. (2020) under the Creative Commons Attribution License

This protein comprises a family of six isoforms with 352–441 amino acids (Goedert and Jakes, 1990). The major protein is encoded by 11 exons, and the 2, 3, and 10 exons are spliced which leads to the formation of six isoforms. Tau is already present in the brain, with the average person's brain containing 80–450 pg/ml of Tau (Schraen-Maschke et al., 2008). The average athlete who receives an MTBI ends up with Tau aggregation and increased neuroinflammation within their brain (Figure 1). However, after a concussion, the increased calcium levels in the brain causes Tau to detach from microtubules and stick to other Tau molecules. These Tau

molecules join together and form neuron tangles, aiding brain neurodegeneration. These tangles impact the brain and have to do with a wrongful distribution of Nup98, a gene that is a transcriptional generator, instead of staying in the Nuclear Pore (Daigle et al. 2018). This stops the transportation of molecules into the nucleus and damages the transport system. However, this is not determined to be true yet but it is a theory. It is also linked to defects in pore function and causes Tau to fibrilize within the brain. Athletes have been shown to have higher Tau protein levels at baseline compared to healthy non-athletes (Gill et al., 2017) Tau Proteins are more prevalent in student-athletes brains due to the demanding nature of the sports played, which usually include football, rugby, lacrosse, wrestling, and other high-contact sports. However, this differs from sport to sport.

Concussion

Concussions are one of the crucial external factors that cause the increase of blood biomarkers in the brain (Giza and Hovda, 2001). There is a procedure known as SCAT 5, a concussion test, to be followed by the athletic trainers to ensure that the injury isn't worsened; however, occasionally, some athletes are still allowed to return to play before their symptoms are resolved. The SCAT 5 procedure includes Maddocks Questions for Memory Assessment, the Glasgow Coma Scale (GSC), a symptom evaluation, the Standardized Assessment of Concussion (SAC), and the modified Balance Error Scoring System. (Giza and Hovda, 2001). Student-athletes have been shown to contain more of the Tau protein in the brains in comparison to patients who have been diagnosed with Alzheimer's, Dementia, and other neurodegenerative diseases that involve Tau proteins (Pathol, 2015). These athletes are also more at risk of being diagnosed with such diseases. A collection of studies regarding male athletes concluded that there was proof that retired professionals had faced much worse repercussions from playing contact sports (Batty et al., 2022). This essential piece of evidence also emphasizes the athlete's gender, which makes this not wholly viable which is further proven when examining the sex differences in Tau. It is shown that there is a distinct difference in the levels of T-tau in the brains of concussed female and male athletes, with the females having a greater buildup of protein (Mondello et al.).

Tau Protein and Head Trauma

A common injury in athletes playing a contact sport such as football or rugby is concussion or mild traumatic brain injury. There is a procedure known as SCAT 5, a concussion test, to be followed by the athletic trainers to ensure that the injury isn't worsened; however, occasionally, some athletes are still allowed to return to play before their symptoms are resolved. Athletes can return to play after passing the following tests, which would therefore prove that they are no longer concussed, or received side effects from the concussion. The SCAT 5 procedure includes Maddock's Questions for Memory Assessment, the Glasgow Coma Scale (GSC), a symptom evaluation, the Standardized Assessment of Concussion (SAC), and the modified Balance Error Scoring System (Giza and Hovda, 2001). This case study reviewed how

the athlete returned to the field after surgery. At the same time, this is so rare that many clinicians do not encounter such cases; on the rare occasions where it occurs, the second injury results in malignant swelling of the brain, which leads to death but can be treated by decompression therapy within the given time frame, before the injury is too dangerous to the person. Concussions can increase the levels of Tau in the brain by causing a chemical change, which causes Tau to detach and link with other Tau molecules, causing brain tangles and resulting in degeneration. These chemical changes include the transmission of neurotransmitters such as Glutamate, ionic shifts, changes in glucose metabolism, and an altered cerebral flow (Giza and Hovda, 2001). The chemical changes that occur include a change in Tau, which is also involved in other neurodegenerative diseases; however, genetics, age, and internal factors cause the chemical changes rather than mild traumatic brain injury (Giza and Hovda, 2001). Second Impact Syndrome (SIS) is also a prevalent, however rare, occurrence that could prove fatal if it does occur. Second Impact Syndrome is characterized by two MTBIs happening back to back and by a malignant generalized cerebral edema (Wolfe 2012) This is considered a controversial syndrome due to the necessary studies that are still pending currently, and the lack of knowledge about it. The controversy revolves around the frequency of its occurrence, as it is quite rare. (Bey and Ostick et. al 2009) What is known however is that second impact syndrome includes two back-to-back MTBI which therefore trigger swelling in the brain, causing death shortly after (McLendon et al.,) Concussions are one of the largest causes of Tau buildup in the brain, aside from the aging process.

Discussion

Through the different sources that were analyzed, a common finding regarding Tau was that it was found in excess in the brains of athletes who had participated in contact sports throughout their high school career and received mild traumatic brain injuries during their time playing sports. It was also noted that there were many adverse effects when these athletes were not treated or tested for such traumatic brain injury. In interpreting these results, it has been proven that one can identify the severity of the traumatic brain injury and further analyze to what extent the injuries would cause future complications (Sahler and Greenwald, 2012). Based on the neurodegenerative diseases caused by excessive Tau proteins in the brain, it has been concluded that Tau is an important factor in the development of neurodegenerative diseases, including Alzheimer's and other fatal diseases. These results can be used in further research regarding the reasons behind sports-related neurodegeneration. The findings that were all common within each of the literature sources used can be a crucial indicator of Tau's role in these diseases. Findings included an increased buildup of Tau in athletes that predominantly played contact sports, and received injury through sport. It was also shown that because of an unnatural buildup of Tau, neurodegeneration was more likely to occur. However, the limitations were due to a lack of experimental data and more regarding the vague numbers given rather than precise data, which could have provided a more extensive insight into this matter. Many articles that were reviewed did not provide a baseline level of Tau that would be expected in the brain and rather provided an

out-of-context amount of the Tau that was built after the occurrence of a brain injury. This would have given a base value of the average amount of Tau in the brain. This research could further aid in analyses of Tau in the role of brain injuries and how those complications could lead to fatal neurodegenerative diseases. Through this research, it has been concluded that concussions affect the level of Tau protein concentrations in the brains of student-athletes, which leads to a chemical imbalance in their brains, causing an increase in the amount of Tau in their brain. This amount is usually more than the average Alzheimer's patient would have in their brains, after multiple years of buildup. This could lead these students to the development of Neurodegenerative diseases later in their lives (Ledreux et al., 2020). Based on these conclusions, fellow researchers should consider further researching SIS, as the results from these studies vary when compared to specific scenarios. To understand the implications, it would be beneficial to provide further data regarding Tau's average levels when in the brain of a non-athlete in excellent or average health. Adding onto the research, it has been shown that after some time, after their sports career, athletes who had experienced multiple MTBIs had a significant amount of Tau in their brains, which caused an unnatural chemical change in the brain, therefore resulting in the brain slowly being degenerated (Taghdiri et al., 2019). Overall, based on the compared data covered extensively, it is suggested that Tau deposition in the brain is very prominent in concussed athletes. Through this paper, the end goal was to compare the findings regarding Tau levels, and the efficiency of different Tau Biomarkers. An overall review of numerous literature reviews provided insight through which it can be concluded that Tau buildup in the brain is caused primarily by mild traumatic brain injuries.

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The Foreign Countries Roles in The Ukraine-Russia War

By Oleksandr Kirieiev & Mohammed Ali

While many people believe the Ukraine-Russia war started on February 24, 2022, the conflict can be traced back to 2014 when the Russian Federation invaded and annexed Crimea, a peninsula in the northern part of Ukraine. The peninsula was strategically important to Ukraine since it provided access to the black sea making it easy and quick to access the Eastern Mediterranean, Balkans, and Middle East. Preceding events, including the nuclear non-proliferation treaty between Ukraine, Russia, the U.S., Belarus, and Kazakhstan, the collapse of the USSR, the Orange Revolution, and the Revolution of Dignity, may have influenced and contributed to the onset of the war in Ukraine and the annexation of Crimea.

Ukraine played a pivotal role within the USSR, serving as one of its founding republics in 1922. During its time in the USSR, Ukraine maintained strong relationships with Russia, Belarus, and other countries in the USSR. However, Ukraine, as many other countries in the Soviet Union, was under centralized control from Moscow. Russia had a significant impact on Ukraine as Russia was the biggest and most dominant republic in the USSR (Marple, 2011). Ukraine's relationships with eastern bloc countries like Poland, East Germany, Czechoslovakia, and Hungary were also fairly good as they all took part in the Warsaw Pact, the military alliance led by the USSR (Marple, 2011). While Ukraine did have good ties with USSR republics and East bloc countries, its relationships with the West, specifically NATO allies and the USA, were much more tense (Office of The Historian, N.d.). The main reason was the major difference in political views: Ukraine and the USSR were communists while the Western countries were capitalists (Office of The Historian, N.d.)

1991, a crucial year. On August 24th 1991 Ukraine declared its independence and left the Soviet Union after a failed coup attempt in Moscow in 1991, which declared the collapse of the USSR (Office of The Historian, N.d.). The parliament of Ukraine, Verkhovna Rada voted for Ukraine's independence. Ukraine was the second republic to declare its independence. After Ukraine became independent, many Ukrainians have been wondering, is Ukraine becoming a more pro-Western country? Throughout so many years in the USSR, Ukraine shared many historical, cultural and even blood ties with Russia, almost making them seem like "brothers." Although Ukraine did have a lot in common with Russians, its orientation was still described as balanced between the West and Russia (Marple, 2011). The first Ukrainian president, Leonid Kravchuk, initially leaned towards maintaining good relations with Russia while also pursuing closer ties with the West. However, his position began to change overtime. He started leaning more towards the Western side and began to develop relationships with European countries (Harasymiw, 2020). Did his actions knock the first domino?

The first Russian president, Boris Yeltsin, initially pursued closer ties with the West and Europe, seeking economic assistance and cooperation. However, tensions began over issues like NATO expansion towards Russia and Western intervention in the Balkan countries (History.com

Editors , 2021). One of the most important at that time treaties, The Ukrainian Trilateral Treaty, also known as the Budapest Memorandum, was signed on January 5, 1994 (Pifer, 2016). The treaty granted Ukraine protection from the UK, USA, and Russia in exchange for Nuclear weapons (Pifer, 2016). I think that by signing this Trilateral treaty all Ukraine wanted was peace and protection from the biggest and most powerful countries in the world making this “trade” seem like a good idea.

Well, Russia, just like many other countries wanted to develop as a country and were in fact becoming more pro-Western. A former NATO head, George Robertson says that in the 2000’s, right after Putin became the president of Russia, he asked “When are you going to invite us to join Nato?” to which George Robertson responded “Well, we don’t invite people to join Nato, they apply to join Nato.” (Rankin , 2021) This made Putin very mad and he responded “Well, we’re not standing in line with a lot of countries that don’t matter.” Later Putin claimed that if Russia is not welcomed in Nato then Russia is certainly against Nato expansion towards Russian borders (Rankin , 2021). This conversation also describes Putin as a president, he does not seem to care much about smaller and weaker countries. Previously Putin claimed that he doesn't see Russia in isolation from Europe as they share cultures, history, and traditions (Rfe/rl, 2015). This is very ironic as more and more countries oppose Russia and their politics.

The 2004 Ukrainian presidential elections and the orange revolution in Ukraine. On November 21, 2004 Yanukovich was elected as the 3rd Ukrainian President (Marples & Collins , 2024). The election results, initially declared in favor of the elected president, Yanukovych, were widely criticized for fraud and irregularities. This sparked mass protests, known as the Orange Revolution, led by Yushchenko's supporters, who demanded a re-election (Marples & Collins , 2024). The protests lasted for weeks and drew international attention. Countries like Russia, USA, and EU countries had their own opinions. The USA was supportive of the Orange revolution and described it as an act of freedom and democracy. The USA and EU called for a re-election and supported the people who were present in the revolution protests. Russia on the other side had a different point of view (Bivings, 2024). Russia had supported Viktor Yanukovych during the 2004 presidential election, and Russian officials initially criticized the protests as interference in Ukraine's internal affairs (Dickinson, 2020). President Putin expressed concern in American actions that in his opinion interfered in Ukrainian politics.

Vladimir Putin became president by starting out as Prime Minister under Boris Yeltsin (Ray, 2024). He then took over as Acting President in 1999 after Yeltsin recommended him to be the president and has won several elections since (Ray, 2024). In 2008, Vladimir Putin gave an interview in which he said, “Moscow recognizes all of Ukraine's borders, and that there is no issue of ethnic conflict in Crimea.” However, Putin contradicted this in several other speeches by stating: "Crimea has always been an integral part of Russia in the hearts and minds of people," "Russian people and other ethnic groups have been living in Crimea for centuries," and "Crimea returning to Russia is not merely a question of territorial integrity, but of historical justice and the rights of people to self-determination." (Rfe/rl, 2015) All these quotes contradict with what he said in 2008 making him a very questionable political figure.

In 2008, the Russian Federation also invaded Georgia. The USA, NATO, and EU all supported Georgia and disagreed with Russia's decision to invade Georgia (Dickinson, 2021). Russia explained the intervention as a response to Georgia's military actions in South Ossetia and to protect Russian citizens living in the region. I think this action heavily affected Russia's relationships with other countries (Dickinson, 2021).

The 2014 Revolution is named for the protestors who wanted a more democratic Ukraine freed from corruption and Russian influence. It is also referred to as "EuroMaidan." (The Editors of Encyclopaedia, T.E.) How did The Revolution of Dignity Begin? The first protests began on November 21, 2013 right after Yanukovich decided to abandon an association agreement with the European Union. Instead of that, a treaty was signed with Russia in order to be closer with them (The Editors of Encyclopaedia, T.E.). The protests continued to spread day after day. More and more people wanted early elections and reforms to improve democracy and eliminate corruption. In January of 2014, Yanukovich passed an anti protest law (Shveda, Y., & Park , J. H. 2015). While this might have been the end to the protests, it didn't stop Ukrainians from fighting and getting what they wanted and what was better for the country. There were large-scale acts of violence between the protestors and the security forces resulting in many deaths. The revolution reached its peak in February 2014 when intense and deadly clashes erupted in Kyiv. There were many threats from the protestors to different politicians, including the president Yanukovich, who decided to leave the country and flew to Russia. The Ukrainian Parliament voted him out of power shortly after the escape (The Editors of Encyclopaedia, T.E.). This revolution meant a lot for Ukraine and its future. Ukraine soon got a new president, Poroshenko, and its political views became more pro European. It also made Ukraine's and Russia's relationship worsened.

The annexation of crimea

As an introduction, Crimea is a small peninsula in the northern part of Ukraine. Crimea has historically been ruled by many forces like Greece, Bulgars, Scythians, Romans, Gots, Huns, Khazars, Kievan Rus, the Byzantine Empire, Venice, Genoa, Kipchaks, the Mongol Golden Horde, the Ottoman Empire, the Russian Empire, Soviet Russia, the Soviet Union, Germany, the Soviet Union again and Ukraine. In its long and interesting history, it has been independent for less than 4 decades (Bebler, 2015). The conflict between Russia and Ukraine over Crimea began on February 10th, 2014 when the Russian Federation invaded the peninsula (Ray, 2024). Russia stated that the new Ukrainian president Petro Poroshenko was pro-Western and was leaning towards the West. Russia also claimed that people living in Crimea did not want to be part of Ukraine and that initially the separatists started the movement against Ukraine (Ray, 2024). The so-called "Little Green Men" occupied key locations in Crimea in late February 2014. In March 2014, Russia hosted a referendum that showed that people living in Crimea wanted to become more independent and become a part of Russia. The referendum formally resulted in Crimea joining Russia (Bebler, 2015). Only 17 countries across the whole world recognize Crimea as a part of Russia, while other countries see the annexation as a violation of Ukraine's sovereignty and territorial integrity (The Editors of Encyclopaedia, T.E.).

Petro Poroshenko

Petro Poroshenko was born in Bohrad, Ukraine in 1965. In 1993, he and his father created a UkrPromInvest Ukrainian Industry and Investment Company, which specialized in the confectionery and automotive industries. Under the same investment group there were several other businesses like Roshen, 5 Kanal, Group, and others (Ray, 2024). The group fell apart in April 2012. In 2014, soon after the annexation of Crimea and Euromaidan, he became the 5th president of Ukraine. Poroshenko became the president in a very hard time for Ukraine, Ukraine's economy was not stable and it was experiencing territorial loss. At his inauguration Poroshenko promised to do anything to keep Crimea a Ukrainian territory. Additionally, his goal was to develop Ukraine into a democratic country and join the EU (Ray, 2024). One of the most important accomplishments Poroshenko did was that he tried to get Ukraine into NATO to grant safety, additionally Poroshenko fought through the war in Donbass and tried to defend territories (Al Jazeera, 2019).

The year was 2022. Ukraine had a new president Vladimir Zelensky who was also more pro western. On February 24 2022 Russia declared a full scale invasion in Ukraine. This invasion became the biggest in the world since WW2. Russian President Vladimir Putin called this war a Special Military Operation whose purpose was to protect the Russians and Russian speakers living in Ukraine (Messieh, 2023). Putin made a false statement that Ukrainian political figures were "Neo-Nazis" and that there was serious genocide and humiliation of Russian speakers in Ukraine. Putin also claimed that occupying Ukraine is not in his interest and that Ukrainians should choose their future (Messieh, 2023). His main goals were demilitarization and denazification. The question many people ask the Russian Officials who stated that the politicians in Ukraine are "Neo-Nazis" is that how could Ukraine's president be a "Neo-Nazi" when he is Jewish. Before the invasion there were thousands of Russian troops on the Ukrainian border but Russian officials kept denying any possible war scenario. The excuse they made was that it was military training (Messieh, 2023). I think not only the politicians were denying any sort of war scenario but also regular citizens. Both Russians and Ukrainians considered themselves "brothers" and close friends. As an example, Russia and Ukraine played each other in Futsal 2022 Euros, a month before the full scale invasions and when the captains shook hands before the game they said "we are brothers." President Zelensky also stated that Russians and Ukrainians cant start a war because they are brothers several times in interviews before the full scale invasion.

Now let's talk about the day of the war. On February 24th, early in the morning, shortly after Putin's announcement, Ukrainians heard rocket explosions and sirens across the whole country. Russia sent hundreds of missiles to Ukraine that reached as far as Lviv in the west part of Ukraine. Shortly after the explosions in the capital, president Volodymyr Zelensky gave several formal speeches across different platforms including social media. Volodymyr Zelensky stated "We are here and ready to protect our country." He also stated that he had a conversation with the U.S. President Joe Biden and that everyone is working on gathering international support (Al Jazeera, 2022). Zelensky told Ukrainian Citizens to stay at home and stay calm, the

Ukrainian army was ready to defend their country. In his speech Zelensky talked in Ukrainian, Russian, and English to address everyone. Zelensky also initiated a phone call with Putin but the result was silence (Al Jazeera, 2022). Russia deployed their troops from the North, East, South sides of Ukraine (France 24, 2023). Belarus let Russian troops enter their territory and start an attack on Ukraine on the 24th having Russian soldiers break through the border between Belarus and Ukraine and have an unmarked helicopter without any identification marks attack the Slavutych bridge (France 24, 2023). CNN showed different videos of Russian tanks entering Ukraine through the Senkivka border crossing. Belarus also allowed Russians to use their airbases for Russian aircrafts and its army installations. On the day of the invasion, Russians launched several ballistic missiles from Belarus causing several deaths. What really surprised Ukrainians and Ukraine's politics was that Belarus let Russia do that and supported Russia after President Zelensky and the President of Belarus Alexander Lukashenko had good relationships. Russia also launched several Ballistic Missiles from Crimea and Donbass, previously occupied territories.

While the war continues, many people ask themselves, "Should we have ended the war in the beginning?" This question comes from a lot of people from Russia, Ukraine, and other countries that encounter negative effects from the war. At the very start of the full scale invasion there were peace talks between Russia and Ukraine. Ukraine's delegation group consisted of 7 people, David Arahamiya, Rustem Umerov, Aleksey Reznikov, Andrey Costin, Nikolay Tachinskiy, and Denys Kireev. Russia's delegation group consisted of 5 people, Vladimir Medinskiy, Boris Grislov, Leonid Slutskiy, Andrey Rudenko, and Alexander Fomin (Roshina, 2022). Ukraine's goals were to stop the war as soon as possible. Ukraine was willing to become a neutral country that wouldn't join any military alliances. Russia wanted several things before ending this war. First, recognition of Russia's annexation of Crimea, and recognition of Luhansk and Donetsk people's republics as independent territories (News, 2022). Secondly, keep Ukraine a neutral country and have them stay out of NATO (Balmforth, 2022). And thirdly, demilitarize and denacificate Ukraine as from Putin's claims Ukraine's government were "Neo-Nazis" who carried out genocide in Donbass and Luhansk (Roshina, 2022). The first 3 rounds of peace talks were held in Gomel Belarus close to Ukraine's border. The peace talks were initiated by Belarus President Alexander Lukashenko who promised Zelensky that all helicopters, planes, and missiles would remain on the ground and unused. The first round on February 28th ended with no results and all the members from both sides returned for consultation. The second round began on March 3rd in which both sides agreed to "open humanitarian corridors for evacuating civilians" While the Ukrainian side was ready for resuming talks, Russian demands did not change. The next 3 rounds of peace talks did not reach a breakthrough and had no results other than evacuating civilians (Dutta, 2022).

To the current day Russia and Ukraine keep fighting and winning and losing battles. Some battles were strategically important while winning others were much more about morality and morals. Important battles include the battle of Kherson. On the very first days of the invasion Russia invaded Kherson from the south side of Ukraine, specifically from Crimea (Cotovio,

Kiley, Rudden, & Konovalova, 2022). Residents of a town called Chaplynka heard several fighting sounds and eventually saw tanks, armored personnel carriers, and multiple rocket launchers moving in the direction of Nova Kakhovka. On March 2, Russia occupied Kherson and had full control over it (Cotovio, Kiley, Rudden, & Konovalova, 2022). Kherson was a strategically very important city as it blocked Ukraine from counter attacking Crimea. One of the most important battles of this war was certainly the battle of Antonov Airport. For Ukraine, this battle was most important because the existence of Ukraine depended on this battle. On February 24th, just a few hours after president Putin announced the Special Military Operation, Russia deployed their troops in the Antonov Airport (Collins, Kofman, & Spencer, 2023). Russians were hoping to capture the airport to have more Russian troops land in the airport to get closer to Kyiv and potentially capture. This was their goal. Russians did eventually capture the airport after 2 days fighting for it. The capturing of the airport meant that Russia could get their troops very easily to this cargo airport to continue their way to Kyiv. The airport though was too damaged to be used because of all the rocket explosions. Ukraine restored control over the airport a month later on April 2nd (Collins, Kofman, & Spencer, 2023).

While it may seem that Russia always had the same people ruling their country and following people's interest, in reality, there were several individuals opposing Putin. The first man was Aleksey Navalny, he was a Russian opposition leader, lawyer, anti corruption activist, and political prisoner (Ray, 2024). Navalny was also heavily disliked by Putin as he supported independent candidates most of which were not allowed to participate in the elections. Aleksey Navalny organized several anti-government demonstrations and ran for office to advocate reforms against Putin and the corruption in Russia. Putin feared Navalny so much that he poisoned him in August 2020. Navalny was on a plane from Tomsk, Russia when during the flight he started screaming and calling for help. The plane was sent to Germany for treatment. As it became known later, Navalny's team said that he was most likely poisoned before leaving the hotel as they found traces of the nerve agent used to poison him on an empty water bottle in his hotel (Ray, 2024). Soon Navalny fully recovered and flew back to Moscow. As soon as he landed in Moscow's airport he got detained and remained in custody until the court hearing in which he got two and a half years in a corrective labor colony. After being held in a corrective labor colony for almost 3 years, Navalny died on February 16th, 2024 (Ray, 2024). Could his death be connected with Putin? Certainly, there has been another case where things were very sketchy and suspicious. Yevgeny Prigozhyn was also one of the victims of Putin's death list. After several progress in the front lines made by Prigozhins private military company called "Wagner" Prigozhyn started opposing the Russian government. Earlier, Prigozhyn made several videos asking Russian minister of defense Sergei Shoigu for ammunition after several heavy battles in Ukraine (Steele, 2023). Shoigu and Gerasimov, chief of the general staff, never provided anything for the Prigozhin military group which led to further tensions. The final domino was the events on June 23, 2022 when Prigozhins private military group announced a staged rebellion after an intended attack on Wagners forces. Prigozhyn called this event a "Marsh of Justice". Soon after announcing the rebellion Wagner took control over Rostov-on-don and Wagners

troops were making their way to Moscow through the Voronezh Oblast (Steele, 2023). During the march, the president of Belarus Lukashenko agreed to stop the march and end the rebellion. All of the forces in Wagner started withdrawing and leaving Rostov-on-don. In the same year after the rebellion, after Prigozhyn decided to leave the country and flew to Africa, Prigozhyn's plane crashed in Kuzhenkino, Russia (Steele, 2023). All of this was after a big conflict with Putin after being close colleagues. Some people describe Prigozhyn's death as a way the Kremlin deals with traitors.

As days go on, more and more Ukrainians die for their freedom and peace. Each day Russia strikes missiles at cities in Ukraine killing several civilians. Even though Russian officials say that they are only hitting military targets, there are now about 10,582 civilians killed after the full scale invasion making their claims simply not true. After all, this conflict's first spark was the annexation of Crimea in 2014 when the countries which signed the Ukrainian Trilateral treaty did not step up and help Ukraine protect and get back Crimea after the so called "separatists" movement which was later known to be Russian sponsored people. If the countries simply followed the treaty and helped Ukraine get their territory back none of this would've happened.

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Breaking Silence: An Exploration of Gender and Mental Health in the Wake of the #MeToo Movement By Tanvi Gogate

Abstract

This review aims to investigate the portrayal of depression, anxiety, and post-traumatic stress disorder (PTSD) in fictional women characters across current media. This paper will explore significant cultural shifts before and after the #MeToo movement. The paper also aims to contextualize these portrayals within broader sociohistorical changes in women's roles and analyze the impact of various waves of the feminist movement. As part of this analysis, the paper will explore the development of mental health representation in mainstream media and analyze three fictional characters with mental health conditions. This paper seeks to compare the accuracy of these media depictions to the causes and pathophysiology of depression, anxiety, and PTSD. Ultimately, the paper aims to uncover evolving trends in media portrayal and societal attitudes toward women and mental health.

Introduction

The representation of women in media has often reflected their status in society. For centuries, women have been limited to the lifestyle, thoughts, and emotions of their families and the men in their lives. This stereotype and expectation were widely reflected in fictional women characters in media (Santoniccolo et al., 2023). The consequences of this societal norm were discussed widely in feminist movements in the 20th century. Since then, there has been an increase in awareness of the complexities of womanhood, particularly with other social movements such as the #MeToo movement in the early 21st century. This social movement grew in the context of social media against sexual abuse and fought to improve the workplace and educational environment for women. With the increased focus on societal and cultural injustice women face, the portrayal of women in media and books has gone from catering to the male gaze and stereotyping characters to the raw and vulnerable portrayal of women's issues and mental health issues (Santoniccolo et al., 2023). There has been substantial progress in the diverse representations of women and femininity, but various stigmas and stereotypes surrounding women and mental health continue to permeate the media. Does the portrayal of women's mental health and psychology strike a chord with the real experiences of women around the world? Is representation falling back on degrading and stereotypical views?

Despite the immense progress in representations of women and mental health in the media, it's important to consider whether the representations are truly authentic and relatable to women in reality. The connections between media, real life, and scientific research can help to understand if true progress is being made in the representations of mental health and women. The present paper will begin by discussing how women have been portrayed in the media historically, followed by a brief overview of how social movements have impacted representations of women in the media. The paper will then discuss how the media has typically represented mental health issues - particularly issues related to women. Lastly, to compare and contrast media

representation to scientific literature, this paper will use extensive research on depression, anxiety, and PTSD to analyze three popular fictional women characters in the media. These characters were created at the pinnacle of or after the #MeToo movement: Cassie Howard from *Euphoria*, Diane Nguyen from *Bojack Horseman*, and Jessica Davis from *13 Reasons Why*.

Representation of “Traditional Female Roles” in Society and Media

Throughout history, women have been confined to various societal expectations and gender roles that revolve around the domestic sphere (Rutherford & Alexandra, 2017). Notably, they have been bound to feminine endeavors in life such as marriage and bearing children, confining their identity to the household (Kachel et al., 2016). In addition, societal expectations have emphasized qualities like purity, submissiveness, and domesticity for women. In parallel, women in 20th-century media were put into stereotypical roles, embodying innocence, and submission to men (Santoniccolo et al., 2023). This stereotype is seen in popular 20th-century Disney princesses like *Snow White*, *Sleeping Beauty*, *Cinderella*, and more, where the premise of the movie relies on their naivety, innocence, and being saved by a prince. Additionally, the premise of a man transforming a girl into a “real lady” in society is seen in acclaimed films such as *Pretty Women* in 1990 starring Julia Roberts, and *My Fair Lady* in 1964 starring Audrey Hepburn. Women’s bodies were also subject to frequent sexual objectification which led to further gender discrimination and harassment (Santoniccolo et al., 2023). Because of this, most of the fictional women characters only existed to support the male lead characters and that overshadowed any exploration of their internal struggles (Santoniccolo et al., 2023). However, in the mid to late 20th century, an important shift in social and family dynamics occurred with the help of women’s movements advocating for equal rights (Rutherford & Alexandra, 2017). This led to an immense shift in the previously defined gender roles and expectations for women, which also began to be reflected in media.

Social Movements for Equality in Society and Media

The journey to gender equality was marked by waves of feminism that brought important issues and people to the spotlight. The first wave, occurring in the late 19th and early 20th centuries, focused on women's suffrage and legal rights which included the United States extending voting rights to women (Guy-Evans & Olivia, 2024). However, the movement focused on extending rights of white women in particular over minority women (Guy-Evans & Olivia, 2024). The second wave, emerging in the 1960s and 1970s, addressed gender inequalities in various aspects of life, including the workplace, reproductive rights, and cultural expectations (Guy-Evans & Olivia, 2024). This wave laid the foundation for legal reforms and increased awareness of gender discrimination in different facets of society. The third wave of feminism in the early 1990s focused on the individual self, sexual identity, and representation of diverse races in public spaces (Guy-Evans & Olivia, 2024). In the early 21st century, the women’s movement expanded upon social media usage and the #MeToo movement, which gained momentum in the 2010s as women spoke out about suffering sexual harassment and violence (Guy-Evans &

Olivia, 2024). Overall, the women's movement evolved throughout the century, focusing on different issues that affected gender inequality.

As feminist discourse gained momentum in the late 20th and early 21st century, there were greater calls for representation of women in media that went beyond stereotypes. The Bechdel-Wallace test was created in 1986 by Alison Bechdel as a test to assess the representation of women in media (Appel & Gnams, 2023). The test sets three criteria: the presence of at least two named women, who engage in conversation with each other about something other than a man (Appel & Gnams, 2023). This test helped to assess if media represented women as fully fleshed-out characters with apparent internal and external challenges (Appel & Gnams, 2023). In addition, changing roles for women in society helped decrease stereotypes in media such as "science" and "career" for men but "arts" and "family" for women (Kumar et al., 2022). These calls also coincided with a call for greater representation of mental health in the media to reduce stigma and raise awareness, especially for young women (Lind & Wickström et al., 2023). The representation of women in media was drastically transformed by the women's movement and initiatives like #MeToo.

Mental Health in Media

Mental health representations in media through the 20th century were subject to years of stereotyping which perpetuated stigma for viewers. Movies and media, especially in popular culture, tended to demonize people, men, and women, with mental health issues. Many villains in crime dramas attributed their violent or criminal actions to mental illness (Johnson, Malynnda, and Olson, 2021). Many media portrayals also showed mass shooters or terrorists as violent due to mental illnesses. This perpetuated the stigma that mental illness connects with demonstrations of violent acts (Johnson, Malynnda, and Olson, 2021). Media depictions of villains as 'mad' or 'crazy' caused people to fear and stigmatize those with mental illnesses (Johnson, Malynnda, and Olson, 2021). Despite these media representations, the U.S. Department of Health and Human Services found that only less than five percent of individuals with serious mental conditions or disorders committed violent acts (Johnson, Malynnda, and Olson, 2021). Furthermore, those with mental illness commit less than one percent of mass shootings (Johnson, Malynnda, and Olson, 2021). Most portrayals of mental health in the media have been one-dimensional and do not consider the various biological, chemical, genetic, and environmental factors that can lead an individual to develop mental health conditions. Due to this lack of nuance, media representations of mental health issues in the 20th century fell on degrading stereotypes which contributed to stigma in reality.

However, over the past decade, media portrayals of mental health have become increasingly more accurate (Johnson, Malynnda, and Olson, 2021). As fictional women characters in media have gained more depth and nuance, they have also contributed to greater mental health representation. This is because the stereotypical expectation of women being emotional often leads to media depictions of women being more open and vulnerable about certain mental health issues than men (Santoniccolo et al., 2023). Despite there being limited

research on media depictions of fictional women characters with mental illness before the #MeToo movement, the research on how mental illness was typically portrayed in media before the early 21st century when the #MeToo movement occurred, showed a disconnect with authentic representations of mental illness and women (Johnson, Malynnda, and Olson, 2021). However, nuanced representations of women with mental health conditions have grown and offered audiences a chance to empathize with authentic media representations (Johnson, Malynnda, and Olson, 2021).

Many mental health disorders disproportionately impact women at a greater scale than men. The lifetime risk for many mood and mental disorders is 1.5 times higher for women than men (Parker et al., 2010). This prevalence in gender discrepancy is seen throughout adulthood and varying ethnicities (Parker et al., 2010). This paper will analyze real-life incidences of prevalent mental health disorders that disproportionately impact women, such as depression, anxiety, and PTSD. The analysis will focus on the condition's specific impacts on women and also compare the analysis to popular media characters representing mental health conditions.

Depression in Women

Depression is a mood disorder that affects how a person feels or thinks daily. Approximately 12 million women in the United States suffer from clinical depression each year and it occurs most frequently in women aged 25 to 44 (MHA, 2014). Depressive symptoms include feelings of stress, loss of personality, apathy, changes in appetite, weight gain or loss, thoughts of death or suicide, and more ("Depression", NIMH, 2023). Women are particularly vulnerable to depression due to a myriad of biological, hormonal, and societal factors (Parker et al., 2010).

A variety of societal factors can contribute to depression in a woman. Since the late 20th century, there has been increased societal pressure for women to be successful at work, bear children, look out for family, contribute to society, and more (Parker et al., 2010). Due to these external stressors and limited resources for help, women are vulnerable to mental health conditions like depression. In addition, according to the 'sex role' hypothesis, girls are often brought up to be more passive and internalize frailty under feminine norms which can deteriorate their mental psyche (Parker et al., 2010). This can lead to a greater risk of mental conditions like depression as they reach adolescence (Parker et al., 2010). Further, the 'social factor' hypothesis states that women have been socialized to put all their efforts, self-esteem, and vulnerability into one basket, i.e. marriage or romantic relationships (Parker et al., 2010). This leaves women with few options to turn to in case of marital or relationship issues which can trap them in unhealthy circumstances. This increases their risk of vulnerability to mental health conditions. On the other hand, the 'social factor' hypothesis states that men have been socialized to have a greater investment in social, intimate, and work relationships which leaves them less vulnerable to depression. This is shown directly in the findings that married men have lower rates of depression than single divorced men while married women are more likely to have depression (Parker et al., 2010). Social stress factors contribute heavily to the prevalence of depression

among women.

There are a variety of biological factors that can cause depression in women. Hormonal changes at puberty, menstruation, pregnancy, and menopause can lead to greater neuroticism which includes brain activation response to negative stimuli such as social stress factors (Parker et al., 2010). This increases the risk of depressive conditions (Parker et al., 2010). A woman's vulnerability and susceptibility to depression can vary over her lifetime due to hormonal fluctuations. For example, cyclical steroid hormones, such as estrogen and progesterone, increase after puberty and decrease after menopause (Parker et al., 2010). The increase of estrogen and progesterone impacts several brain sites that are related to anxiety, which as a predisposition can lead to depressive states in a person (Parker et al., 2010). These hormone changes can cause increased stress response and vigilant behavior in women which can contribute to depression (Parker et al., 2010). In essence, as women grow older, they go through phases of puberty, menstruation, menopause, and more which can contribute to depression.

Lastly, pre-existing conditions like anxiety or health issues and genetics can also contribute to depression. Overall many external and internal factors can contribute to depression in a woman.

Cassie Howard and Depression

Euphoria is an American teen drama television series created by Sam Levinson and premiered in 2019. Cassie Howard is one of the lead characters in the HBO series "Euphoria," portrayed by Sydney Sweeney. Cassie Howard is introduced as a beautiful and vulnerable high school student. Cassie Howard's depiction in "Euphoria" offers a nuanced exploration of depression and mental health struggles that are seen in real-life experiences of young women. In the series, Cassie grapples with complex emotions caused by familial pressures, relationship pressures, and societal expectations which are common environmental stressors that can contribute to depression.

Cassie's journey in "Euphoria" has many parallels with real-world experiences of depression as social stress factors are known to heavily contribute to depression in young teenagers (Parker et al., 2010). Cassie's childhood was fraught with familial instability that came from her father's absence and struggles with addiction. Her father's abandonment leaves Cassie with a desire for replacement male validation which affects her decisions and relationships throughout the show. She seeks male validation and attention through romantic relationships which reflects the 'social factor' hypothesis. This states that women have been socialized to put all their efforts into one basket, specifically marriage or in the case of romantic relationships over work relationships, friendship, and family (Parker et al., 2010). This leads to greater vulnerability to depression when those specific relationships fall apart despite the time and investment put into them. These relationships exacerbate her existing insecurities and lead her to self-destructive behavior which further takes a toll on her mental health. In addition, her vulnerability and emotional frailty can be attributed to the 'sex role' hypothesis in which girls are brought up to internalize passive behavior which leads them to be at greater risk for mental health conditions

like depression (Parker et al., 2010). Due to the ‘sex role’ hypothesis and the way she is brought up, she struggles with self-image, familial and romantic relationships, and unhealthy coping mechanisms that reflect the reality of depression. This portrayal resonates with the understanding that depression can manifest differently in individuals, influenced by childhood and environmental factors (Parker et al., 2010).

Cassie Howard’s actions and symptoms are concurrent with the actual symptoms of depression. Throughout the show, she is shown feeling hopeless and stressed when her friendships, familial, and romantic relationships don’t work out. This causes her to lose self-esteem and look down on herself. In season 2, episode 2 “Out of Touch”, Cassie Howard portrays a loss of interest and pleasure in her normal activities and has difficulty taking care of herself, getting out of bed, and completing daily tasks (Sam Levinson, 2022). This is consistent with studies that show many gender differences in depression with women being more likely to experience low self-esteem, fatigue, and hypersomnia than men (“Depression”, NIMH, 2023). Also, as seen in season 2, episode 7 “The Theater and Its Double”, Cassie often seeks safety and respite by locking herself in a room and crying, trying to hide her pain from the world (Sam Levinson, 2022). This is concurrent with the findings that women are also more likely to exhibit signs of internalizing their depression, such as isolating themselves from social support, not talking, and crying profusely, while men are more likely to externally show anger and lash out (Parker et al., 2010). Her behaviors and actions as a young woman are accurate to the specific depressive symptoms.

Biological and hormonal causes contribute highly to depression in young teenage girls, especially during puberty and menstruation (Parker et al., 2010). However, these causes are not explicitly stated throughout most of the show. Most of the causes of her depression are attributed to her societal and relationship pressures disregarding genetics, biological, and hormones that lead to a great risk of depression. In addition, the series also takes creative liberties to emphasize the emotional intensity of her symptoms of depression like anxiety and mood swings. A scene in season 2, episode 6 “A Thousand Little Trees of Blood” shows Cassie Howard yelling in a violent fit and then sitting on the kitchen skin sobbing uncontrollably showcasing a dramatic moodswing (Sam Levinson, 2022). In contrast to real-world experiences, "Euphoria" occasionally amplifies or alters aspects of Cassie's depression for dramatic effect and leaves out important components of depression like the biological aspects.

Overall, the representation of depression through Cassie Howard's depiction in "Euphoria" does not acknowledge the hormonal, genetic, and biological factors that contribute to depression and emphasizes certain aspects of the show for artistic representation. Despite this, Cassie Howard offers a compelling portrayal that resonates with real-life experiences of young women navigating the intersections of mental health, relationships, and societal pressures.

Anxiety in Women

Anxiety disorders are common mental health conditions that are characterized by excessive worry, fear, and tension. Women are twice as likely as men to develop an anxiety

disorder in their lifetime due to a variety of vulnerability factors (Catuzzi, 2014). For generalized anxiety disorder (GAD) and panic disorder, two of the most common anxiety disorders, women make up 55 - 60% of people diagnosed (Catuzzi, 2014). There are a variety of ways anxiety can manifest in an individual and there are different factors that contribute to them.

Many anxiety disorders are characterized by varying symptoms. GAD involves persistent anxiety caused by stress factors that interfere with one's daily life ("Anxiety Disorders", NIMH, 2023). Symptoms include being irritable, exaggerated feelings of worry, fatigue, and more ("Anxiety Disorders", NIMH, 2023). Panic disorder is characterized by frequent panic attacks which are periods of intense fear and stress. The panic attacks result in physical symptoms like a racing heart, sweating, trembling, and more ("Anxiety Disorders", NIMH, 2023). Many phobia-related disorders are characterized by avoidance and intense fear of certain objects or situations ("Anxiety Disorders", NIMH, 2023). The phobias can exaggerate the perception of the actual danger of the object or situation. They may cause people to irrationally worry, run away, and feel unbearable anxiety ("Anxiety Disorders", NIMH, 2023). Environmental stressors like relationships, familial stresses, work stress, and more can contribute to women developing these anxiety disorders. Anxiety can manifest differently in an individual depending on the type of disorder.

Biological and hormonal changes are one of the most prominent causes of anxiety disorders in women. GAD and panic disorder are shown to increase more distinctly for women rather than men during early adolescence (Parker et al., 2010). Many studies have shown that this is a result of limbic system hyperactivation, a change in brain function that can occur post-puberty. The limbic system hyperactivation can lead to higher 'neuroticism,' or intense emotional and stress responsiveness. In turn, women are predisposed to experiencing a greater prevalence of anxiety and depression (Parker et al., 2010). Further organizational changes in the brain, such as the impact of cyclical steroid hormone changes during menstruation, and the successive loss of these steroid hormones during menopause, can cause changes in emotional and stress responsiveness (Parker et al., 2010). In addition, women tend to have lower levels of testosterone than men and lower testosterone has been linked to higher anxiety levels in many cases (Catuzzi, 2014). This can also help explain the biological and hormonal factors that can predispose women's vulnerability to anxiety disorders (Guarnotta & Byars, 2022). Overall risk factors for anxiety disorders in women include biological and hormonal changes during puberty, pregnancy, and menopause, as well as experiences of gender-based traumas. (Guarnotta & Byars, 2022).

In addition, women are more likely to develop an anxiety disorder if they have a second vulnerability factor like Behavioral Inhibition (BI) temperament. This is a temperamental trait that causes sensitivity to novelty and uncertainty in developing children (Pérez-Edgar et al., 2014). Women are thought to be more vigilant than men and have a harder time extinguishing fear responses which are symptoms of anxiety disorder (Catuzzi, 2014). It is speculated that this is due to protecting their babies and watching out for harmful entities that are physically stronger than them (Catuzzi, 2014). This is a unique vulnerability factor that can contribute to high rates

of anxiety in women.

Overall, many biological, hormonal, and environmental factors can contribute to various anxiety disorders in women.

Diane Nguyen and Anxiety

Bojack Horseman is an American adult animated comedy-drama TV show created by Raphael Bob-Waksberg. Diane Nguyen is a lead animated character in the show, voiced by Alison Brie. She is intelligent and deeply empathetic, allowing her to understand and relate to BoJack, the show's main character, in ways that few others can. Diane Nguyen's journey as an animated character in "Bojack Horseman" offers a complex exploration of anxiety and mental health struggles. As she struggles with her identity, career, marriage, and friendships, she experiences various symptoms of generalized anxiety disorder (GAD) and panic disorder that coincide with the real-world struggles of young women.

Throughout the show, Diane Nguyen is portrayed as having constant anxiety and exaggerated worry. This is due to various stress factors that keep her from having a healthy relationship with her husband and making a career as a writer. Initially, she appears as an idealistic and naive writer, determined to make a meaningful impact on the world through her writing. However, as she becomes more involved with the entertainment industry in Los Angeles, she faces numerous moral dilemmas and conflicts. Diane's growing frustration with her marriage and her career leads to various internal and external conflicts in the show. A scene in season 6, episode 10 "Good Damage" shows Diane having a panic attack after spiraling into intrusive thoughts while writing a novel (Raphael Bob-Waksberg, 2020). This panic attack causes her to sweat, tremble, and have a racing heart. This is parallel to the symptoms of panic disorder, a type of anxiety disorder ("Anxiety Disorders", NIMH, 2023). There are very good representations of her taking antidepressants to help her cope with her depression which also helps ease her anxiety to a certain extent (Parker et al., 2010). The depictions of her gaining weight due to the anti-depressants are also realistic. Overall, Diane Nguyen portrays accurate symptoms of GAD and panic disorder throughout the show.

As the series progresses, Diane experiences significant personal growth. She divorces Mr. Peanut Butter due to their fundamentally different worldviews. As she grapples with many mental health conditions like depression and anxiety due to her choice to initiate the divorce, she seeks therapy and medication to manage her mental health ("Anxiety Disorders", NIMH, 2023). Despite an accurate depiction of the symptoms of anxiety, the various biological and hormonal factors that contribute to anxiety are not very explicitly talked about (Guarnotta & Byars, 2022). Information about the predispositions that cause a woman's vulnerability to anxiety like lower testosterone levels or BI temperament is not depicted in the show (Guarnotta & Byars, 2022). The show mostly points to external factors causing her anxiety disorder despite biological and hormonal changes being one of the most prominent factors contributing to the disorder.

Overall, Diane Nguyen's depiction in Bojack Horseman is a dynamic and accurate portrayal of anxiety for many young women. It resonates with many symptoms and

environmental causes of anxiety that are unique to young women, despite there being scarce discussion around biological and hormonal aspects contributing to anxiety disorders.

PTSD in women

Post-traumatic stress disorder (PTSD) is a mental health condition that can be triggered in people after a traumatic event or situation. Women are twice as likely as men to develop PTSD and 1 in 10 women will develop PTSD in their lifetime (Verywell Health, 2024). Symptoms include flashbacks or distressing memories of a stress-inducing incident, avoidance of thoughts and objects related to the event, feelings of anxiety, apathy, and more (Verywell Health, 2024). Stress and fear that can occur in a person during a traumatic event may last long after and interfere with their daily life in the form of PTSD. Various external and biological factors can contribute to PTSD in an individual.

Women may be more susceptible to PTSD due to various psychosocial factors and biological differences. The hypothalamic-pituitary-adrenal axis (HPA-axis) is a crucial documented neuroendocrine response system that is important to stress-coping in the case of a traumatic external situation. This releases a major stress hormone called cortisol which is significant in acute stress response (Olf et al., 2007). Research has shown that interactions between personal factors like age, gender, genetics, and previous trauma can affect the HPA-axis response to adversity or traumatic stress (Olf et al., 2007). Differences between men's and women's HPA-axis response to traumatic stressors can be linked to gender differences in vulnerability (Olf et al., 2007). When the body is unable to fully recover to its baseline state from flight or flight response, it can lead to vulnerability to mental disorders like anxiety and PTSD (Olf et al., 2007). As a result, comorbidity of depression and anxiety with PTSD is of high prevalence in women (Verywell Health, 2024). This is a crucial biological factor that increases vulnerability to PTSD in a woman.

The intensity and prevalence of traumatic events in a woman's life can contribute to PTSD. Even though 60.7% of men and 51.2% of women have experienced one traumatic event in their life, women are at a 20.4% risk of developing PTSD while men are at 8.1% (Olf et al., 2007). Women have lower reported levels of exposure to physical trauma from war/combat than men. On the other hand, women have higher rates of exposure to serious sexual abuse and violence starting from a young age (Olf et al., 2007). Women are also found to have higher PTSD rates after childhood with a higher trauma severity than men (Olf et al., 2007). In addition to objective facts, subjective interpretation of significant traumatic events can also increase vulnerability to PTSD in some individuals (Olf et al., 2007). A perceived loss of control in certain events where others may be at fault or higher perceptions of threat are more prevalent in women. This suggests a gender-specific pattern of trauma perception which can increase vulnerability to PTSD in women (Olf et al., 2007). Many prevalent consequences of a stress-inducing or life-threatening event can contribute to a high risk of PTSD.

Various symptoms can manifest as a result of PTSD and as a coping mechanism. After traumatic events, women are more likely than men to report acute emotional responses after

intense fear and anxiety, panic, helplessness, psychological dissociation, and intrusive thoughts (Olf et al., 2007). In addition, coping mechanisms for PTSD include disengagement, social isolation, rumination, substance abuse, and more (Olf et al., 2007). Women's coping styles tend to lead toward apathy and avoidance behaviors (Olf et al., 2007). Many gender-oriented symptoms and coping mechanisms can arise as a result of PTSD.

Overall, many external and biological factors can contribute to intense PTSD symptoms and coping mechanisms.

Jessica Davis and PTSD

Jessica Davis is a central character in "13 Reasons Why", an American teen drama series based on the novel *Thirteen Reasons Why* by Jay Asher. The series begins with Jessica as a popular student at Liberty High School. Jessica Davis's depiction throughout the show offers a complex exploration of PTSD and mental health struggles that surface from sexual trauma which coincides with the real-life struggles of many young women. In season 2, episode 7 "The Third Polaroid", Jessica experiences a traumatic situation and grapples with complex PTSD symptoms that manifest and interfere with her daily life (Brian Yorkey, 2017).

Women experience PTSD at a high rate after traumatic events and their vulnerability to experiencing PTSD is further affected by age and genetics (Olf et al., 2007). Furthermore, women are more likely to experience PTSD as a result of sexual trauma or abuse while men are more likely to experience PTSD as a result of war or combat (Olf et al., 2007). Jessica Davis was a high schooler when she became a victim of sexual assault and that fits into the statistics of young women who are victims of sexual abuse being at high rates for suffering from PTSD. In addition, the victim's perception of the stress-inducing or life-threatening situation can influence their vulnerability to mental trauma and conditions like PTSD (Olf et al., 2007). Experiencing a loss of control due to the fault of another and Jessica's perception of the situation as such increases the risk for her to suffer from PTSD symptoms in her daily life (Olf et al., 2007).

Initially, Jessica struggles to accept and process what happened to her. She faces her trauma and assault with denial at first as an avoidance behavior. She also falls into substance abuse as a coping mechanism which is consistent in real-life experiences of women (Olf et al., 2007). She also goes through a multitude of symptoms such as intense fear and anxiety, helplessness, and intrusive thoughts which are intense emotional responses that many women go through after a traumatic event occurs (Olf et al., 2007). A scene in season 1, episode 7 "Tape 5, Side A" shows Jessica having a panic attack while changing in a dressing room and having distressing flashbacks that stem from her helplessness and loss of control as a sexual assault victim (Brian Yorkey, 2018). Jessica's journey of coming to terms with her trauma and coping with PTSD is a significant part of her evolution in the television series.

Overall, Jessica Davis's depiction in *13 Reasons Why* is a dynamic and accurate portrayal of PTSD for many young women. The portrayal resonates with the causes and symptoms of PTSD that are unique to young women. It also portrays the intensity and pain of PTSD that stems from assault accurately.

Conclusion

The representation of mental health and women has improved substantially with the new fictional women characters that are being portrayed in media concurrent with fourth-wave feminism and the #MeToo movement. Cassie Howard, a central character in the series “Euphoria,” offers an accurate portrayal of a young teen struggling with depression, depicting symptoms like hopelessness, low self-esteem, and loss of interest in activities (Parker et al., 2010). The portrayal also showcases coping behaviors such as the tendency to internalize emotions by isolating oneself and crying in a closed room (Parker et al., 2010). The show effectively highlights environmental factors such as societal pressures, along with familial and relationship stressors, that contribute to her depression (Parker et al., 2010). However, the depiction places less emphasis on the biological and hormonal changes in a teenage girl, even though they play a significant role in adolescent depression (Parker et al., 2010). This theme is concurrent with the characters Diange Nguyen, the lead animated character in “Bojack Horseman”, and Jessica Davis, the lead character in “13 Reasons Why”. For both characters, external factors like societal expectations and trauma that contribute to anxiety and PTSD are portrayed well. Still, the underlying genetic, biological, and hormonal changes that occur, especially for a young growing woman, are not explicitly stated or depicted.

The social movements that focused on improving women’s rights elucidated knowledge of primarily social factors that contribute to mental health concerns for women, which may be a reason those factors are being represented more than biological factors. However, the issue of not portraying the two sides, external and internal, of mental illness can be harmful to the public who may only look to external factors contributing to mental illness. Oftentimes, people who do not face immense external challenges in their lives can still face debilitating mental illness as a result of biological and hormonal factors. Without proper knowledge and representation of how biological factors contribute to mental health concerns, these struggles may be dismissed by people who perceive others as living a “perfect” or “glamorous” lifestyle.

This paper has advanced knowledge by exploring the flaws and strengths in recent media representations of mental health conditions in women. It has also given the background of how and why this representation is evolving as a result of social movements like #MeToo. However, there is limited research on media depictions of fictional women characters with mental illness before the #MeToo movement specifically, although research on how mental illness was typically portrayed in media before the early 21st century exists. Future research can expand on understanding the impact of the #MeToo movement by analyzing media representation before and after the movement. Also, future research can continue to advance knowledge through empirical work, such as the collection of data on the public's opinions and takeaways on specific mental health conditions as a result of media representation. This data can help connect how media depiction of mental illness and women can change the viewers' perceptions and why complete accuracy of representation is important in mainstream media.

Overall, my research and character analysis have found that representation of the physiology, causes, and symptoms of depression, anxiety, and PTSD, especially in women, is

evolving in a complex and nuanced direction. Some stereotypes and stigma for fictional women characters and mental illness do exist, but with the emergence of social media, the #MeToo movement, and new waves of feminism, the representation of women and mental health in media is going beyond stereotypes and showcasing accurate inner and external conflict. Further research can be conducted on media depictions of mental health conditions in women and how that is reflected by and works to change attitudes in society. Future media representation of mental illness, especially in women, can be fleshed out in a more complex and accurate portrayal that doesn't dramatize or glorify much past the accuracy of its depiction. With growing awareness and greater calls for accurate representation on-screen, the depictions on-screen should be improved so that women struggling with mental health conditions are being portrayed accurately and authentically.

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The Impact of PropTech on the Real Estate Industry By Brunella Delgado

Abstract

The increasing integration of technologies such as Artificial Intelligence (AI), Virtual Reality (VR), and Blockchain has significantly impacted the real estate market, collectively referred to as Property Technology (PropTech). This research addresses the growing importance of PropTech, particularly in the COVID-19 pandemic, by exploring the critical question: How will PropTech transform the real estate industry? Through an analysis of key studies, this research identifies both the positive and negative impacts of PropTech. The key positive impacts include increased transparency, efficiency, customer satisfaction, and employment opportunities, while the main negative impacts concern privacy issues, heightened competition, and the lack of regulatory frameworks. This study contributes to the existing body of literature by engaging robustly with current research and proposing new avenues for investigating the potential impacts of PropTech on the real estate industry.

Key Words PropTech, Real Estate, Artificial Intelligence (AI), Virtual Reality (VR), Blockchain

1. Introduction

The traditional nature of the real estate industry makes it an intriguing case study for examining the impact of technological advancements. While the sector's digitization has generally mirrored the broader adoption of technology across various industries, the COVID-19 pandemic presented unique challenges that necessitated innovative solutions. Unlike other sectors, where the transition to digital platforms was relatively straightforward, the real estate industry, which is inherently tied to physical spaces, faced significant hurdles in shifting to a predominantly digital environment. This urgency for adaptation spurred interest and innovation, leading to a rapid acceleration in the adoption of Property Technology, or "PropTech."

PropTech quickly became central to the operations of businesses within the real estate industry, driving the implementation of new ideas, attracting investment, and fast-tracking the adoption of technologies that might have otherwise been introduced more gradually.

This research seeks to answer several key questions: What technological tools were instrumental in helping the real estate industry navigate the challenges of the COVID-19 pandemic? How was PropTech utilized in the industry before the pandemic? And will this technological disruption ultimately have a positive or negative effect on the sector? The core objective of this study is to explore the impact of PropTech on the real estate industry.

To achieve this, a thorough literature review was conducted to identify the most widely recognized impacts of new technologies in the real estate sector. This research provides a comprehensive definition of PropTech, tracing its evolution and categorizing its various types. It also outlines the methodology used to analyze existing research articles to assess the impacts of PropTech. Finally, the study presents the findings on the positive and negative effects PropTech has had—and is likely to have—on the real estate industry. The ultimate goal is to stimulate

further research and innovation within the sector, enabling the industry to harness the benefits of technology while mitigating the potential harms that come with technological disruption.

2. Literature review

This section provides an overview of PropTech, including its definition, categories, and the specific technologies discussed in this research.

2.1 What is PropTech?

To understand the impact of PropTech on the real estate industry, it's essential to clarify what PropTech encompasses. Despite various definitions in academic literature, PropTech generally refers to the suite of digital tools used by real estate professionals throughout the property transaction cycle—from research and listing to buying and selling (National Association of Realtors). The objective of PropTech, like any technological advancement, is to optimize interactions between consumers and real estate professionals. Given the broad scope of PropTech, ranging from everyday tools like Google to advanced robotics, it has led to efforts to categorize these technologies more specifically. However, the broad definition often results in overlap with other technology categories. For instance, Financial Technology (Fintech), Construction Technology (Contech), Shared Economies (e.g., Airbnb or WeWork), and Smart Real Estate frequently intersect with PropTech. Andrew Baum (2017) considers these as sectors within PropTech, while others view them as separate but overlapping categories (Shaw). The evolving nature of PropTech complicates the categorization of different companies and technologies, making it challenging to establish a precise definition.

2.2 PropTech Categories

To further elucidate PropTech, this review examines the various categories that have emerged over time, culminating in the focus of this research. The initial phase, PropTech 1.0, began in 1980 with the advent of personal computers and database management systems. During this period, the real estate industry adopted tools like Excel to analyze and store data, significantly improving portfolio management (Casertano et al.). Even seemingly basic tools like Excel are considered part of PropTech, reflecting the term's broad application. PropTech 2.0, which started around 2008, represented a significant shift in the real estate market. This phase transitioned from "digitization," which involved creating digital copies of physical documents, to "digitalization," where information was converted into formats that allowed for greater automation and analysis (Casertano et al.; Baum, Saull, and Braesemann). This era introduced technologies such as cloud computing, mobile internet, and lean coding, which facilitated more efficient real estate operations. Currently, PropTech 3.0 is emerging, characterized by innovations such as Artificial Intelligence (AI), Virtual Reality (VR), and Blockchain. This research will focus on PropTech 3.0 and its impact on the real estate industry.

2.3 Technologies in the Third Wave of PropTech

In this section, we define and provide examples of the three main technologies within PropTech 3.0, which will be referenced throughout the research.

Among the top PropTech investments globally, Blockchain is based on distributed ledger technology, enabling data sharing, replication, and synchronization without a central administrator (Ullah and Al-Turjman). It functions as a decentralized database, facilitating private transactions and applications such as land registration, relational value calculations, and smart contracts (Baum, Saull, and Braesemann).

Though Virtual Reality (VR) was invented in the late 1960s, its role in PropTech has gained prominence in recent years (Sulaiman et al.). VR, augmented reality (AR), and mixed reality (MR) are categorized as "immersive" technologies. VR creates interactive virtual environments, while AR overlays virtual information onto the physical world (Azmi et al.). These technologies have enabled virtual property viewings, which became particularly valuable during the COVID-19 lockdown, boosting the use of tools like 360 photography and virtual tours (Sulaiman et al.).

Artificial Intelligence (AI), which simulates human intelligence, has gained traction due to its potential for efficiency, accuracy, and personalization. Research indicates that 77% of companies are either using or exploring AI, with 83% identifying it as a top business priority (National University). AI's ability to process large volumes of data rapidly enhances tasks such as property inspections and showings, though companies must carefully manage the data provided to AI systems to ensure reliability (Miljkovic, Shlyakhetko, and Fedushko). Understanding both the positive and negative impacts of PropTech is crucial for leveraging its benefits while addressing potential drawbacks. By doing so, the real estate industry can embrace innovation and improve its operations effectively.

3. Methodology

3.1 Search and Selection Process

Initially, keywords such as "Real Estate," "Artificial Intelligence," and "Virtual Reality" were used to search Google Scholar. During this process, the term "PropTech" emerged as a recurring theme. Further investigation into the definitions of PropTech and its relevance to the research topic led to more focused searches. However, accessing some of the articles proved challenging. Out of 22 research articles identified, 7 were not accessible, reducing the dataset to 15 articles.

When reviewing the list of articles, recurring themes across the literature were identified. Three of the articles were ultimately excluded from the final analysis because they were not sufficiently aligned with the predominant themes. This resulted in a final pool of 12 articles for detailed evaluation. The recurring topics were categorized into the positive and negative impacts of PropTech, guiding the development of the research question.

3.2 Analysis Process

Each research paper reviewed presents both benefits and drawbacks associated with AI, VR, and Blockchain technologies in the real estate industry. By comparing these perspectives, this research provides a comprehensive view of how these technological tools impact the sector. While some studies advocate for widespread investment in PropTech, they often overlook the financial constraints faced by companies that may wish to adopt these technologies but lack the resources. This analysis highlights fundamental challenges within the real estate industry that complicate the transition to PropTech. Therefore, while the literature may highlight certain recurrent themes as benefits, this research also critically examines its downsides to provide a well-rounded analysis of the impacts of PropTech on the real estate industry.

3.3 Study Limitations

Several limitations were encountered in this study. The most significant was the limited number of research articles specifically focused on PropTech, particularly PropTech 3.0. Additionally, there is a scarcity of recent articles on PropTech 3.0, with few addressing the significant market shifts that occurred during the COVID-19 pandemic—an important factor when analyzing technology-based markets like PropTech. Some articles did not have public access, also limiting the research pool.

3.4 Focus on PropTech 3.0

The decision to focus solely on the impacts of PropTech 3.0 was influenced by two key factors: the availability of information and the broad definition of PropTech. Given that PropTech encompasses a wide range of technologies, each with varying impacts, a comprehensive analysis would require a much broader scope. By narrowing the focus to PropTech 3.0, this research can provide a more in-depth and up-to-date analysis of its impacts on the real estate industry. Additionally, PropTech 3.0 represents the latest developments in the field, making it more relevant to current market conditions.

4. Results

4.1 Transparency

Transparency is a crucial factor in governmental efficiency, fair competition, and quality of life. It is particularly important in the real estate sector, where transparency helps in creating smoother, more efficient markets. A more transparent market also fosters trust among stakeholders, which is vital for the industry's growth and stability. Blockchain technology, which has been gaining traction in recent years, offers a powerful tool to enhance transparency within the real estate sector.

The impact of blockchain technology on transparency in real estate is well documented in the academic and professional literature. According to Siniak et al., recent technological advancements have made information more readily accessible, which in turn removes trade

barriers and fosters greater transparency. This is especially important in real estate, where the accuracy and availability of information can make or break transactions.

Casertano et al. argue that blockchain technology inherently promotes transparency due to the public nature of blockchain transactions. In the real estate industry, this technology allows for the integration of blockchain into smart contracts, which are often used to replace traditional, paper-based contracts. Smart contracts, powered by blockchain, offer a level of transparency that traditional contracts cannot match, as all parties involved have access to the same data in real time (Ullah and Al-Turjman).

Blockchain technology also ensures that crucial documents such as contracts are stored securely and are easily accessible to authorized parties. This reduces the risk of fraud and forgery, as each transaction is logged and cannot be altered without detection. As a result, blockchain technology provides a clear, auditable trail of data, which significantly enhances the transparency of real estate transactions (Casertano et al.).

4.2 Efficiency

For real estate companies, the primary objective of adopting digital technologies is to improve efficiency and decision-making. The KPMG Global PropTech Survey reveals that 65% of PropTech respondents are focused on improving efficiencies, 47% are concerned with reducing costs, and 44% aim to enhance decision-making processes. Technologies such as Virtual Reality (VR), Artificial Intelligence (AI), and Blockchain have proven to be particularly effective in achieving these goals.

Virtual Reality (VR) has emerged as a powerful tool in real estate marketing. It allows potential buyers to experience properties in a more immersive and interactive way. Azmi et al. note that the effectiveness of VR in marketing depends on the quality of the virtual environment and the satisfaction it provides to users during property viewings. VR technology can replicate the atmosphere of a property, creating positive emotions that can significantly influence buyers' decisions. Additionally, VR helps real estate agents save time and money by reducing the need for physical visits to properties and enabling virtual property staging (Miljkovic, Shlyakhetko, and Fedushko, 2023).

Artificial Intelligence (AI) plays a crucial role in enhancing efficiency by automating tasks such as property inspections, showings, and due diligence processes. AI algorithms can analyze vast datasets to predict market trends, assess property values, and identify investment opportunities, helping real estate professionals make informed decisions. Furthermore, AI can streamline the contract management process by summarizing and indexing legal documents, which is essential in a field that generates a large volume of paperwork (Miljkovic, Shlyakhetko, and Fedushko).

Blockchain technology also contributes to improving efficiency by reducing transaction times and simplifying the management of contracts. For instance, the transaction time on the Bitcoin blockchain is approximately 10 minutes, a speed that could be replicated in real estate transactions (Baum). Smart contracts, enabled by blockchain, allow for the digital signing of

agreements, which reduces the time and cost associated with traditional paper-based processes. Additionally, blockchain offers real-time authentication and control of contracts, eliminating the need for intermediaries and further streamlining transactions (Casertano et al.).

4.3 Customer satisfaction

Customer satisfaction is a key metric for success in the real estate industry. In today's digital age, 92% of home buyers begin their search online before contacting a real estate agent (Sulaiman et al., 2020). PropTech plays a significant role in enhancing customer satisfaction by offering high-quality Virtual Reality (VR) experiences and personalized Artificial Intelligence (AI)-driven services.

Virtual Reality (VR) technology significantly enhances property engagement and interest by providing immersive, realistic views of properties. For example, the Matterport VR platform allows users to explore properties in detail, offering accurate measurements and labels for every space. This level of detail gives customers a comprehensive understanding of the property, leading to higher levels of satisfaction (Sulaiman et al.). Additionally, VR enables buyers to take virtual tours of properties that are still under construction, helping them make informed decisions and increasing the likelihood of a sale (Miljkovic, Shlyakhetko, and Fedushko).

Moreover, VR increases accessibility for individuals with disabilities, the elderly, and those living in remote areas, who might otherwise have difficulty visiting properties in person. By providing these individuals with the ability to explore properties from the comfort of their homes, VR technology greatly enhances their overall experience and satisfaction (Miljkovic, Shlyakhetko, and Fedushko).

Artificial Intelligence (AI) also plays a crucial role in enhancing customer satisfaction by offering personalized services. AI algorithms can analyze client preferences and browsing behaviour to provide customized property recommendations and virtual tours. This level of personalization helps clients find properties that match their needs more quickly and accurately. AI-driven chatbots and virtual assistants further enhance the customer experience by offering instant responses to inquiries, assisting with property comparisons, and guiding clients through the decision-making process (Miljkovic, Shlyakhetko, and Fedushko).

4.4 Impact on Employment

The introduction of AI and other PropTech innovations in the real estate industry has led to the automation of various tasks, raising concerns about job displacement. A 2013 study by Oxford University predicted that 47% of U.S. employees were at high risk of losing their jobs to robotic automation by 2023 (Baum). In the real estate sector, Piazzolo and Dogan estimate that 36% of jobs have a high potential for automation, while 15% have a medium potential. However, the rise of PropTech also creates new job opportunities, particularly for professionals with expertise in these emerging technologies.

The impact of PropTech on employment is multifaceted. On one hand, automation displaces unskilled labour, reducing the need for human involvement in routine tasks. For

example, platforms like FinCase, which offer automatic real estate valuations, have diminished the demand for human valuers (Siniak et al.). On the other hand, the growing reliance on PropTech has led to increased demand for specialists in digital technologies, ensuring job security for those with advanced technological skills.

While the automation of tasks may lead to job losses in certain areas, it also presents an opportunity for the real estate industry to evolve and create new roles that require a different set of skills. As PropTech continues to develop, the industry is likely to see a shift in the types of jobs available, with a greater emphasis on digital literacy and technological expertise.

4.5 Privacy

As AI systems become more prevalent in the real estate industry, they collect and analyze vast amounts of data on buyers, sellers, and properties. While this data is crucial for making informed decisions, it also raises significant privacy concerns (Miljkovic, Shlyakhetko, and Fedushko). The rapid development of AI and other PropTech innovations has often outpaced the establishment of regulatory frameworks, leaving personal data vulnerable to exploitation by major technology providers (Shaw).

The potential misuse of private data in PropTech applications could lead to monopolization and exploitation, posing a threat to fundamental human rights such as privacy and freedom of expression. For example, if a small group of companies controls the majority of PropTech platforms, they could potentially manipulate data to serve their interests, undermining the integrity of the market (Baum, Saull, and Braesemann). Additionally, errors or biases in the data used to train AI systems can result in inaccurate property valuations and poor investment decisions, leading to financial losses for buyers and sellers.

Privacy concerns are further exacerbated by the lack of transparency in how data is collected, stored, and used by PropTech companies. As these technologies continue to evolve, regulators need to establish clear guidelines and standards to protect consumers' privacy and ensure that PropTech applications are used ethically and responsibly.

4.6 Competition

Implementing PropTech involves substantial costs, which can particularly hinder smaller companies in their adoption process (Casertano et al.). For instance, the quality of Virtual Reality (VR) visuals is often influenced by a company's budget; higher budgets typically allow for better-quality, more persuasive visuals. Consequently, larger companies with more significant financial resources gain a competitive marketing advantage through enhanced VR experiences, which smaller companies might struggle to match (Azmi et al.). Beyond initial acquisition, maintaining VR systems incurs ongoing costs, adding to the financial burden for companies (Miljkovic, Shlyakhetko, and Fedushko).

Larger companies are more likely to have a comprehensive digital strategy due to their higher budgets for investment. They also tend to have these strategies led by individuals with technological expertise—44% of large companies have technology experts in leading roles,

compared to 21% of companies with revenues between US\$1 billion and US\$5 billion, and only a quarter of those with less than US\$1 billion (KPMG Global PropTech Survey). This strategic advantage enables larger firms to integrate PropTech and digital solutions more seamlessly into their core IT systems. In contrast, a quarter of smaller companies lack a dedicated digital or technology innovation strategy, which also extends to their data strategies and cybersecurity measures (KPMG Global PropTech Survey).

The disparity in PropTech development between high- and low-income countries is stark. Developed countries average 6 to 9 PropTech companies per one million population while developing countries average only 0.2 to 1.1 per million (Braesemann and Baum). This gap highlights the uneven advancement of the PropTech sector globally.

Moreover, PropTech-related inequality extends beyond companies and employees to potential customers. AI technology in real estate could inadvertently perpetuate existing inequalities by using data in ways that disadvantage certain groups. This could lead to discriminatory practices, such as restricting access to properties or neighbourhoods for specific demographics. Thus, the socioeconomic disparities in real estate markets might not be eradicated but rather masked by new technologies (Shaw).

High-income countries, with their well-connected innovation ecosystems, tend to attract more venture capital and are better positioned to compete in the PropTech sector (Braesemann and Baum). Large digital disruptors like Airbnb, WeWork, and Amazon exemplify how major players can dominate their markets and outpace competitors. Their substantial budgets and increased visibility allow them to attract significant investment and potentially create monopolistic conditions in the real estate market. Investment data from CrunchBase shows at least \$11.5 billion invested in PropTech, underscoring both the intense competition and the emergence of conflicting platform sovereignties within the industry (Shaw).

4.7 Regulatory issues

The rapid evolution of technology, including PropTech, has outpaced the development of regulatory frameworks, leading to significant concerns about inadequate oversight. Specifically, blockchain technology, a cornerstone of many PropTech solutions, remains largely unregulated by governments, illustrating the broader issue of PropTech's regulatory gaps (Ullah and Al-Turjman).

Research by Casertano et al. and Baum, Saull, and Braesemann highlights that regulatory barriers represent a challenge for new technologies, which often navigate existing legislation without fully addressing it. There is a critical need for regulations that do not stifle innovation but rather ensure that technological solutions are transparent regarding their data sources and the rationale behind their outputs. Such regulations are essential to maintain privacy and credibility in the market and to safeguard against potential misuse or manipulation of PropTech (Casertano et al.).

5. Discussion

5.1 Transparency

PropTech significantly enhances transparency in the real estate market, a crucial factor for building trust and differentiating companies. Blockchain technology plays a pivotal role by enabling real estate companies to transparently manage data, privacy, and security, thereby increasing consumer trust (KPMG Global PropTech Survey). The importance of transparency is particularly evident in the "Big 8" markets (Brazil, China, India, Indonesia, Mexico, Russia, Thailand, and Turkey), which represent nearly 50% of the global population. These markets hold immense real estate potential, currently hampered by a lack of transparency (Siniak et al.). The integration of Blockchain in real estate is a testament to PropTech's impact on improving transparency globally.

5.2 Efficiency

PropTech also drives efficiency in the real estate industry. Virtual Reality (VR) enhances digital property showings, making them more persuasive and accurate, which in turn leads to higher sales. By reducing the need for in-person showings, VR saves time and costs associated with travel and parking, particularly in scenarios like the COVID-19 lockdown, where physical showings were restricted. Blockchain's role in smart contracts can eliminate intermediaries, reducing transaction costs and further boosting efficiency (Casertano et al.). Additionally, AI tools streamline operations by handling mundane tasks and analyzing vast data sets, providing valuable insights for both brokers and consumers. These technologies collectively contribute to significant efficiency gains in the real estate sector.

5.3 Customer Satisfaction

PropTech enhances customer satisfaction by improving the overall customer experience. VR, for instance, allows real estate businesses to reach previously untapped markets, offering more detailed property views and increasing accessibility for remote buyers. This expansion into new markets makes customers feel valued, thereby boosting satisfaction. AI contributes by personalizing the property search experience, making it less tedious and more aligned with individual preferences. These improvements not only persuade more customers but also reduce the inefficiencies of traditional property showings, saving time and money for all parties involved.

5.4 Impact on Employment

PropTech's impact on employment in the real estate industry is nuanced. While AI can automate and analyze data faster and more accurately than humans, it is less likely to replace the role of real estate agents in the sales process, where personal interaction remains critical. The fear of job losses due to AI's increasing capabilities is valid, particularly as tasks like property inspections and showings become automated (Miljkovic, Shlyakhetko, & Fedushko). However, even with 90% of home sales originating from online portals, consumers still prefer working with agents to minimize errors and avoid costly mistakes (Baum, Saull, & Braesemann).

PropTech is also creating new job opportunities in emerging fields. The growth of digital real estate marketing, for instance, is driving demand for specialists in VR and AR, remote sensing, and indoor mapping (Siniak et al.). This shift from traditional roles to technology-driven ones highlights the importance of higher education and technical skills in the evolving job market. However, this transition may exacerbate the rich-poor divide, as those with advanced skills are more likely to benefit from the new opportunities (Baum).

5.5 Privacy

The integration of AI in real estate offers significant benefits but also raises critical privacy concerns. To protect consumers, it is essential that AI systems are trained on accurate and unbiased data, and that these technologies are used ethically and responsibly (Miljkovic, Shlyakhetko, & Fedushko). Failure to do so not only risks violating consumer privacy but also undermines the effectiveness of the PropTech investments. Studies consistently emphasize the need for regulations to ensure data is handled appropriately, stored securely, and used only with consent (Baum, Saull, & Braesemann; Casertano et al.). Without such safeguards, real estate properties may lose value due to mismanagement of data and privacy concerns.

5.6 Competition

Virtual Reality (VR) is poised to revolutionize the consumer experience in real estate, making it essential for companies to stay updated with technological advancements. Investing in high-quality VR equipment and training is necessary to provide a seamless and user-friendly experience (Miljkovic, Shlyakhetko, & Fedushko). However, the high costs associated with PropTech adoption create a competitive disadvantage for smaller companies, which may struggle to keep up with larger, better-funded competitors. Although there is a growing investment in PropTech, it predominantly benefits larger companies, leaving smaller firms behind in the innovation race. The gap between developed and developing countries' advances in PropTech further highlights inequality in the industry. As technology becomes more accessible, competition for market share is expected to intensify (Braesemann & Baum).

5.7 Regulatory Issues

Effective regulation is critical to ensure that technologies like Blockchain and AI are used ethically and legally in the real estate industry. For example, smart contracts in real estate require all stakeholders to be informed about the contract's details, including payments and conditions (Ullah & Al-Turjman). Without proper regulation, the legal complexities of innovative programs could overshadow the benefits of PropTech. Braesemann and Baum argue that a deeper understanding of PropTech is necessary to refine legal and policy responses, preventing the market from becoming unregulated and potentially harmful.

6. Conclusion

The evolving landscape of modern PropTech illustrates that this sector is still in its developmental stages, with much work needed to ensure its broader adoption and effectiveness. This review has identified both the positive and negative impacts of PropTech, including transparency, efficiency, customer satisfaction, employment, privacy, competition, and regulatory challenges. However, the journey doesn't end with identification; the next step is to develop strategies to mitigate the negative effects of PropTech so that its benefits can be fully realized. PropTech holds significant potential to enhance the real estate market for both businesses and consumers. For instance, the use of Blockchain-powered smart contracts increases transparency by allowing stakeholders to easily keep records of all legal paperwork. AI's capacity to handle vast amounts of data enables personalized property recommendations, enhancing the consumer experience during online searches. Virtual Reality (VR) has revolutionized the quality and standard of online property visuals, reducing the need for in-person visits, and thereby saving time and costs associated with travel. These technological advancements also expand market accessibility, allowing people to access detailed property information remotely, thereby improving customer satisfaction.

Conversely, PropTech presents challenges related to privacy, regulation, and competition within the real estate industry. AI, for example, relies on vast data sources to function optimally. However, if AI utilizes data that is not publicly owned or is proprietary to another entity, privacy concerns can lead to legal complications, potentially damaging a company's reputation and affecting sales. Additionally, the high costs associated with implementing PropTech can widen the gap between large and small real estate firms. Smaller companies that cannot afford to adopt these technologies risk falling behind in industry innovation, and losing market share to larger competitors—particularly as higher-quality VR and other advanced technologies tend to come with higher price tags. The rapid pace of innovation in PropTech 3.0 and the scarcity of up-to-date research further complicate the regulatory landscape, as policy makers struggle to keep regulations up to date with the latest developments.

Employment within the real estate sector is another area where PropTech presents both opportunities and challenges. While increased automation through AI has led to job losses for less-skilled workers who previously performed repetitive tasks, PropTech has also created new opportunities for technology specialists within the industry. This shift underscores the growing importance of higher education and the need for workers to understand how to leverage innovative tools like AI and VR. The ability to adapt to these changes could determine whether an individual secures or loses their job.

Recognizing the significance of PropTech in the real estate industry is crucial for motivating the sector to embrace innovation, thereby increasing transparency, efficiency, and customer satisfaction. By balancing these positive impacts with an understanding of the potential negative consequences—such as the misuse of technology and the challenges of inadequate regulation—this research calls for a proactive approach to managing the effects of PropTech. There is a pressing need for more empirical and up-to-date research, especially on PropTech 3.0,

given its association with the most modern technologies and its parallels with how new technologies have transformed other sectors.

This study also highlights the importance of making these new technological tools more accessible to the broader market. Innovation is costly, and if the industry does not develop strategies to ensure that small businesses can also access PropTech, the gap between large and small firms will only widen over time. Issues like inequality between businesses and employees are not unique to real estate; however, given the sector's traditionally conservative stance on technological adoption, its impacts are particularly significant. The real estate industry can learn valuable lessons from the successes and failures of other sectors in adopting technological solutions, promoting the ethical and efficient use of PropTech 3.0.

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Social Media's Effect on Attention Span and Multitasking By Eunhae Hwang

Abstract

Integration of the internet into our everyday lives has had numerous effects on how we work, socialize, and even how we think. Recent neuroscience and psychology studies have examined how decentralized information on the internet and the multimedia on websites and applications are impacting human cognitive processes. The general consensus has been that heavy use of digital media, and especially media multitasking, is leading to shorter attention spans and lower rates of productivity. For the younger generation of digital natives whose brains are still developing, some believe that their shorter attention span and tendency to multitask will be a detriment to their education and future job prospects. While these concerns are understandable, the goal of this paper is to add nuance to the discussion. Is the rise in shallow attention, or breadth-based cognitive processes, a deficit in brain functionality? Or could it be another mode of information processing that has its own benefits in our increasingly online world? Drawing on real-life examples and the works of scholars such as Ophir and Lin, I raise several points to put research about digital media, attention, and multitasking into greater context.

Introduction

The rise of the internet has made digital media ubiquitous in all aspects of life. From education to travel, commerce, and entertainment, almost all individuals in developed countries rely on digital media for their livelihood. Over 30% of American adults confess that they're online constantly and that number rises with the younger generation, or digital natives, who have only experienced the world connected via the internet (Perrin and Atske). 95% of US teenagers use a smartphone and almost half of them are constantly online, compared to a quarter of adults (Anderson and Jiang). With this rapid change in our technological landscape, scholarship has rushed to examine how digital media is changing the way we think, feel, and live our lives in the internet-addicted society. For example, one study found that participants who played an online role-playing game for six weeks exhibited "significant reductions in grey matter within the orbitofrontal cortex" just like those with age-related dementia (Zhou et al.) Similar studies have indicated that digital media, especially media multitasking, will change human cognitive abilities forever, and for the worse. This paper seeks to add nuance to the debate—are the changes to our cognition, especially attention, always negative? The results have implications for changing habits and emerging needs of adolescents growing up in the digital age as well as future generations who will become increasingly dependent on digital media.

Digital Media and Attention Span

The general consensus among both scholars and the general public is that intense usage of digital media has a negative impact on cognitive abilities. One of the most prominent areas of study has been digital media's effect on our attention and attention span, specifically "how the

constant influx of online information...may encourage individuals to displace their concentration across multiple incoming media streams – and the consequences this may have for attentional-switching versus sustained-attention tasks” (Firth et al.) According to Dr. Gloria Mark, in 2004 the average attention span on screen was two and a half minutes; however, the average span on screen in 2012 was 75 seconds and in 2017 it was 45 seconds (Mills, 2023, 37:08). These changes mean that over the year the average time spent to maintain interest and concentration on a screen is decreasing. Simultaneously, shots in tv shows, films, and commercials are also getting shorter. The short attention spans are having a marked effect on the population, especially negatively impacting the “academic achievements, cognitive development, and mental health of students” (Oaten).

The shorter attention span is detrimental because the students' inability to focus for the long term makes it difficult for students to engage in depth with academic content. While listening to lectures, reading difficult textbooks, or solving hard problems, the “constant mental switching and fragmentation erodes their capacity” to focus in depth (Oaten). According to Marks’ study, the constant exposure of digital distraction could result in negative aspects in mental health such as anxiety and depression. Furthermore, smartphones and especially social media apps encourage users to constantly check their phones for new information, personal messages, or updates because of the notification system. Firth et al. writes that users are more likely to engage in checking behavior because of the rewards they receive upon engaging with the device; these perceived rewards “engage the cortico-striatal dopaminergic system due to their readily available nature,” which encourages future compulsive checking to chase the dopamine high (Firth et al.) For teens who have not yet had the chance to develop impulse control, it is easy to get accustomed to instant gratification such that they no longer learn to “tolerate boredom, delay gratification, and engage in depth” which are crucial skills for their cognitive development, education, and future employment (Oaten).

The Impact of Media Multitasking on Cognitive Processes

One of the main mechanisms by which digital media shortens the attention span is media multitasking. There are two types of media multitasking: using multiple media simultaneously and using media while engaging in a non-media activity. The first type of media multitasking involves the simultaneous use of different media, e.g. using a laptop for online shopping and watching videos on Youtube (van der Schuur et al.) It is possible to multitask on a single webpage as well. For example, on one facebook page, there are statuses, pictures, comments all on one screen and it is also possible for new windows to pop up if a user receives a message while performing other tasks on the site. Performing at least two of these activities at the same time constitutes the first type of media multitasking. The second type of media multitasking describes situations in which an individual performs an online and offline activity at the same time, such as engaging in face-to-face conversation while checking messages on Instagram. To examine how media multitasking affects attention, one famous study by Ophir and colleagues examined how heavy media multitaskers and low media multitaskers exercise cognitive control

on various tasks. The first was a test of filtering ability in which participants were asked to track the changes in one set of shapes while ignoring distractor shapes. The second was the Continuous Performance Task in which participants were asked to respond “yes” if they saw a certain pair of letters in random alphabetical sequences, and no if they did not. The third set of tasks were two and three-back tasks which monitored representations of letters in the participants’ working memory and how quickly they were changed or updated in the presence of distractions. The results indicated that heavy media multitaskers process information differently than those who media multitask less frequently. Heavy media multitaskers had a more difficult time filtering out distractions during the tasks and were less effective at “suppressing the activation of irrelevant task sets” (Ophir et al.) Thus, their focus in sustained attention tasks were poorer, it seems as if heavy media multitaskers brains are more easily distracted and also poor at task switching. Other studies substantiate these findings, showing that even fifteen minutes of digital media “reduces attentional scope for a sustained duration after coming offline,” whereas offline reading does not induce this effect (Firth et al.)

Advantages to Media Multitasking and Other Considerations

Do these results mean that generations are doomed to short attention spans and poor educational outcomes? While some seem to think so, I would like to argue that a shorter attention span and multitasking does not necessarily equal poorer quality of life or educational outcomes. For one, the way academics test attention and working memory does not always mirror real-life circumstances. For example, in Ophir’s study certain shapes were labeled as distractions or irrelevant, but in real life when a media multitasker comes across multiple streams of information, there may be multiple relevant pieces of information, so what constitutes a distraction is not as clear-cut as it is in controlled tasks. If a media multitasker is able to gather relevant information from all incoming sources, their ability to process multiple inputs, even shallowly, can be advantageous. Similarly, those who tune out “extraneous” inputs to focus on one piece of information may miss out on key information simultaneously present on screen (Lin). Depending on the task the individual needs to accomplish, the breadth-based cognitive control used by multitaskers may be just as helpful if not more advantageous than the linear depth-based control of light media multitaskers.

This possibility gains further traction when we consider the changing nature of education and employment. According to Indeed, there is an increasing demand for multitasking in today’s workplaces (“The Pros and Cons of Multitasking”). The integration of technology and digital media in the school systems of developed countries further puts pressure on students to both multitask and engage deeply with educational materials. In short, society may be evolving to favor multitasking over focusing on one task for a long time. Therefore, it is possible that the ability to gather and synthesize information across stimuli is becoming more valuable than ever before.

Additionally, if this is the way that society is evolving, it is possible that people will become better at media multitasking over time. Our brain structures could change to better

accommodate switching between tasks and gathering and synthesizing shallow information, or individuals can train the multitasking habit so that they suffer less from negative consequences. While it seems like a farfetched possibility, the structural changes in the brain have been observed before, such as when learning a new language. Therefore, it is not impossible for changes to happen when it comes to adjusting to new methods of processing information from decentralized sources.

Finally, studies have not yet investigated how different types of media multitasking affect cognitive processes. Just as the effects of social media on mental health vary according to individual factors, the social media platform, and whether the media is used actively or passively (Masciantonio et al.), it is also possible that digital media's impact on our cognitive processes are similarly varied. For example, it is possible that media multitasking on a single device has a different impact on the attention span than performing an online task and an offline task simultaneously. As Lin suggests, there is yet the possibility that how familiar an individual is with a task may also modulate impact on attention. If a person is already skilled in one task, such as knitting, and they engage in another task simultaneously, the cognitive load of multitasking will be lighter because knitting requires less attention. Because these factors have not been examined in laboratory settings, it is too early to make final conclusions, but it is evident that more research is required before labeling breadth-based cognitive control as a deficit rather than simply a different mode of processing.

Conclusion

In conclusion, reports on digital media's effect on human cognitive processes have been overwhelmingly negative because studies have found that heavy media use, especially media multitasking, can lead to shorter attention spans and poorer working memory. Media multitaskers are more likely to treat all information on a screen as equally important, and so they have trouble filtering out irrelevant information. This can be problematic because adolescents still need to learn focus and impulse-control, but the reliance on media by digital natives could prevent them from doing so. This could have negative implications for school performance and later, job performance. While concern for the younger generation is valid, this paper has argued that the change in human cognitive processes need to be examined in a larger context. Because the kinds of experiments are limited, they do not yet capture all the mental processes of media multitaskers; the experiments only indicate that multitaskers are not excellent at sustained-attention tasks. There may yet be more hidden strengths to this new mode of information processing. Moreover, if society is evolving to prefer multitasking, then the shift in information processing could be an advantage moving forward. Future studies that examine breadth-based cognitive processes in modern contexts will help shed some light on the severity of this shift in human behavior.

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Discrimination in Canadian Healthcare: Impacts on Indigenous Peoples and Efforts to Improve Health Outcomes By Eunseo Lim

Abstract

This journal review examines cases of differential and culturally insensitive care provided to indigenous patients in Canadian healthcare institutions and its impacts in creating disparities in health outcomes. It explores how unjust healthcare systems perpetuates prejudice and reflects a history of colonial thought and practice. It evaluates ICST (Indigenous Cultural Safety) programs, a key initiative dedicated to addressing these issues, by discussing the influence currently implemented ICSTs have and its possible developments. The condensation of both qualitative and quantitative information present is used to dissect cases and accurately articulate causes and effects of discriminative care, which is imperative for assessing the resolutions that create productive change. It follows the goals of reports such as the Truth and Reconciliation Commission Calls to Action to investigate the relevant needs for a more equitable and inclusive healthcare environment.

Introduction

An alarming number of reported instances of cultural insensitivity and mistreatment against Indigenous peoples within Canadian healthcare settings has raised concerns about the presence of systemic racism. Reported cases describe discriminatory behaviors of healthcare providers that cause inequitable healthcare for Indigenous individuals, where the differential quality and access to healthcare has often resulted in their health outcomes being poorer than non-indigenous peoples. This perpetuates disparities that reflect a long history between colonial policies and indigenous peoples in Canada. Thus, it is important to investigate and recognize the cases and bridge these gaps in the context of current Truth and Reconciliation efforts. Possible courses of action include training in cultural safety for healthcare professionals, and the development of policies that commit to bringing about systemic change on all levels of healthcare.

Racism drives discriminatory practices and results in differential access to goods, services, and opportunities for certain groups of people who are viewed as inferior and socially categorized based on their cultural background (McLane et al. 2). Racist beliefs of Indigenous people being weak and savage stems from the idea that they are racially inferior, which has enabled Canada in the past to enforce policies that segregated, assimilated, and governed the aspects of Indigenous peoples (“In Plain Sight”). Racist ideas have motivated colonial practices in Canada to justify social injustices such as expropriation of indigenous land (McLane et al. 2) and the forcible removal of indigenous children for state sponsored residential schools. These policies and laws that have been built have maintained violence on indigenous human rights, which suppressed their capacity to self-govern and ability to determine their own social and cultural way of life, thus not only disempowering the people, but restricting them to conform and depend on the colonial state (“In Plain Sight”).

Today, the power of Canada as a settler state is “still expressed...through the exercise of power to ‘let die’ by withholding life saving care and withholding resources” (McLane et al. 12). Indigenous people experience marginalization and impacts of stereotypes when they are withheld from or given deficient quality of public services, such as health care, that of which they have been historically forcibly made dependent on. As Indigenous land claims remain unsettled and challenged, colonialism persists in Canada as a reality today and is a social determinant of indigenous health. Systemic racism in healthcare against indigenous peoples results in failure for them to receive services or equitable opportunities in healthcare, or health outcomes the same as citizens who are not negatively profiled. Racial profiling describes when people are grouped based on their ethnicity, often leading to different and discriminatory treatment, or being assumed of engaging in certain activities without individual suspicions (“In Plain Sight”). Therefore, when unfair systems are present in public healthcare institutions and cause health inequalities, it promotes the race-based discriminatory thinking that has advanced colonialism and allowed oppressive efforts of detention, assimilation, and elimination of indigenous peoples.

In Canada’s public health sector, there have been actions and comments made by healthcare providers that suggest this kind of negative racial profiling in play, where providers exhibit perceptions that indigenous patients are less entitled to care. Qualitative data reveals that patients living in indigenous communities are often viewed as being problematic, as they are associated with certain criminal behavior or substance use. One emergency department (ED) healthcare provider stated that “...the idea of coming to the [emergency department] and [seein ‘Oh another Indigenous or First Nations patient with a ton of kids’ or ‘Oh, is [Children’s Services] involved?’ or um, you know..all of those sorts of things ...- they’re not as educated, they are squandering their money from the government” (McLane et al. 5). Another healthcare professional shared that “...if a patient is coming in...and the paramedics said, you know, ‘we’re bringing someone in and they’re intoxicated,’ quite often we’re going to say, ‘oh I wonder if they are, I wonder if they’re Indigenous?’ And I’m going to say...probably seventy percent of the time they are,” noting that among those that are presented for substance abuse issues, First Nations patients are disproportionately represented, which caused the provider to “...kind of think to [themselves], ‘oh too bad, I wish that they weren’t.’ Because it [reinforced] [their] thinking about that population” (McLane et al. 6). It is evident that when ED healthcare providers express their prejudice and apathy, the limitations it places on an indigenous individual from receiving the standard quality of healthcare perpetuates the kind of state-sponsored violence that originates from colonial thought (McLane et al. 12). Racial stereotypes affect First Nations in the ED in particular, as they are affected by practices of ‘categorizing and rationing’ (McLane et al. 3). This is described as when the actions of caregivers appear to reflect a judgment based on stereotypes of how deserving a patient is to receive care, as well as how “legitimate” their emergency situation may be, thus influencing the capacity of provided care. It can affect a number of things associated with quality healthcare, such as the length of time the patient waits for care, the allocated time that the healthcare provider spends with the patient, and whether and

what kind of care is provided to the patient (McLane et al. 3). Such dehumanizing stereotypes can quickly lead to inequitable experiences like abusive and neglectful services.

One of the most widespread assumptions about indigenous patients have centered on them of being substance abusers, with over a quarter of indigenous respondents to a study stating that they have been treated as if they were drunk or cross-examined about drug use when they sought out healthcare, in contrast to only about 5% of non-Indigenous respondents having been questioned like this (“In Plain Sight”). Indigenous patients who are assumed to be intoxicated often lead to their medical needs being overlooked or untreated, despite the patient denying such questions. For instance, an indigenous mother reported that when she dialed 9-1-1 upon her 11-year old having a seizure due to epilepsy, multiple nurses and doctors repeatedly asked the child if she had used alcohol or drugs, which the mother found inappropriate given her daughter’s young age and clear display of her medical condition. This case also showed signs of neglect, where the daughter was told to wait nearly five hours before a doctor got to examine her emergency (“In Plain Sight”). Another case reports the death of an indigenous woman named Joyce Echaquan and the treatment she received from medical staff up to her death. Echaquin recorded footage of her pleading for help from chest pains, to which nurses responded with remarks that indicate a lack of cultural sensitivity and awareness such as “stupid as hell,” and “you made some bad choices, my dear.” Quebec coroner Gehane Kamel found out that the nurses assumed the patient was experiencing withdrawal symptoms from opioid, where such assumption was incorrectly derived from a mixture of prejudice and neglect of the patient’s symptoms (Cecco, “Dead Because She”).

Not only do these cases of mistreatment lead to negative health outcomes of the affected patients, but cascades to further impact the opportunities for indigenous peoples to achieve equitable healthcare as it discourages them from seeking healthcare. Cases like Echaquan’s warns of a pattern of abuse that creates distrust between indigenous peoples and the healthcare system. Indigenous patients are likely to expect to be treated unequally due to the past discriminatory experiences they had with healthcare practitioners (Wylie et al. 40). One healthcare provider’s response to a interview supports this, as they note that once a lady in their emergency waiting room “said that her wait time was discriminatory because of her Aboriginal status,” to which the healthcare provider “...was able to explain to her about the triage system...and that the wait time was not related to that at all,” and “could perceive that that patient had a negative perspective of how things were going in the emergency department” (Wylie et al. 40). Due to this widely experienced and expectations of discrimination, indigenous peoples are thus more hesitant to seek care when they become ill (Shawanda). This avoidance then leads to a greater likelihood for indigenous people to have worse health outcomes or to die from conditions that could’ve been treatable or preventable if detected earlier.

The discriminatory experiences Indigenous peoples face in healthcare settings and the need for improvements to healthcare policies and practices has been identified in written reports such as the “Truth and Reconciliation Commission of Canada: Call to Actions.” One effort to

address systemic racism in healthcare that has been in development responds to Call to Action #24, which states:

“We call upon medical and nursing schools in Canada to require all students to take a course dealing with Aboriginal health issues, including the history and legacy of residential schools, the United Nations Declaration on the Rights of Indigenous Peoples, Treaties and Aboriginal rights, and Indigenous teachings and practices. This will require skills-based training in intercultural competency, conflict resolution, human rights, and anti-racism” (Truth and Reconciliation Commission).

The increasing recognition of the lack of equitable healthcare for indigenous communities in Canada came about through the discussions of the Truth and Reconciliation Commission. These discussions amongst the Canadian public have incited many groups and individuals to take an active role at addressing these challenges. The recommendations provided by the calls to actions, along with new mandates from Health Quality Ontario expects hospitals to implement equity measures, driving efforts to overcome the systemic barriers to healthcare access for indigenous peoples (Wylie et al. 30). The current efforts into the development and implementation of Indigenous cultural safety training (ICST) in Canadian healthcare institutions aims to eliminate racism from health policies and institutions. This pursuit of antiracism requires a commitment of people “to educate [themselves] and take action to create conditions of greater inclusion, equality and justice” by “understanding how the present exists upon colonial and racist foundations” (“In Plain Sight”). ICST programs train healthcare professionals by enhancing their understanding of indigenous peoples, their histories, and cultural safety. As healthcare professionals are likely to be the figure of authority in healthcare settings such as the ED, there is an imbalance of power between the medical practitioner and the patient, increasing the risks of unconscious prejudices manifesting into discriminatory behaviors (Webb et al. 1).

With ICST programs, health care providers are able to critically question their possible internal biases about indigenous peoples “embedded in their own understanding and practice, as well as the goals of the patient-provider relationship” (“In Plain Sight”). Currently, ICST programs have been identified across Ontario at organizations such as the “Native Canadian Center of Toronto...and the University of Toronto through the Indigenous Initiatives Office” (Webb et al. 3). Proper reflection should enhance cultural humility and tackle systemic racism at the hands of individual healthcare professionals, and work towards a sustainable anti-racist systemic change. The ability for healthcare providers to deliver respectful healthcare environments would develop, as “cultural humility allows for...patient/provider relationships based on respect, open and effective dialogue and mutual decision-making” (“In Plain Sight”). Indigenous people will then feel physically and socially safe in the environment free of challenges to their distinct culture or identity, ensuring better health outcomes and overall well being.

While the currently developed ICST serves as the foundational basis for systemic change, there are still many improvements and evaluations of the programs that need to be completed to ensure their efficacies. One concern about the ICST arises from the fact that there is a lack of implemented measures that hold trainees' accountability when they participate in the training. This concern particularly applies to "non-mandatory and/or 'self-paced' training (Webb et al. 5)" that operate with not much supervision or guidance that can check for ICST participants' true engagement. Out of the ICST programs offered, "only the Toronto Aboriginal Support Services Council and the Wabano Centre for Aboriginal Health in Ottawa, Ontario" (Webb et al. 5) has incorporated a kind of outline for health providers' participation and accountability. Additionally, there is still little known about the efficacy of cultural training programs. The methods to evaluate ICST have solely relied on surveys where participants give their feedback about their personal opinion on how much they have grown in their knowledge after training. For ICST to be further developed, future evaluations and research should aim to address these concerns (Webb et al. 5). ICST programs will only hold large significance in the support for indigenous cultural safety if evaluations confirm that ICST can facilitate a long-term process of self-critique and challenges to one's personal views, as that is how cultural humility evolves.

There are also concerns about the limitations of holding individual healthcare providers accountable as well; when trainees are tasked with determining the extent to which they address patient needs in situations, the still yet under-supervised nature of current ICST leaves much of how training skills should be applied to interpretation of the provider. This means that indigenous patients may end up once again facing differences and even arbitrariness in their healthcare. Therefore, instead of relying on efforts from what individuals make of ICST, systems in healthcare settings may need to undergo structural changes. A setting that is prone to discriminatory events, like the ED, for instance, could benefit from adopting a standardized set of protocols that apply to ED members collectively. This approach may allow more consistency in healthcare equity compared to having only the individual responsible for accountability, and thus transforming healthcare at all practitioner, organizational, and systemic levels. As outlined in Article 23 of the United Nations Declaration of the Rights of Indigenous Peoples, "[I]ndigenous peoples have the right to be actively involved in developing and determining health...programmes affecting them..." (*United Nations*), Indigenous input should also be included in frameworks that aim to improve indigenous health. An indigenous health regulator or another organizational mechanism could protect indigenous rights to self-determination (McLane et al. 15). Having Indigenous leadership in the process of developing new public health models will ensure that they have control over how federal health services are maintained and executed to address the social and economic concerns within their communities.

Conclusion

In Canada's healthcare systems, indigenous people are denied equitable access and quality to public healthcare and affected by the expression of a state's power when healthcare providers are allowed to racially categorize individuals and act upon their stereotypical thinking.

Racial profiling leads to differential healthcare for indigenous individuals, which most often leads to a greater likelihood of having poor, even lethal health outcomes. The distrust that is created between Indigenous people and health institutions further inhibits Indigenous access to equitable healthcare. As such discrimination in healthcare sustains the disparities rooted in colonialism, it is crucial to acknowledge these issues with ongoing Truth and Reconciliation efforts. Strategies such as ICST programs that foster healthcare professionals' cultural humility and the development of frameworks with indigenous partnership to mitigate racism at each level of healthcare allows for a step closer to a reality where equitable healthcare is culturally safe and free of discriminatory practices for all.

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Why Social Media Marketing Captivates Teens and Signals a Shift From the Traditional Marketing By Heeseo Rho

Abstract

For the past two decades, scholars and journalists have been discussing the death of traditional media as the public interest in print, radio, and television has steadily declined. It is now more common for people to get their news and entertainment from new (digital) media like websites, social media, and other internet-enabled platforms. This is especially true for teenagers who are growing up solely reliant on digital media. Because trends indicate that the prevalence of digital media will continue to grow, it is important to understand how companies can use this medium to communicate with their target audience. Thus, the purpose of this paper is to investigate why social media marketing is more appealing for teenagers, and why companies will find social media marketing more effective moving forward. Research methods include an analysis of existing literature about the rise of new media, social media advertising, and teenager's preferences about advertisements. The results show that social media marketing is particularly effective with teenagers because it is more personalized and accessible than traditional media. Additionally, social media advertising is highly dependent on building and maintaining good producer-consumer relationships in a way that traditional media was not. This research is important because it highlights how communication technology has shaped and will continue to shape spending habits.

Introduction

The last few decades have brought a shift in how humans interact with media. Ogidi and Utulu write, "While consumers may have spent 25 minutes reading the morning print newspaper, a form of traditional media, they may spend, on average, 90 seconds on a news website" (58). Not only are consumers shifting from print to screens, they are also spending less time on any platform than they were previously. This change from traditional media to new media means that consumers rely more on social media advertisements than traditional advertisements. Interestingly enough, this shift is not happening evenly; traditional forms of advertisements may still provide efficacy for brands targeting a more mature age group, but have been less effective in advertisements for teenagers.

This paper investigates why social media marketing is more appealing for teenagers, and why companies will find social media marketing more effective moving forward. For the purposes of this paper, traditional media refers to television commercials, radio commercials, and newspaper commercials. Social media advertising refers to commercials on social media as well as internet-enabled platforms such as Wikipedia, YouTube, Instagram, Twitter, Facebook, etc (Ogidi and Utulu). Marketing through social media is more effective because of the more personal relationship between consumers and producers, intermediaries such as influencers, accessibility, and cost-effectiveness. The following sections provide an in-depth discussion of each point respectively.

Personalization

For both companies and consumers, social media advertising can be more appealing than traditional advertising because of higher levels of personalization. 20 years ago, all teenagers watching the same local TV channel saw the same commercials; with social media advertising however, teenagers are likely to encounter advertisements for goods and events based on the algorithm for their personal account. The algorithm functions through clickstream data, and clickstream data works by monitoring the content the user has clicked, viewed, or even hovered over (Goldfarb). This data allows the algorithm to understand the user's interests and provide content that matches those interests. Similarly, retargeting also helps create a more personalized ad experience. Retargeting is when following one search, similar advertisements appear to the user (Wu). For example, if a user searches for a sofa on an online search engine, they are more likely to encounter advertisements related to sofas and other furniture. With these social media marketing tools, companies can target a demographic that would desire their product, and audiences can be exposed to advertisements for desired products while minimizing the number of irrelevant advertisements. Findings from researchers at the University of Jordan and Durham University show that young social media users find social media ads effective and personalized (Al Qudah, Dana A., et al.). Traditional advertisements, on the other hand, lack this level of personalization. Because of the broader target audience, it is hard for traditional media advertisements to fulfill the needs of the consumer or the company.

Influencers & Consumer Relationships

In addition to personalization, one great appeal of social media marketing for teenagers is the presence of digital celebrities. Digital celebrities have a large number of online followers who actively engage with their content; this is the core to the effectiveness of digital celebrities, better known as “influencers” (Şenyapar). Influencers are often considered an expert in a certain topic or niche, so users with the same interests will follow the influencer for authentic and reliable information (Şenyapar). Beauty influencers, for instance, are knowledgeable about the latest skincare products and makeup trends, so their fanbase would consist of makeup enthusiasts.

Compared to traditional media, where movie stars, athletes, and other celebrities would serve as a spokesperson, social media's use of influencers for marketing is more subtle, and users find influencers more realistic and relatable than superstars. This is because influencers often make content from their homes, incorporating aspects of their personality and everyday life into their content. In some cases, influencers first purchase products themselves and review them, so their followers also see the influencer as a customer, not a brand representative. This establishes their credibility, which is the main thing consumers look for before buying a product. Additionally, there's a two-way feedback process between influencers and their followers in which both parties can comment on each other's content or directly exchange messages, making influences seem more approachable than a corporation. Because of this “informal and transparent way of marketing,” influencers become a friendly and relatable face that can foster “positive

brand awareness and a good reputation for the brand” (Peng). Thus, companies and brands often collaborate with influencers to appeal to a larger audience in an authentic way that is not through their own company (Şenyapar). Through various opportunities to interact and analyze consumers through social media advertisement, it accomplishes something that traditional marketing cannot.

Accessibility

Another benefit of marketing via social media is accessibility for both companies and consumers. Companies can locate their target demographic worldwide rather than having to create only country-specific advertisements. Similarly, teenagers have a lot more access to products through their phones and social media compared to 30 years ago when traditional media was king. In countries where the appropriate technology is widely available, teenagers are less likely to watch TV or listen to radio than older generations, and more likely to rely on their cellphones for media. About 86.5% of teenagers in the U.S. were expected to use a cell phone in the year 2017. In contrast, the adult population was expected only to have about 74% phone usage (eMarketer). According to the Pew Research Center, 81% of online teens use social networking sites such as Facebook, while 67% of all online adults use these sites. When it specifically comes to using social media for finding goods or services, teenagers are also taking the lead. 85% of Gen Z users learn about new products through social media, and 62.8% of 14-17 year olds have purchased items through social media before (eMarketer). Social media users can access content such as microblogs, short-form videos, and live broadcasts, which may be unavailable on traditional media outlets, thus giving companies a variety of platforms or ways to showcase their product or service. These statistics suggest that it is more effective to use social media platforms when advertising to teenagers since the teenage population is heavily correlated with cellphone and social media usage.

Cost-Effectiveness

The final reason for the dominance of social media advertising is its cost-effectiveness. Compared to traditional marketing channels, it is often cheaper to advertise on social media platforms. For example, with the cost-per-click model, companies pay for how many clicks or likes an advertisement gets, and the rates range from \$0.38 to \$5.26 per click depending on the platform (Nutshell); there’s also the cost-per-mille (CPM) option, which charges companies for the number of people who see the ad on their social media feed. Thus, the costs are often dependent on the consumer’s level of engagement with the ad. This differs from traditional marketing methods where the fees are the same regardless of whether or not it garners engagement or leads to a sale.

The marketing campaigns on social media are easily changeable due to real-time feedback, easily adjustable parameters, and budget allocation (Evans). For example, with just a few clicks, companies can change their target audience. If an advertisement has a typo, a social media post can easily be edited. However, with traditional advertisements, if an advertisement has already been printed or is scheduled to air, it is extremely costly and time-consuming to

change if it is possible at all. With a smaller initial investment amount, it is easier for companies to adjust accordingly as they continue to advertise their product.

Lastly, it is much harder to measure results because the correlation between sales and media marketing is not clear. Although some customers may have bought the product after seeing the advertisement, others may have just bought the product because they needed it. There is no way for marketers to see how their audience reacts to their product. Because of how social media marketing is structured, companies can reduce the amount of resources devoted to creating content for aggregating and sorting potential buyers, while increasing the accuracy of the match between the buyer and seller (Evans).

Conclusion

In summary, social media marketing is more effective than traditional marketing methods for teenagers. Brands can use algorithms, retargeting, and influencers to create a personalized experience for their target audience. These methods thus far have been effective in gaining the attention, trust, and engagement of young consumers. However, this does not mean that social media marketing is without its drawbacks. First, with traditional advertising methods, advertisements are more equally dispersed, but with social media, consumers are constantly bombarded with advertisements no matter what they're doing online. Second, there are bots that are designed to comment on posts or post reviews. From the advertiser's perspective, this could be an effective tool to artificially boost numbers, but it lowers the credibility of reviews because they do not reflect real usage. Third, companies are prone to get negative feedback because the anonymity of online spaces can allow consumers to be more critical than usual and reviews are unfiltered. While these are legitimate concerns about social media marketing, they can be mitigated through lifestyle changes on the consumer's end or marketing strategies/technological changes on the company's end. Thus far, the issues do not outweigh the benefits to all stakeholders. So, companies who wish to focus more on the younger generation have a much better chance at success through social media marketing. This is significant because with the growth of teenage users and consumption of products, many brands strive to target teenagers. Despite some criticisms, the advantages of social media advertising in terms of personalization, engagement, and efficiency make it a superior choice for marketing in the modern age.

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AI-Powered Inclusion: Revolutionising Microfinance Accessibility in India

By Shlok Rawat

Keywords Microfinance, Artificial Intelligence, Financial Inclusion

Abstract

This paper seeks to evaluate whether AI-driven microfinancing systems have improved financial accessibility for underbanked populations in India. By conducting a comprehensive analysis of key metrics such as loan disbursement rates, loan approval rates, disbursement times, customer satisfaction, reach and penetration, and loan default rates before and after AI integration, the study provides a quantitative assessment of AI's impact on the microfinance sector. Key findings indicate that AI integration has led to significant improvements, including a 25.5% average annual growth in sector expansion, a 41.63% average annual reduction in loan disbursement times, a 19.7% average annual reduction in loan default rates, and a 5.73% average annual increase in customer satisfaction rates. These results suggest that AI-driven microfinancing systems have not only enhanced the efficiency and effectiveness of financial services but have also played a crucial role in expanding financial inclusion for underserved communities. However, the study also acknowledges potential challenges associated with AI adoption, such as data privacy concerns and the need for technological infrastructure, which must be addressed to ensure the sustainable development of AI in microfinance.

Introduction

Microfinance has long been recognized as a powerful tool for fostering financial inclusion, particularly in developing countries like India, where a significant portion of the population remains outside the formal banking sector. Traditionally, microfinance institutions (MFIs) have served as vital intermediaries, providing small loans to individuals and small businesses who lack access to conventional banking services. However, the efficiency and reach of these institutions have often been limited by manual processes, high operational costs, and challenges in assessing the creditworthiness of borrowers with little to no financial history.

In recent years, the integration of Artificial Intelligence (AI) into financial services has promised to revolutionise the microfinance sector by addressing these limitations. AI technologies, such as machine learning algorithms, natural language processing, and predictive analytics, offer the potential to enhance the speed, accuracy, and scalability of microfinance operations. By automating loan disbursement processes, improving risk assessment, and personalising customer interactions, AI has the potential to make microfinance more accessible and effective for underbanked populations.

This paper seeks to evaluate whether AI-driven microfinancing systems have indeed fulfilled this potential in the context of India. By analysing key metrics such as loan disbursement rates, loan approval rates, disbursement times, customer satisfaction, reach and penetration, and loan default rates before and after the integration of AI, this study provides a

comprehensive assessment of AI's impact on the microfinance sector. Through this analysis, the paper aims to determine the extent to which AI has improved financial accessibility for underbanked and often overlooked populations in India, and to explore the broader implications of these findings for financial inclusion and sectoral growth.

Background

Micro Financing in India

Microfinance has been a cornerstone of financial inclusion in India, providing much needed capital for the populus who have been ignored by the formal banking sector. The microfinance sector originally gained popularity in 1998¹, emerging as a response to the limitations of traditional banking, which often excluded low-income individuals due to lack of collateral and formal financial histories. Key players in the Indian microfinancing industry include primarily Non-Banking Financial Companies (NBFCs), who have furthered the accessibility of loans and credit to the underbanked communities in India, helping improve financial inclusion.

Introduction of AI in Financial Services

Artificial Intelligence (AI) has quickly penetrated the world of finance, automating mundane tasks and accelerating the pace of complex actions, improving the customer experience while enhancing the systems of financial companies. AI technologies such as Natural Language Processing (NLP), Machine Learning (ML), and predictive analytics are being adopted into the Indian financial system, streamlining operations of numerous companies and drastically improving financial instruments. In the context of microfinance, AI can help drastically speed up loan disbursement times by quickly and efficiently analysing creditworthiness using non-traditional data sources, improving the efficiency of microfinance and thus theoretically improving financial accessibility to the underbanked.

Literature Review

The body of research on the integration of AI in financial services, particularly within the context of microfinance, talks about the significant role that AI technologies play in enhancing financial inclusion for underbanked populations. For instance, Kandpal's study on AI and Self-Help Groups (SHGs) in India illustrates how AI can enhance financial accessibility by employing psychometric evaluations to predict loan repayment behaviours, which is critical for extending credit to individuals with limited financial histories. This idea is further supported by Mondol's research, which emphasises how AI-powered tools are revolutionising microfinance in developing countries, notably in Bangladesh, by improving cost efficiency, risk management, and fraud detection, thereby enabling broader financial inclusion.

¹ Vandana Sethi, "Evolution of Microfinance in India," SRCC, accessed July 29, 2024, <https://www.srcc.edu/system/files/Pg%20169-184%20Vandna%20Sethi%20%3B%20Evolution%20of%20Microfinance%20in>

Expanding on these ideas, Kaur's research provides a framework for integrating AI with financial literacy to create a sustainable financial ecosystem. Her work emphasises how AI can optimise financial decision-making processes, particularly for underrepresented groups, by making financial services more accessible and personalised. This theme of enhancing accessibility through AI is also echoed in Bhawnra's study on AI for financial inclusion in India, where AI is shown to lower costs and break down geographical barriers in the banking sector, significantly increasing access to financial services.

The integration of AI into financial systems is also discussed in the work by Rawat, who explores how intelligent digital financial inclusion systems can reduce the digital divide, particularly in the context of Industry 5.0. Her research highlights the potential for AI and other emerging technologies to scale financial services to underserved populations, thereby promoting financial literacy and inclusion. Similarly, Yanting's conceptual framework focuses on the dual benefits and challenges of AI in financial services, particularly the improvement of credit scoring and customer verification systems, while also addressing concerns such as the digital divide and privacy issues.

Furthermore, the research by Ochuba and McKenzie Skene examines the role of AI in enhancing efficiency and accessibility within financial markets, particularly in emerging economies. Their work underscores the transformative potential of AI in democratising financial services and enhancing financial market development. This theme is also present in Singla's study on microfinance in India, which discusses how AI and microfinance together can stimulate economic growth by making financial services more accessible to disadvantaged and low-income groups.

Additionally, the literature also addresses the regulatory challenges associated with AI integration in financial services. Lee's paper on the regulation of AI in financial markets highlights the need for a legal framework that balances innovation with consumer protection and market integrity, ensuring that AI-driven financial inclusion efforts do not lead to systemic risks or privacy concerns.

Finally, studies by Kshetri and Dwivedi discuss the broader implications of AI in promoting financial inclusion globally and in India, respectively. Their research emphasises the role of AI in extending financial services to unbanked populations by overcoming traditional barriers, such as lack of access to physical banking infrastructure and limited financial literacy. These studies collectively contribute to a growing body of evidence that AI has the potential to significantly enhance financial inclusion, particularly in developing economies like India, by improving the accessibility, efficiency, and personalization of financial services.

Research Question and Objectives

The primary research question addressed in this paper is: "Do AI-driven microfinancing systems improve financial accessibility for underbanked populations in India?" The objectives of the study are as follows:

1. Assess the impact of AI on loan disbursement rates.

2. Analyse the effect of AI on microfinance sector growth rates.
3. Evaluate changes in loan approval rates due to AI integration.
4. Measure the reduction in loan disbursement times post-AI integration.
5. Examine the impact of AI on loan default rates.
6. Assess consumer satisfaction rates pre- and post-AI integration.
7. Provide qualitative insights from document analysis, and customer satisfaction surveys to contextualise the quantitative data.

Conceptual Framework

To evaluate the impact AI has on the microfinance sector of India in a holistic manner, the paper utilises three important concepts which relate to the integration and utilisation of AI in microfinance.

1. Financial Intermediation Theory²
 - a. Definition of Theory: Financial Intermediation Theory explains how financial intermediaries, such as banks and microfinance institutions, facilitate the allocation of resources by channelling funds from savers to borrowers, reducing transaction costs, providing liquidity, and managing risks.
 - b. Application to this Paper: AI enhances the role of financial intermediaries in microfinance by improving risk assessment, reducing operational costs, and providing personalised financial services. This results in more efficient resource allocation, increased loan disbursement rates, and better financial inclusion for underserved populations.
2. Technology Acceptance Model (TAM)³
 - a. Definition of Theory: The Technology Acceptance Model (TAM) posits that the acceptance and use of new technology are determined by perceived ease of use (the degree to which a person believes that using a system would be free from effort) and perceived usefulness (the degree to which a person believes that using a system would enhance their job performance).
 - b. Application to this Paper: In the context of AI-driven microfinance, TAM helps to understand how the perceived ease of use and usefulness of AI technologies influence their adoption by microfinance institutions and clients. This includes faster loan approvals, improved customer service, and enhanced operational efficiency, leading to higher acceptance and satisfaction rates.

² Bert Scholtens and Dick V. Wensveen, "THE THEORY OF FINANCIAL INTERMEDIATION," SUERF - The European Money and Finance Forum, last modified January 2003, https://www.suerf.org/wp-content/uploads/2024/01/s_903ce9225fca3e988c2af215d4e544d3_143_suerf.

³ Davit Marikyan and Savvas Papagiannidis, "Technology Acceptance Model," TheoryHub - Academic Theories Reviews for Research and T&L, last modified September 23, 2023, <https://open.ncl.ac.uk/theories/1/technology-acceptance-model/>.

3. Diffusion of Innovations Theory⁴

- a. Definition of Theory: Diffusion of Innovations Theory explains how, why, and at what rate new ideas and technologies spread through cultures. It highlights the roles of early adopters and the characteristics of innovations that facilitate their diffusion, such as relative advantage, compatibility, complexity, trialability, and observability.
- b. Application to this Paper: This theory helps to analyse the adoption rates of AI technologies in the microfinance sector. Early adopters of AI in microfinance demonstrate its benefits, such as increased efficiency and better risk management, influencing broader adoption. Understanding these dynamics helps explain the rapid spread and integration of AI in the sector, leading to significant improvements in loan disbursement and approval rates.

Methodology

Research design

This paper incorporates quantitative data analysis to comprehensively evaluate whether AI-based microfinance systems improve credit accessibility for the underbanked in India. The quantitative data was collected from a combination of industry reports, financial statements, and surveys, specifically focusing on metrics such as loan disbursement rates, approval rates, disbursement times, default rates, and customer satisfaction. These data points were drawn from reliable sources, including regulatory documents, microfinance institution reports, and previous academic studies. The analysis of this data involved descriptive statistics intended to identify trends and measure the impact of AI integration over time.

The research is further guided by theoretical frameworks such as Financial Intermediation Theory, the Technology Acceptance Model (TAM), and Diffusion of Innovations Theory, which inform both the data collection strategy and the analytical approach. These theories help in framing the analysis, ensuring that the data collected is not only relevant but also interpreted within a robust theoretical context, allowing for more nuanced conclusions about the role of AI in enhancing financial inclusion.

Data collection methods

1. Loan disbursement rates:
 - a. Pre AI-Integration: Compile data on the total amount of microfinance loans disbursed before AI integration over a particular timespan(one fiscal year). This will indicate the size of the microfinance sector in India before the widespread adoption of AI. This is informed by Financial Intermediation Theory, which emphasises the role of financial intermediaries in efficiently allocating resources.

⁴ Clay Halton, "Diffusion of Innovations Theory: Definition and Examples," Investopedia, last modified January 17, 2011, <https://www.investopedia.com/terms/d/diffusion-of-innovations-theory.asp>.

By examining pre-AI loan disbursement rates, we assess the baseline efficiency of microfinance institutions in channelling funds from savers to borrowers.

- b. Post AI-Integration: Compile data on the total amount of microfinance loans disbursed after AI integration over the same timespan as taken above. This will indicate how much the microfinance sector has grown post AI integration, demonstrating how AI improves the efficiency of resource allocation by enabling faster and more accurate loan disbursements, reflecting enhanced financial intermediation.
2. Microfinance sector growth rates:
 - a. Pre AI-Integration: Compile data on the average growth of the microfinance sector in India, taking two years before the integration of AI. This will provide a clear idea on the typical growth rate of the microfinance sector before the integration of AI. This data establishes a baseline for analysing the diffusion of AI technologies and their impact on sector growth, informed by Diffusion of Innovations Theory. Understanding the growth rate before AI adoption helps to contextualise the sector's baseline growth without technological interventions.
 - b. Post AI-Integration: Compile data on the average growth of the microfinance sector in India, taking two years after the integration of AI. This will help conclude whether AI has helped accelerate or decelerate the growth rate of the microfinance sector in India. By comparing growth rates, we can assess how the adoption of AI technologies has influenced the expansion and performance of the microfinance sector, as explained by Diffusion of Innovations Theory.
 3. Loan approval rates:
 - a. Pre AI-Integration: Compile data on loan approval rates prior to the implementation of AI. This includes approval rates segmented by borrower categories, to gauge the disparity between the banked and unbanked prior to the implementation of AI. This analysis is informed by the Technology Acceptance Model (TAM) to understand how traditional approval processes functioned before the introduction of AI and to identify areas where perceived usefulness and ease of use of AI could improve approval rates.
 - b. Post AI-Integration: Compile data on loan approval rates post AI implementation, along with approval rates segmented by borrower categories. This will verify whether AI has bridged the disparity between loan approval rates of income groups, or made it greater. TAM helps us to understand how the perceived ease of use and usefulness of AI technologies have influenced the acceptance and effectiveness of AI in improving loan approval rates. By analysing post-AI approval rates, we can evaluate how these factors have changed with the introduction of AI-driven systems.
 4. Loan disbursement times:

- a. Pre AI-Integration: Compile data on the average time taken to disburse microfinance loans before the integration of AI. This baseline data will reflect the efficiency of traditional systems without AI enhancements. This data helps to establish the baseline efficiency of microfinance institutions in processing loans, informed by Financial Intermediation Theory. Understanding the pre-AI disbursement times allows us to measure the initial efficiency levels of microfinance institutions.
 - b. Post AI-Integration: Compile data on the average time taken to disburse microfinance loans after the integration of AI. This helps gauge how AI has helped improve efficiency of microfinance loan disbursements. AI's role in reducing disbursement times showcases its effectiveness in enhancing the operational efficiency of financial intermediaries, aligning with Financial Intermediation Theory. TAM assesses how the ease of use of AI technologies has contributed to these improvements. By comparing pre- and post-AI disbursement times, we can demonstrate the impact of AI on operational efficiency.
5. Loan default rates:
- a. Pre AI-Integration: Compile data on the loan default rate before the integration of AI. This data will provide insight into the risk management capabilities of microfinance institutions before AI adoption. This analysis is informed by Financial Intermediation Theory, which emphasises the importance of effective risk management. By examining pre-AI default rates, we can understand the baseline risk levels and the effectiveness of traditional risk assessment methods.
 - b. Post AI-Integration: Compile data on the loan default rate post AI-integration to determine whether AI has made the microfinance loan system more efficient for firms. AI's ability to enhance risk assessment and management should reflect in lower default rates, demonstrating improved financial intermediation efficiency as described by Financial Intermediation Theory. By comparing pre- and post-AI default rates, we can evaluate the impact of AI on risk management and loan performance.
6. Customer satisfaction rates:
- a. Pre AI- Integration: Compile data on the customer satisfaction ratings pre AI-Integration. This data will be in the form of percentages taken from various surveys. This will help gauge the overall sector's performance in terms of consumer ratings, and will give a baseline to indicate the sentiment related to the microfinance industry in India.
 - b. Post AI- Integration: Compile data on the consumer satisfaction ratings post AI-Integration. This will help gauge whether AI has helped improve customer satisfaction and bettered the borrowing experience. Customer satisfaction data will reveal how the perceived ease of use and usefulness of AI-driven services

have impacted borrower experiences and satisfaction levels, as described by the Technology Acceptance Model (TAM).

Data

Quantitative Data^{5 6 7}

Metric	Pre AI - Integration	Post AI - Integration
Loan Disbursement Rates	FY 2017-18: INR 1.89 lakh crore	FY 2020-21: INR 2.70 lakh crore
	FY 2018-19: INR 2.10 lakh crore	FY 2021-22: INR 2.95 lakh crore
	FY 2019-20: INR 2.31 lakh crore	FY 2022-23: INR 3.19 lakh crore
Microfinance Sector Growth	FY 2017-18: 9.8%	FY 2020-21: 17.5%
	FY 2018-19: 10.9%	FY 2021-22: 20%
	FY 2019-20: 11.5%	FY 2022-23: 22%
Loan Approval Rates	FY 2017-18: 60%	FY 2021-22: 72%
	FY 2018-19: 62%	FY 2022-23: 75%
	FY 2019-20: 65%	FY 2023: 78%
Loan Disbursement Times	FY 2017-18: 24 days	FY 2020-21: 14 days
	FY 2018-19: 21 days	FY 2021-22: 10 days
	FY 2019-20: 19 days	FY 2022-23: 3 days
Loan Default Rates	FY 2017-18: 4.9%	FY 2020-21: 3.8%
	FY 2018-19: 4.5%	FY 2021-22: 3.3%
	FY 2019-20: 4.2%	FY 2022-23: 2.1%
Customer Satisfaction Rates	FY 2017-18: 68%	FY 2020-21: 76%
	FY 2018-19: 70%	FY 2021-22: 80%
	FY 2019-20: 72%	FY 2022-23: 85%

⁵ Kiran Samudrala et al., "Microfinance India Report 2023," Equifax, accessed August 9, 2024, <https://assets.equifax.com/marketing/india/assets/mfi-india-report-2023.pdf>.

⁶ "Microfinance Pulse," Small Industries Development Bank of India, accessed August 9, 2024, <https://www.sidbi.in/en/microfinance-pulse>.

⁷ "MFINDIA ANNUAL REPORTS," MFINDIA, accessed August 9, 2024, <https://mfindia.org/Resources/annualreport>.

Quantitative Data Analysis and Results

To begin the data analysis, we first explore the descriptive statistics of the key metrics, both before and after AI integration. This approach helps to provide a foundational understanding of the changes in these metrics over time.

Loan Disbursement Rates

Pre AI-Integration:

- FY 2017-18: INR 1.89 lakh crore
- FY 2018-19: INR 2.10 lakh crore (11.1% increase from the previous year)
- FY 2019-20: INR 2.31 lakh crore (10% increase from the previous year)

Post AI-Integration:

- FY 2020-21: INR 2.70 lakh crore (16.9% increase from the previous year)
- FY 2021-22: INR 2.95 lakh crore (9.3% increase from the previous year)
- FY 2022-23: INR 3.19 lakh crore (8.1% increase from the previous year)

The average annual growth in loan disbursement rates was around 10.6% before AI integration. Post AI integration, this growth accelerated to an average of 11.4% per year. This suggests that AI integration has positively influenced the growth in loan disbursement rates, with a notable jump in the first year of AI implementation.

Theoretical explanation:

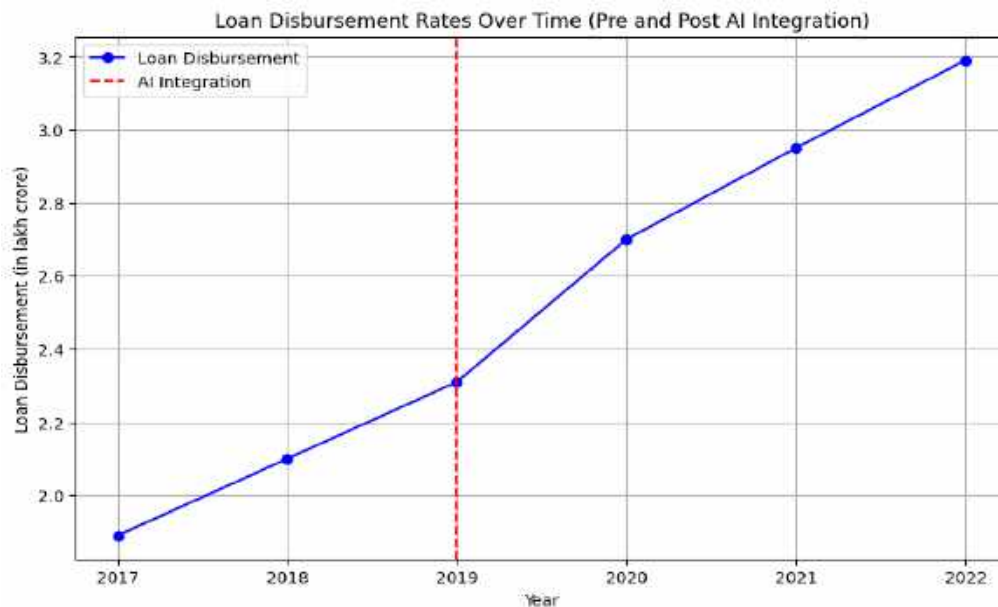
The observed increase in loan disbursement rates post-AI integration can be effectively explained through the lens of Financial Intermediation Theory. This theory posits that financial intermediaries, such as microfinance institutions, play a critical role in channelling funds from savers to borrowers, thereby facilitating economic activity and growth. AI technologies have enhanced the efficiency of these intermediaries by improving their ability to assess creditworthiness, manage risks, and process loans more rapidly. This leads to a more effective allocation of resources, which is reflected in the accelerated loan disbursement rates observed post-AI integration.

Additionally, the Technology Acceptance Model (TAM) helps to understand the rapid adoption of AI by these institutions. The significant increase in loan disbursement rates suggests that microfinance institutions perceived AI as both useful and easy to integrate into their existing processes. The perceived usefulness of AI, in particular, likely stemmed from its ability to streamline loan processing and improve the accuracy of credit assessments, thereby leading to higher loan disbursement rates.

Moreover, the Diffusion of Innovations Theory provides insight into how AI technologies spread through the microfinance sector. The sharp increase in loan disbursement following AI integration indicates that early adopters of AI demonstrated its relative advantage—such as faster processing times and improved risk assessment—which encouraged broader adoption across the

sector. As more institutions recognized these benefits, AI's adoption became more widespread, contributing to the overall growth in loan disbursement rates.

Figure 1: Time Series Plot for loan disbursement rates



This time series plot illustrates the trend in loan disbursement rates from FY 2017-18 to FY 2022-23, highlighting the impact of AI integration in FY 2019-20. The graph shows a noticeable increase in loan disbursement rates following the adoption of AI, suggesting that AI may have contributed to more efficient and accelerated loan processing in the microfinance sector.

Microfinance Sector Growth Rates

Pre AI-Integration:

- FY 2017-18: 9.8%
- FY 2018-19: 10.9% (11.2% increase from the previous year)
- FY 2019-20: 11.5% (5.5% increase from the previous year)

Post AI-Integration:

- FY 2020-21: 17.5% (52.2% increase from the previous year)
- FY 2021-22: 20% (14.3% increase from the previous year)
- FY 2022-23: 22% (10% increase from the previous year)

The sector's growth rate was modest before AI integration, with an average annual increase of 8.35%. Post AI integration, the growth rate saw a significant jump, particularly in the first year with a 52.2% increase, averaging 25.5% annually. This sharp increase suggests that AI may have contributed significantly to the sector's expansion.

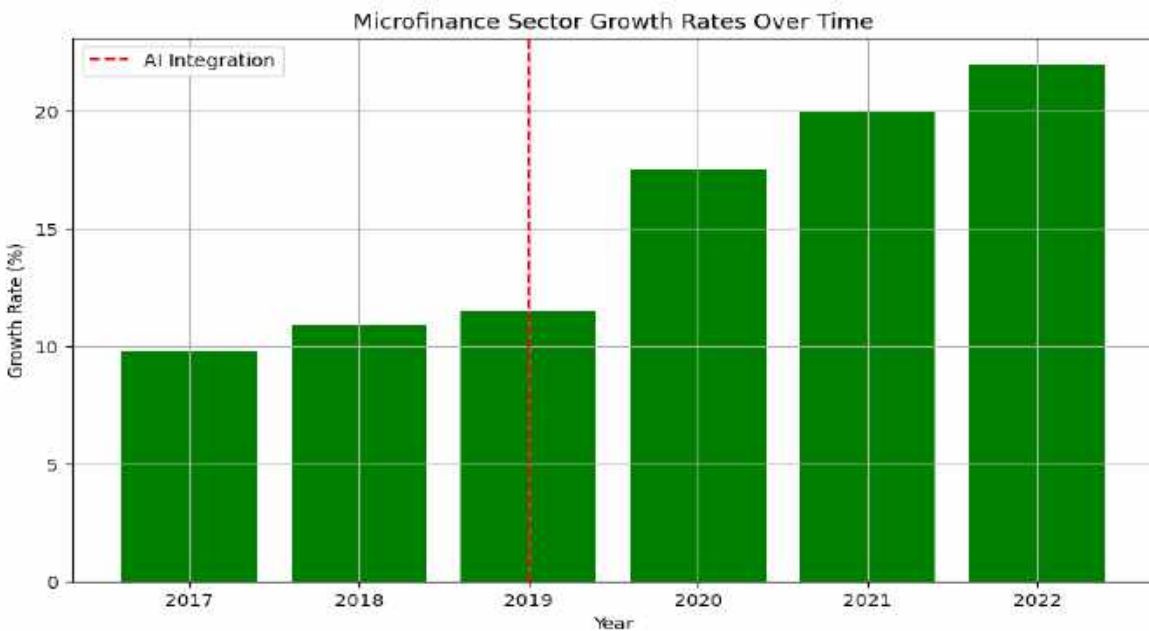
Theoretical explanation:

The sharp increase in the microfinance sector's growth rate post-AI integration can be understood through the lens of Financial Intermediation Theory. This theory emphasises the role of financial intermediaries, such as microfinance institutions, in efficiently allocating resources by reducing transaction costs and managing risks. The adoption of AI technologies has significantly enhanced these intermediaries' capabilities, leading to improved efficiency in processing and disbursing loans. As a result, the sector has experienced accelerated growth, particularly in the first year post-AI integration, where the growth rate jumped by 52.2%. This suggests that AI has facilitated better financial intermediation, contributing to the sector's expansion.

Additionally, the Technology Acceptance Model (TAM) provides insight into the rapid adoption of AI technologies within the sector. The substantial growth in the sector's performance post-AI indicates that these technologies were perceived as highly beneficial by microfinance institutions. The ease of use and the clear operational advantages provided by AI, such as faster processing times and more accurate risk assessments, likely drove the widespread acceptance and integration of AI tools, leading to the observed growth.

The Diffusion of Innovations Theory further explains the widespread adoption of AI technologies that has contributed to this growth. Early adopters of AI likely demonstrated its substantial advantages in improving operational efficiency and expanding market reach. As these benefits became evident, other institutions quickly followed, leading to a broader diffusion of AI across the sector. This widespread adoption has been a key factor in driving the sector's accelerated growth rates in the years following AI integration

Figure 2: Bar Graph for microfinance sector growth rates



This bar graph presents the annual growth rates of the microfinance sector from FY 2017-18 to FY 2022-23. The significant increase in growth rates post-AI integration, particularly in FY 2020-21, indicates that AI has likely played a crucial role in accelerating the expansion and performance of the microfinance sector.

Loan Approval Rates

Pre AI-Integration:

- FY 2017-18: 60%
- FY 2018-19: 62% (3.3% increase from the previous year)
- FY 2019-20: 65% (4.8% increase from the previous year)

Post AI-Integration:

- FY 2021-22: 72% (10.8% increase from the previous year)
- FY 2022-23: 75% (4.2% increase from the previous year)
- FY 2023: 78% (4% increase from the previous year)

Before AI integration, the average increase in loan approval rates was around 4.05% annually. After AI integration, the average increase accelerated to 6.33% annually. This suggests that AI has played a role in improving the efficiency and accuracy of loan approval processes.

Theoretical explanation:

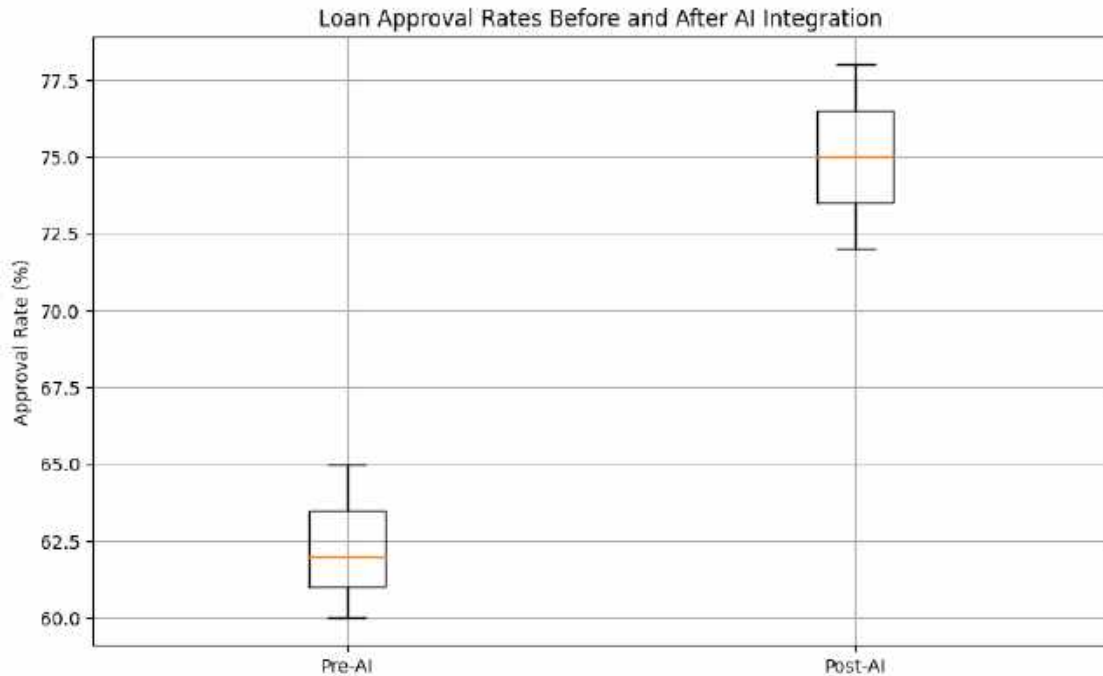
The observed improvement in loan approval rates post-AI integration can be effectively explained through Financial Intermediation Theory. This theory highlights the role of financial intermediaries in efficiently channelling funds between savers and borrowers, with a particular emphasis on risk assessment and transaction costs. AI technologies have enhanced the capacity of microfinance institutions to assess borrower creditworthiness more accurately and efficiently, reducing the risk of defaults and increasing the likelihood of loan approvals. This aligns with the observed increase in loan approval rates and suggests that AI has strengthened the financial intermediation process, making it more effective in allocating resources.

The Technology Acceptance Model (TAM) also plays a critical role in understanding these changes. The accelerated increase in loan approval rates post-AI integration indicates that microfinance institutions found AI technologies both useful and easy to adopt. The perceived usefulness likely stems from AI's ability to streamline the loan approval process, improving both the speed and accuracy of credit assessments. The reduced variability in loan approval rates post-AI, as indicated by the box plot, further suggests that AI has introduced a level of consistency and reliability in the approval process that was not present before its integration.

Additionally, the Diffusion of Innovations Theory explains the broader adoption of AI technologies that has led to these improvements. The early adopters of AI in the microfinance sector likely demonstrated its effectiveness in increasing loan approval rates, thereby influencing other institutions to follow suit. As AI's relative advantage in improving loan processing became

evident, it spread more widely across the sector, leading to the overall enhancement in loan approval rates observed post-AI integration.

Figure 3: Box and Whiskers plot for loan approval rates



This box plot compares the distribution of loan approval rates before and after AI integration. The graph shows an increase in the median approval rates and reduced variability post-AI integration, suggesting that AI has improved the consistency and accuracy of loan approvals.

Loan Disbursement Times

Pre AI-Integration:

- FY 2017-18: 24 days
- FY 2018-19: 21 days (12.5% reduction)
- FY 2019-20: 19 days (9.5% reduction)

Post AI-Integration:

- FY 2020-21: 14 days (26.3% reduction)
- FY 2021-22: 10 days (28.6% reduction)
- FY 2022-23: 3 days (70% reduction)

The average reduction in loan disbursement times before AI integration was 11%. After AI integration, the reduction rate increased dramatically, averaging 41.63% annually, with the most significant decrease in FY 2022-23. This indicates that AI has substantially improved the speed of loan processing.

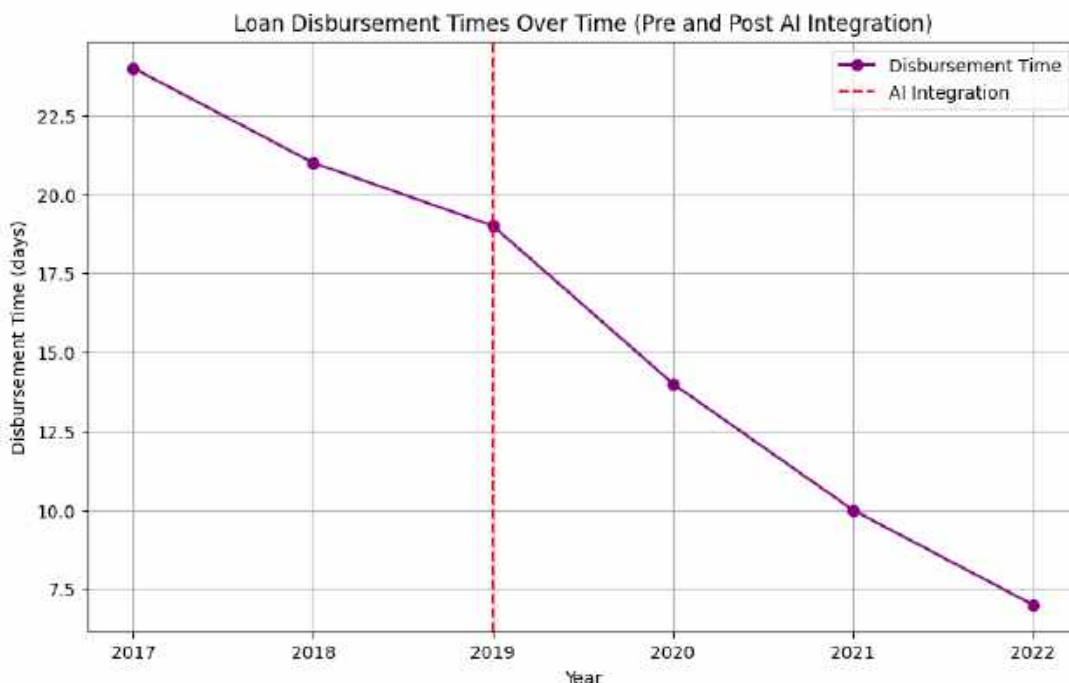
Theoretical explanation:

The significant reduction in loan disbursement times post-AI integration can be understood through the framework of Financial Intermediation Theory. This theory emphasises the role of financial intermediaries, such as microfinance institutions, in reducing transaction costs and enhancing the efficiency of financial services. The introduction of AI has greatly accelerated the loan processing capabilities of these institutions by automating and optimising various aspects of the approval and disbursement process. This reduction in disbursement times reflects the enhanced operational efficiency provided by AI, enabling financial intermediaries to deliver services more quickly and effectively to their clients.

The observed improvements also align with the Technology Acceptance Model (TAM). The dramatic decrease in disbursement times post-AI integration suggests that microfinance institutions perceived AI technologies as both highly useful and easy to implement. The significant gains in processing speed would have made AI an attractive tool for these institutions, leading to its widespread adoption. The TAM framework helps explain why these institutions were quick to integrate AI into their operations, as the benefits of faster loan processing were both clear and substantial.

Finally, the Diffusion of Innovations Theory provides insight into how AI technologies were adopted across the sector. The sharp decline in disbursement times indicates that early adopters of AI demonstrated its effectiveness in streamlining loan processing, encouraging broader adoption within the industry. As AI's advantages in reducing loan disbursement times became evident, its use spread rapidly among microfinance institutions, leading to the consistent and significant reductions in processing times observed in the years following AI integration.

Figure 4: Time Series Plot for loan disbursement times



This time series plot displays the reduction in loan disbursement times from FY 2017-18 to FY 2022-23. The sharp decline in disbursement times post-AI integration highlights the efficiency gains brought by AI, leading to faster loan processing and reduced wait times for borrowers.

Loan Default Rates

Pre AI-Integration:

- FY 2017-18: 4.9%
- FY 2018-19: 4.5% (8.2% reduction)
- FY 2019-20: 4.2% (6.7% reduction)

Post AI-Integration:

- FY 2020-21: 3.8% (9.5% reduction)
- FY 2021-22: 3.3% (13.2% reduction)
- FY 2022-23: 2.1% (36.4% reduction)

Before AI integration, the average reduction in loan default rates was 7.45%. After AI integration, the average annual reduction increased to 19.7%, with a significant decrease in FY 2022-23. This suggests that AI's enhanced risk assessment capabilities may have led to more effective loan screening and management.

Theoretical explanation:

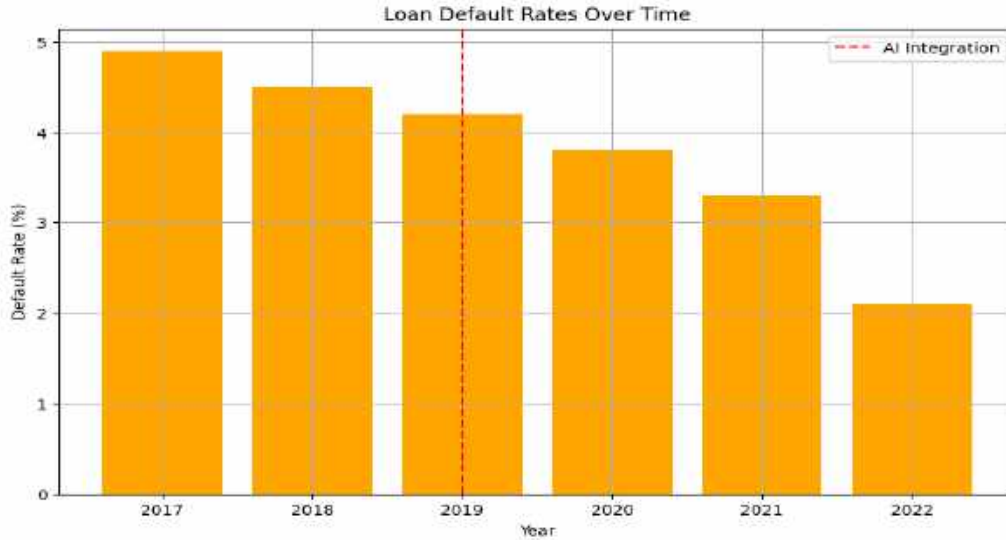
The marked reduction in loan default rates post-AI integration can be effectively explained through Financial Intermediation Theory, which emphasises the importance of efficient risk management in the role of financial intermediaries. AI technologies have significantly enhanced the ability of microfinance institutions to assess and manage credit risk. By utilising advanced algorithms to analyse vast amounts of data, AI can more accurately predict borrower behaviour and identify potential defaults before they occur. This improved risk assessment capability has likely contributed to the sharper decline in default rates observed after AI integration, particularly the dramatic 36.4% reduction in FY 2022-23.

The Technology Acceptance Model (TAM) further explains the adoption of AI technologies that led to these improvements. The substantial benefits in risk assessment and reduction in default rates suggest that microfinance institutions perceive AI as both useful and effective in enhancing their loan screening processes. The ease of integrating AI into existing systems likely facilitated its rapid adoption, enabling institutions to significantly improve their risk management practices and reduce loan defaults.

Moreover, the Diffusion of Innovations Theory provides insight into how these AI technologies spread across the microfinance sector. The consistent reduction in default rates post-AI integration indicates that early adopters of AI demonstrated its clear advantages in mitigating risk and reducing defaults, encouraging broader adoption across the sector. As these

innovations diffused, more institutions were able to leverage AI to enhance their risk management practices, contributing to the overall decline in default rates.

Figure 5: Bar Graph of loan default rates



This bar graph illustrates the trend in loan default rates from FY 2017-18 to FY 2022-23. The significant decrease in default rates post-AI integration suggests that AI has enhanced risk assessment capabilities, leading to better loan screening and management practices that reduce the likelihood of defaults.

Customer Satisfaction Rates

Pre AI-Integration:

- FY 2017-18: 68%
- FY 2018-19: 70% (2.9% increase)
- FY 2019-20: 72% (2.9% increase)

Post AI-Integration:

- FY 2020-21: 76% (5.6% increase)
- FY 2021-22: 80% (5.3% increase)
- FY 2022-23: 85% (6.3% increase)

Customer satisfaction rates increased by an average of 2.9% annually before AI integration. Post AI integration, the rate of increase almost doubled to an average of 5.73% annually. This indicates that AI-driven improvements in customer service, such as faster loan processing and personalised services, have significantly enhanced customer satisfaction.

Theoretical explanation:

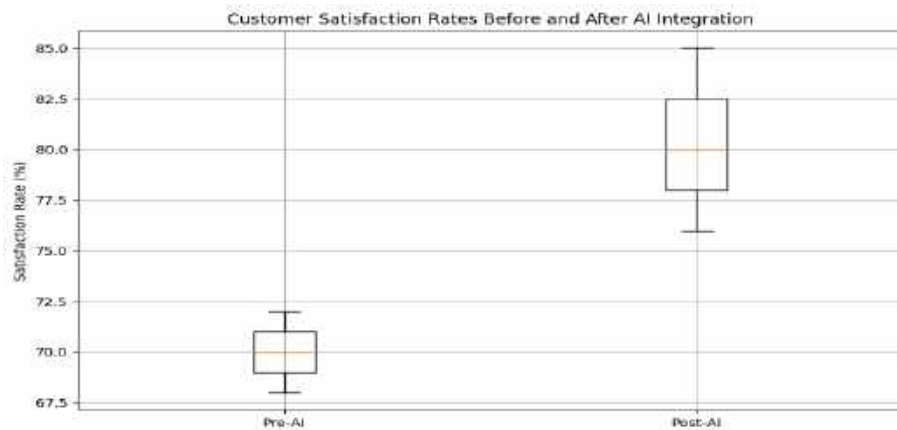
The observed increase in customer satisfaction rates post-AI integration can be attributed to several factors, explained through the Technology Acceptance Model (TAM) and Financial

Intermediation Theory. TAM posits that the perceived usefulness and ease of use of a technology significantly influence its adoption. In the context of microfinance, AI technologies have likely been perceived as highly beneficial in improving service delivery, leading to faster loan processing times, more accurate risk assessments, and personalized financial products. These improvements align with the observed increase in customer satisfaction rates, as AI's ability to streamline processes and offer tailored services likely enhanced the overall customer experience.

Financial Intermediation Theory further explains the role of AI in improving customer satisfaction by enhancing the efficiency and effectiveness of financial service delivery. By reducing transaction times and improving the accuracy of financial services, AI has helped microfinance institutions better meet the needs of their clients. This enhanced service delivery has likely contributed to the significant increase in customer satisfaction post-AI integration, as borrowers experience more reliable and responsive services.

Additionally, the Diffusion of Innovations Theory provides insight into the broader adoption of AI technologies that have driven these improvements in customer satisfaction. Early adopters of AI in the microfinance sector likely demonstrated the clear benefits of enhanced service delivery, leading to the wider diffusion of AI across the industry. As more institutions adopted AI technologies, the overall quality of customer service improved, contributing to the observed increases in customer satisfaction rates and the reduction in variability, as shown in the box plot.

Figure 6: Box and Whiskers plot for customer satisfaction rates



This box plot compares customer satisfaction rates before and after AI integration. The graph indicates an increase in median satisfaction rates and a reduction in variability post-AI integration, suggesting that AI-driven improvements in service delivery have positively impacted customer experiences and satisfaction levels.

Conclusion

Summary of Research

This research aimed to assess whether AI-driven microfinancing systems have improved financial accessibility for underbanked populations in India. By analysing key metrics such as

loan disbursement rates, microfinance sector growth, loan approval rates, disbursement times, default rates, and customer satisfaction, the study has shown that AI has had a significant positive impact on the microfinance sector. The data reveals that post-AI integration, there were notable improvements across all metrics, including a sharp acceleration in sector growth rates, reduced loan disbursement times, increased loan approval rates, and decreased default rates. These outcomes suggest that AI has enhanced the efficiency and effectiveness of financial intermediaries, aligning well with Financial Intermediation Theory. The adoption and widespread acceptance of AI technologies in the sector can be further understood through the Technology Acceptance Model (TAM) and Diffusion of Innovations Theory, which explain the perceived benefits of AI and its rapid diffusion across the industry.

Limitations of AI

Despite the clear benefits observed, there are logical limitations to the integration of AI in microfinance that must be acknowledged. First, AI's reliance on data for decision-making can lead to biases if the data is not representative or if historical inequalities are perpetuated in the algorithms used. This could potentially exclude certain populations or lead to unfair lending practices. Additionally, the implementation of AI requires significant investment in technology and infrastructure, which may not be feasible for smaller microfinance institutions. The complexity of AI systems also demands a higher level of digital literacy among staff and borrowers, which could be a barrier in rural or less developed regions. Finally, while AI improves efficiency, it may reduce the human touch in financial services, potentially impacting customer satisfaction for those who value personalised, human interactions.

Future Directions

To build on the findings of this study, future research should focus on longitudinal studies that track the long-term impact of AI on microfinance, particularly in terms of financial inclusion and poverty alleviation. It would also be valuable to explore the ethical implications of AI in financial decision-making, with a focus on developing frameworks that ensure fairness and transparency. Further research could also investigate the role of AI in enhancing financial literacy among underbanked populations, as well as its potential in addressing the specific needs of rural and marginalised communities. Additionally, examining the integration of AI with other emerging technologies such as blockchain and mobile banking could provide deeper insights into creating more inclusive and resilient financial ecosystems.

In conclusion, the integration of AI into microfinance has not only improved operational efficiencies but has also shown potential to transform financial inclusion in India by making credit more accessible to the underbanked. However, careful consideration of the ethical implications and ongoing efforts to balance technological advancements with human-centred approaches will be essential in ensuring that AI-driven microfinance serves as a tool for equitable growth and development.

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Wegovy's Path to Long Term Success: Enhanced Health Outcomes and Strategic Market Expansion By Ruhan Srisrimal

Abstract

Wegovy, a weight loss medication developed by Novo Nordisk, initially designed for obesity management, has shown significant cardiovascular benefits, reducing the risk of heart attacks and strokes. Wegovy works by mimicking a hormone called Glucagon-like-peptide-1 (GLP1). The clinical efficacy of Wegovy has been measured through Semaglutide Treatment Effect in People (STEP) with obesity trials. If Wegovy could be successfully repurposed in successfully it could help a greater amount of patients suffering from obesity and related diseases, such as Type 2 diabetes and cardiovascular issues. If it could also happen in a way that would also be financially viable for its manufacturer, it could help many other patients suffering from obesity and related diseases, This would enhance the business sustainability of the drug and could focus on patient benefits. This paper will study the feasibility of repurposing the drug Wegovy and its implications for the stakeholders involved.

Introduction

Obesity has become a global epidemic which can cause significant health and financial burdens on patients and people who suffer from it. The prevalence of obesity has also been shown to cause several comorbidities such as Type 2 Diabetes and cardiovascular issues. For many individuals, traditional approaches to weight management have been insufficient or unfeasible. This is where the drug Wegovy, manufactured by Novo Nordisk, a Danish pharmaceutical manufacturer, may play an important role as a weight management drug. For the intents and purposes of this paper we examined within the U.S., as it is the largest market for Wegovy.

This is the case due to obesity being highly prevalent in the United States, two out of every five U.S. adults suffer from obesity. 41.9% of U.S. adults suffer from obesity, and 9.2% of U.S adults suffer from severe obesity. Which means that around 42% of Americans have a BMI of 30 and above, and 9% have a BMI of 40 and above. This means that around 42% of U.S. adults have a BMI higher than 30.0 or higher. It also states that the medical expenditure for people with obesity was \$1,861 higher than people with a healthy weight, whereas those with severe obesity (adults with a BMI of 40.0 spent \$3,097 per person more than those with healthy weight) which finally accounts for \$173 billion in medical expenditures regarding obesity (in 2019 dollars). The financial and health burden on patients suffering from obesity is immense, as they also have comorbidities associated with obesity. Fifty-eight percent of adults who suffer from obesity also suffer from high blood pressure, and 23% of adults who suffer from obesity also suffer from diabetes. Treatments and care to combat obesity are costly and aren't always affordable. Insurance and discounts from the manufacturer can make the treatment more affordable, however, this only occurs if it would be sustainable financially for the manufacturer.

To what extent can Nova Nordisk improve Wegovy's long term business sustainability through the wider implementation of the drug. To investigate this further, an analysis of the current drug, its mechanism, its competitor's and their strategies would be needed.

Section I: Current scenario

Wegovy's Current Function

Wegovy, a rapidly growing weight-loss treatment, has garnered attention due to its effectiveness in controlling appetite and aiding in obesity management. This medication contains semaglutide (Davies et al.), a drug originally formulated to help people with diabetes manage their blood sugar levels. However, it was soon discovered that semaglutide also significantly impacts appetite regulation, leading to its use in obesity treatment. Wegovy is a GLP-1 agonist, meaning it mimics the actions of a naturally occurring hormone in the body to produce specific responses. (Pi-Sunyer et al.)

GLP-1, or Glucagon-Like Peptide-1, is a hormone involved in regulating blood sugar levels and appetite. When Wegovy is administered through a weekly auto-injector, it acts as an agonist by stimulating the GLP-1 receptors in the body. An agonist is a substance that mimics the action of a neurotransmitter or hormone, binding to a specific receptor and triggering a response.

In the case of Wegovy, the medication stimulates the production of a hormone called incretin, which is naturally found in the small and large intestines. Incretin slows down the rate at which the stomach empties, a process known as egestion. By doing so, it helps individuals feel full and satiated for a longer time, reducing the frequency of hunger pangs. This is one of the primary mechanisms by which Wegovy aids in weight loss.

In addition to its effects on the digestive system, incretin also impacts the brain, specifically the hypothalamus. The hypothalamus is responsible for sending signals related to hunger and the desire to eat. When incretin production is stimulated by Wegovy, it slows down the rate at which these hunger signals are sent, making the brain, and therefore the individual, feel less hungry (Le et al. & Wadden et al.) By reducing both the rate of stomach emptying and the frequency of hunger signals from the brain, Wegovy effectively helps individuals manage their appetite and achieve weight loss.

Clinical Evidence & Potential for Drug Repositioning

Wegovy has repeatedly shown to be a treatment with proven efficacy in aiding patients with obesity and cardiovascular issues. The introduction of Wegovy (Semaglutide) has marked a significant advancement in the treatment of obesity and related cardiovascular conditions. Wegovy has demonstrated promising results in reducing the risk of major cardiovascular events, including heart attacks and strokes. This literature review delves into the detailed findings of a pivotal study by Dario Rubino et al., examining the clinical outcomes associated with Wegovy.

A comprehensive study conducted by Rubino and colleagues explored the efficacy of Wegovy in mitigating cardiovascular risks among overweight and obese individuals. The study encompassed 17,604 participants aged 45 or older who were overweight or obese but did not have diabetes. These participants were monitored over nearly three years of treatment with Wegovy and an additional five years of follow-up. The study revealed that individuals taking Wegovy experienced a 20% reduction in the risk of major cardiovascular events compared to

those on a placebo. Specifically, 6.5% of the Wegovy group encountered major heart issues or succumbed to heart disease, whereas this figure stood at 8% for the placebo group.

Participants on Wegovy lost approximately 9% of their body weight on average, significantly higher than the placebo group, which saw just under 1% weight loss. This substantial weight reduction is posited to play a critical role in the observed cardiovascular benefits. Beyond weight loss, the study noted improvements in cholesterol levels and blood pressure among Wegovy users, contributing to better overall cardiovascular health. However, the study also reported that over 16% of Wegovy users discontinued the treatment early due to adverse events, compared to 8% in the placebo group. This highlights the importance of monitoring and managing side effects in clinical practice, and how further research should be conducted to determine the cardiovascular benefits, improve the patient experience and efficacy.

While the exact mechanisms through which Wegovy confers cardiovascular benefits remain to be fully elucidated, weight management appears to be a central factor. The significant weight loss observed in Wegovy users likely contributes to the reduction in cardiovascular risk. Additionally, the improvements in cholesterol levels and blood pressure further enhance heart health. Novo Nordisk, the manufacturer of Wegovy, has sought approval from U.S. and European regulators to use Wegovy specifically for reducing cardiovascular risks in overweight and obese individuals. If approved, this could lead to broader insurance coverage, making the medication more accessible to those in need. Broader insurance coverage would allow for reduced out of pocket payments by patients, and ensure a continued revenue stream for Novo Nordisk. Benefitting both stakeholders, and possibly leading to more accessibility as patients would not have to pay as much. This regulatory move underscores the potential of Wegovy to serve as a vital tool in managing obesity and its associated cardiovascular risks on a wider scale.

The study by Rubino et al. underscores the significant impact of Wegovy on cardiovascular health in overweight and obese individuals. With substantial reductions in major cardiovascular events, notable weight loss, and improvements in cholesterol and blood pressure, Wegovy presents a significant advancement in modern medicine as it is a multipurpose disease treatment drug, which is efficient and convenient for the patients, not to mention cost-effective. However, the occurrence of adverse events necessitates careful monitoring. Future research should continue to explore the mechanisms behind its side effects, ensuring that Wegovy can be effectively and safely integrated into clinical practice for broader patient populations.

The Economic Times article “Wegovy Should Be Treating More Than Just Obesity” discusses how Wegovy, a medication primarily used for obesity, has shown significant benefits for heart disease patients.

The study highlighted in the article, and the study by Rubino et al. has demonstrated that Wegovy reduces the risk of major heart events, such as heart attacks and strokes, by 20%. Participants in the study who took Wegovy also experienced significant weight loss and improvements in cholesterol and blood pressure. Experts suggest that Wegovy could become a new standard treatment for heart disease due to these additional health benefits. Novo Nordisk,

the manufacturer, is seeking regulatory approval to expand Wegovy's use to include reducing heart risks, which could lead to broader insurance coverage.

According to Reuters in "Obesity Drugmaker Novo Nordisk's Q1 Profit Beats Forecast," Novo Nordisk's strong first-quarter performance in 2024, were driven by the high demand for its weight-loss drug Wegovy. The company's profits exceeded expectations, prompting an improved annual outlook. Despite production challenges and competition from Eli Lilly, Novo Nordisk managed to significantly increase Wegovy's supply in the U.S., attracting 27,000 new patients weekly. This success underscores Wegovy's market impact and Novo's leading position in the obesity drug market.

The European Medicines Agency (EMA) article titled "Wegovy" states that Novo Nordisk's Wegovy, a drug designed for weight management, has been identified as a promising candidate for enhancing long-term business sustainability. The European Medicines Agency (EMA) has granted marketing authorization for Wegovy, allowing its distribution across the European Union, Iceland, Norway, and Liechtenstein. This broad approval signifies the drug's established efficacy and safety, making it a viable option for widespread use in these regions. The strategic enhancement of Wegovy's market presence involves negotiating improved coverage terms with insurance providers. By reducing out-of-pocket costs for patients, Novo Nordisk can increase the drug's accessibility and adoption rates. This approach is crucial for ensuring consistent revenue streams and better health outcomes. Additionally, maintaining rigorous compliance with EMA regulations, which include continuous safety and performance assessments, is essential for sustaining market trust and stability (European Medicines Agency) (European Medicines Agency). Improved insurance agreements and broader implementation are pivotal in solidifying Wegovy's market position. By focusing on these areas, Novo Nordisk can drive long-term growth and ensure the drug's success in the competitive pharmaceutical market.

According to Reuters in "Novo Nordisk Says Wegovy Heart Benefits Due More Than Weight Loss," Wegovy not only reduces heart attack and stroke risks but also provides benefits beyond weight loss. The trial results suggest additional mechanisms, such as improvements in inflammation, blood pressure, and blood sugar control. This could influence broader prescribing practices for heart disease patients. This is one of the most important aspects of this drug, as it has shown to benefit other comorbidities present in the treated patients.

Economic Evaluation of Wegovy for Chronic Weight management:

The NCBI article "Economic Evaluation of Wegovy for Chronic Weight Management" discusses Wegovy's cost-effectiveness for chronic weight management, with varying results based on population and assumptions. The incremental cost-effectiveness ratio for Health Canada is \$35,789 per quality-adjusted life-year (QALY). Addressing uncertainties through wider implementation and revised insurance agreements could enhance Wegovy's long-term sustainability. The Quality-Adjusted Life Year (QALY) is a metric used to assess the value of medical interventions by combining the quantity and quality of life into a single measure. Here's a breakdown of how it works:

Quantity of Life: This refers to the number of years of life gained from a medical treatment or intervention.

Quality of Life: This is a measure of how good those years are, which takes into account the health status and well-being of the individual. Quality of life is often rated on a scale from 0 (representing death) to 1 (representing perfect health), though it can be less than 1 if the individual is in less than perfect health.

Calculation: The QALY is calculated by multiplying the number of years of life gained from the intervention by the quality of life score during those years. For example, if a treatment provides 5 years of life with a quality of life score of 0.8, the QALY would be $5 \text{ years} \times 0.8 = 4 \text{ QALYs}$. For example; if Treatment A provides 2 years of life with a quality score of 0.7, and Treatment B provides 1 year of life with a quality score of 0.9, then Treatment A would offer 1.4 QALYs (2×0.7), while Treatment B would offer 0.9 QALYs (1×0.9). This helps in evaluating which treatment provides better overall benefits.

The NCBI article titled “Economic Evaluation of Wegovy for Chronic Weight Management” has conducted an economic evaluation of the drug also uses QALY’s to gauge the cost effectiveness of using Wegovy, summarised as follows:

Cost-Effectiveness Measurement: The article evaluates how cost-effective Wegovy is by looking at its cost per QALY gained. In other words, it assesses how much money is spent to gain one year of life in perfect health (or adjusted health) due to using Wegovy.

Incremental Cost-Effectiveness Ratio (ICER): For Health Canada, the ICER for Wegovy is \$35,789 per QALY. This means that for each additional year of life adjusted for quality (considering both the quantity and quality of life) that Wegovy provides, it costs \$35,789. This figure helps in comparing the value of Wegovy against other treatments or interventions.

Population and Assumptions: The cost-effectiveness varies based on different populations and the assumptions used in the analysis. This means that the effectiveness and cost can differ depending on factors like patient demographics or treatment settings, affecting the overall ICER.

Uncertainties and Future Considerations: The article suggests that addressing uncertainties—such as varying treatment scenarios or updated insurance agreements—could improve Wegovy’s long-term sustainability and cost-effectiveness. If more comprehensive implementation and better insurance coverage are achieved, it could make Wegovy more economically viable and improve its cost-effectiveness in the long run.

Lastly, Eli Lilly’s new weight-loss drug, Zepbound (tirzepatide), has been approved by the FDA for chronic weight management, showing significant weight reduction. Similar to Wegovy, Zepbound offers added benefits for weight loss and heart health. Novo Nordisk can improve Wegovy’s long-term success by negotiating better insurance coverage and emphasizing its cardiovascular benefits. Also, Eli Lilly’s Q2 2024 report demonstrates robust financial performance driven by increased sales and product innovations. Novo Nordisk can similarly

enhance Wegovy's sustainability by expanding its use and securing better insurance coverage, making it more accessible and competitive in the weight management market.

Section II: To what extent do pharmaceutical manufacturers benefit the society, and how might they do that in this case?

The review above highlights various strategies of how competitor companies and drugs such as Eli Lilly's Zepbound and Ozempic have been made sustainable in the long term for the business. Furthermore, long term sustainability and performance of a product, or a drug will be examined alongside the benefits pharmaceutical manufacturers bring to the world.

Pharmaceutical manufacturers play a critical role in advancing public health and contributing to societal well-being. Their benefits extend beyond the development of new medications; they impact healthcare accessibility, economic growth, and overall quality of life. In the context of Novo Nordisk's Wegovy, the benefits can be examined through several dimensions.

Pharmaceutical companies and how they play a role in improving patient outcomes

Improved Health Outcomes: Wegovy, designed for obesity management, addresses a significant public health challenge. With obesity linked to numerous comorbidities such as Type 2 diabetes and cardiovascular diseases, effective weight management can reduce these associated health risks. Clinical trials have shown that Wegovy not only facilitates weight loss but also improves cholesterol levels and blood pressure, which are critical for overall cardiovascular health. To add on, Cardiovascular Benefits: The STEP trials and subsequent studies have highlighted Wegovy's potential to reduce the risk of heart attacks and strokes. By providing these additional health benefits, the drug can significantly enhance patients' quality of life and reduce mortality rates related to cardiovascular conditions.

Economic benefit: Financial benefits for the patients and the healthcare system is another major area impacted through Wegovy. Effective weight management as a result of using Wegovy can lead to healthcare savings, and reducing the burden on the healthcare system and other treatments. As mentioned before, an adult with obesity spends \$1,861 more annually than an adult with healthy weight, and adults with severe obesity spending \$3,079 more than an adult with healthy weight.

Wegovy could alleviate that financial burden by reducing the prevalence of obesity-related conditions too. Novo Nordisk's efforts to negotiate broader coverage terms with insurance providers can also make Wegovy more accessible to a broader population. Enhanced insurance coverages reduced out-of-pocket costs for patients, making it more affordable and easier to maintain. The number of Americans without health insurance dropped by 8.2 million people from 2019 to 2023, highlighting an increase in the number of patients with health insurance.

Innovation and Drug Repurposing: Wegovy's success in weight management and its demonstrated cardiovascular benefits open avenues for drug repurposing. By exploring new therapeutic uses, Novo Nordisk can extend the drug's application to other related health conditions, potentially improving outcomes for a wider patient population. Drug repurposing also offers cost and time savings in drug development, making treatments available more quickly and affordably. The study by V. S. Kulkarni et al. emphasizes the role of technological advancements and collaborative efforts in drug repurposing. Novo Nordisk's strategic use of clinical data and real-world evidence can accelerate the validation of new indications for Wegovy, ensuring that the drug remains relevant and beneficial in the long term.

Additionally, regulatory approvals from bodies like the European Medicines Agency (EMA) allow Wegovy to be distributed across multiple regions, enhancing its global impact. This broad market presence not only ensures sustained revenue streams but also contributes to global health improvements. Furthermore, Novo Nordisk's commitment to research, as seen in its exploration of Wegovy's mechanisms beyond weight loss, underscores the importance of continuous innovation in the pharmaceutical industry. This ongoing research can lead to new discoveries that benefit both the company and society by providing deeper insights into disease mechanisms and treatment options.

Pharmaceutical companies and manufacturers play a significant role in the healthcare system and the healthcare of patients suffering from obesity and looking for a way to manage their weight. To determine how Novo Nordisk might use this opportunity to treat a greater number of patients in a way that is also financially viable for the manufacturer and benefitting the patient is by focusing on drug repurposing.

Section III: Repurposing & Enhanced health outcomes

Drug repurposing identifies new therapeutic uses for existing drugs, offering advantages such as reduced development time and cost (Kulkarni et al., 2022). Successful examples include thalidomide, sildenafil (Viagra), and metformin. Challenges include intellectual property issues, regulatory hurdles, and the need for scientific validation, but the future of drug repurposing is promising due to technological advancements and collaborative efforts.

GLP-1 receptor agonists, such as semaglutide, are primarily used for their glucose-lowering effects in diabetes and weight management. However, they have also been shown to have significant cardiovascular benefits. Reduction in Major Adverse Cardiovascular Events (MACE). GLP-1 agonists reduce the risk of major adverse cardiovascular events, including heart attack, stroke, and cardiovascular death. This benefit has been observed in several large-scale cardiovascular outcomes trials. These drugs improve heart function by enhancing cardiac output and reducing blood pressure. They also have positive effects on endothelial function and reduce inflammation, which are critical factors in cardiovascular health. By promoting weight loss, GLP-1 agonists indirectly reduce cardiovascular risk factors such as hypertension, dyslipidaemia, and insulin resistance. GLP-1 agonists have direct effects on the

heart and blood vessels. They reduce oxidative stress and improve myocardial metabolism, which helps in protecting the heart muscle from damage.

There are several examples of this case. Semaglutides (such as Wegovy and Ozempic)

SUSTAIN-6 Trial: This trial demonstrated that semaglutide significantly reduced the risk of major adverse cardiovascular events in patients with type 2 diabetes at high cardiovascular risk. Reference: Marso SP, Bain SC, Consoli A, et al. Semaglutide and Cardiovascular Outcomes in Patients with Type 2 Diabetes. *N Engl J Med.* 2016;375(19):1834-1844.

PIONEER 6 Trial: This trial showed that oral semaglutide also had cardiovascular benefits similar to its injectable form. Reference: Husain M, Birkenfeld AL, Donsmark M, et al. Oral Semaglutide and Cardiovascular Outcomes in Patients with Type 2 Diabetes. *N Engl J Med.* 2019;381(9):841-851.

Mechanism of Cardiovascular Protection

Endothelial Function Improvement: GLP-1 agonists improve endothelial function, which is crucial for maintaining vascular health and preventing atherosclerosis.

Anti-inflammatory Effects: These drugs reduce systemic inflammation, which is a key factor in the development and progression of cardiovascular diseases.

Blood Pressure Reduction: By promoting natriuresis and diuresis, GLP-1 agonists help reduce blood pressure, thereby reducing strain on the cardiovascular system.

Metabolic Benefits: Improved glycaemic control and weight loss contribute to better overall cardiovascular health by reducing the burden of comorbid conditions like hypertension and dyslipidaemia.

Repurposed drugs which have already shown success in the market usually tend to have more efficient FDA approval procedures. There are many repositioning strategies that could be used, in the case of Wegovy (Figure 1, 2018-Nature review drug repurposing). Firstly, a brief overview of existing successfully repositioned drugs must be done. With the example of Minoxidil, which was originally an antihypertensive, minoxidil was repurposed for treating hair loss. The FDA's approval process for this new indication utilized real-world evidence and existing data on the drug's safety and efficacy for its original use.

Minoxidil was originally developed and approved as an oral medication for the treatment of hypertension (high blood pressure). However, during clinical trials, researchers observed an interesting side effect: patients experienced increased hair growth. This unexpected effect led scientists to explore the potential of minoxidil as a treatment for hair loss.

Repurposing Process (Step by Step):

Observation of Side Effects: The initial observation of increased hair growth during hypertension treatment provided the first clue that minoxidil could be repurposed.

Mechanism of Action: Researchers studied the mechanism of minoxidil and found that it stimulates hair follicles, promoting hair growth. This action is beneficial for treating androgenetic alopecia (male and female pattern baldness).

Formulation Change: Minoxidil was reformulated into a topical solution to target hair loss directly at the scalp, reducing systemic absorption and minimizing potential side effects compared to the oral form.

Clinical Trials for New Indication: Subsequent clinical trials focused on the efficacy and safety of topical minoxidil for hair growth, confirming its benefits and leading to FDA approval for this new use.

Approval and Market Impact: The FDA approved topical minoxidil for the treatment of hair loss in 1988. This repurposing significantly expanded the drug's market and provided a valuable treatment option for individuals suffering from hair loss.

How could Wegovy act as a Repurposed Drug for Cardiovascular Diseases

Given the cardiovascular benefits observed with GLP-1 agonists, there is strong potential for repurposing Wegovy (semaglutide) for cardiovascular disease treatment. The mechanism of action through which Wegovy aids in weight management also plays a critical role in cardiovascular protection (observation of side effects). This dual benefit can make Wegovy a valuable therapeutic option not only for obesity but also for patients at high risk of cardiovascular events.

Section IV: Strategic market expansion & long term business sustainability

Expanding into another field may help Wegovy be financially successful in the long run and provide a stream of revenue for its manufacturer. Financial Benefits for the Manufacturer are by expanding Wegovy use beyond obesity and type 2 diabetes to include cardiovascular disease, the manufacturer can tap into a larger market. Cardiovascular diseases are prevalent, and patients with high cardiovascular risk are a substantial population segment. And according to the CDC nearly half of American adults (about 47%) have high blood pressure, which is a major risk factor for cardiovascular diseases

The introduction of Wegovy for cardiovascular conditions can create additional revenue streams. New indications can drive sales through increased prescriptions and a broader patient base. Improved Market Penetration which leads to a competitive advantage; Wegovy's dual benefits (weight management and cardiovascular protection) could differentiate it from other

cardiovascular drugs, potentially increasing its market share. Repurposing Wegovy can extend the product's lifecycle, delaying the impact of patent expirations. New indications can rejuvenate interest in the drug and prolong its market exclusivity.

Cost Efficiency

Reduced Development Costs: Repurposing an existing drug can be more cost-effective than developing a new drug from scratch. Clinical trials for new indications may be less expensive and shorter, as the safety profile of Wegovy is already established.

Regulatory Efficiency: The drug's existing approval can streamline the regulatory process for new indications, potentially speeding up time to market and reducing regulatory costs.

Financial Benefits for the Patient

One financial benefit for patients may be reduced hospitalization. By improving cardiovascular health and reducing the risk of major adverse events (e.g., heart attacks, strokes), Wegovy could decrease the frequency of hospitalizations and associated costs for patients. Further, it could help prevent complications. Effective cardiovascular management can prevent or delay the onset of expensive complications, leading to lower overall healthcare expenditures for patients.

Enhanced Quality of Life

The drug may also be related to enhanced quality of life. Patients with both diabetes and cardiovascular issues can benefit from a single medication addressing multiple health concerns, simplifying their treatment regimen and potentially improving adherence. Further, for patients with obesity-related cardiovascular issues, Wegovy's weight loss effects can contribute to better health outcomes and quality of life.

Accessibility and Affordability for the patients suffering from Obesity

Insurance Coverage: As Wegovy gains new indications, it might receive broader insurance coverage for cardiovascular conditions, making it more accessible to patients.

Cost Savings: If Wegovy is repurposed, it could be more affordable than new cardiovascular-specific treatments due to its established production and market presence.

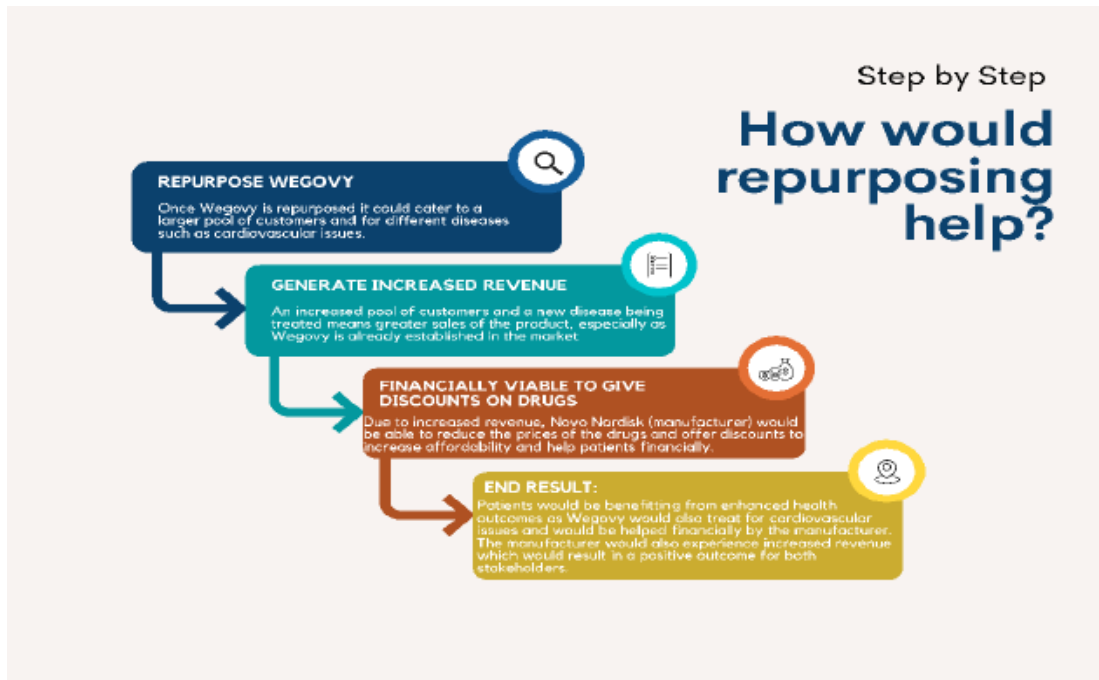


Figure 1: A visual aid and summary on the benefits of repurposing Wegovy

Future directions & progress

The prevalence of obesity in the U.S. and around the world have made it a pandemic. Wegovy can play a role here not only to address weight management but also cardiovascular issues. One approach to make this popular, effective and useful drug more accessible is to ensure that all stakeholders benefit from it, especially the manufacturers, who can make it more accessible, and patients, the direct beneficiaries of the drug. The dual benefits for the patients and business is summarised above in Figure 1.

This literature review has used a wide range of sources to critically and deeply evaluate the potential for the repositioning of the Novo Nordisk Weight management drug Wegovy for treating cardiovascular diseases and enhance business sustainability. Which would ensure greater accessibility and affordability for patients, and profitability for the business. However, there are some limitations of this review. Firstly, Wegovy's performance outside the U.S. needs to be measured in countries and regions that have a similar prevalence of diabetes and obesity. Such as the EU and India. The U.S. is a promising market but to ensure additional revenue streams they will have to tap into additional markets, and cater to a larger pool of customers, especially now that it is treating for Obesity and cardiovascular issues.

Finally, to bring awareness about their drug, Novo Nordisk can employ simple visual communication through videos or advertisements, which would help attract a larger market and customers who have a better understanding of the drug.

Conclusion

Wegovy, initially developed for obesity management, demonstrates significant potential for long-term business sustainability through strategic repurposing and expanded market applications. The drug's additional cardiovascular benefits, as evidenced by recent studies, present an opportunity for Novo Nordisk to enhance its market position and address broader health concerns. By leveraging Wegovy's dual benefits—weight loss and cardiovascular protection—the company can tap into a larger patient base, particularly those at high risk for cardiovascular diseases, thereby driving increased revenue and market penetration. Expanding Wegovy's indications could also prolong its market lifecycle, mitigate the impact of patent expirations, and reduce development costs associated with new drug development. The existing safety profile and proven efficacy of Wegovy streamline the regulatory process, making the transition to new indications more cost-effective and efficient.

For patients, the potential to manage both obesity and cardiovascular conditions with a single medication can improve treatment adherence, reduce overall healthcare expenditures, and enhance quality of life. The successful implementation of these strategies not only underscores Wegovy's role in improving health outcomes but also supports Novo Nordisk's goal of achieving sustainable business growth while addressing critical public health challenges. **Lastly, by** focusing on broader market applications and strategic insurance negotiations, Novo Nordisk can solidify Wegovy's position as a key player in both weight management and cardiovascular health, ultimately contributing to the drug's long-term success and societal impact.

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Confederate Monuments: How Cultural Infrastructure Restored the Confederate Order in the Post-Civil War South By Tyler Park

Introduction

Historical memory has often been the site of controversy in the United States. While conventional history typically focuses on white Americans, other groups, notably Black Americans, have been overlooked despite their critical roles in shaping society. For example, for nearly 200 years after the founding of the United States, the prominent role of thousands of Black people in the American Revolution was all but forgotten. Amidst the absence of a celebration for Black soldiers, who had a significant impact on the war, it is apparent that commemoration of wartime service in the United States is not based on battlefield prowess alone. There is a pattern in American history where “constellation[s] of celebrated noncombatants like Patrick Henry and Paul Revere” (Thomas 7) are celebrated in the aftermath of an important conflict, while marginalized groups are not. This phenomenon is nowhere more apparent than in the aftermath of the Civil War, where a massive effort to celebrate and commemorate the Confederacy by memorial organizations such as the Ladies’ Memorial Association and the United Daughters of the Confederacy pervaded the South. Paradoxically, despite the Confederacy’s defeat, hundreds of Confederate monuments emerged decades after the Civil War glorifying important Confederate figures such as Stonewall Jackson (1824-1863), Jefferson Davis (1808-1889), and Robert E. Lee (1807-1870) (Karen 26). These figures are not “celebrated noncombatants,” but rather generals of a long-defeated secessionist rebellion that brought about the U.S. Civil War. This paper will argue that Confederate monuments significantly altered Southern historical memory and emboldened the Lost Cause narrative, a fallacious narrative glorifying the Confederacy. Furthermore, this paper will show that in addition to shaping culture in the South, Confederate monuments helped restore White political power and Confederate racial hierarchy, degrading African-American status in Southern society by becoming centers for anti-Black collective action.

The commemorative preservation of narratives and war figures through monuments has been a culturally significant practice of the United States since at least the American Revolution. Through their physical beauty and artistic symbolism, war monuments serve as tangible devices to mourn and cope with loss while galvanizing public emotions into patriotism. Their artistic symbolic importance to the community makes monuments an extremely powerful part of cultural infrastructure, reflecting a community’s set of values and cultural identity.

Three decades following the U.S. Civil War, a national movement to erect monuments glorifying the Confederacy swept the South and was spearheaded by former secessionists and their supporters. Understanding Confederate monuments and the reason for their rise in the 1890s-1900s provides insight into Southern culture and shows how the ideas of the Confederacy were revived and integrated into Southern society. While historical narratives are subject to change, an essential quality of monuments is their apparent permanence: they are set in stone and reflect the ideas of their sponsors, which tower over the landscape.

The Civil War and Slavery

The U.S. Civil War, a four-year long conflict between the Confederacy and the Union from 1861 to 1865, was utterly devastating. 620,000 soldiers lost their lives and 18% of the Southern White males aged 13-43 died during the war (Blight 19). The sheer loss of American soldiers during the Civil War was unprecedented and has yet to be matched, with the death toll of the war matching the cumulative deaths in all following military conflicts until the Korean War (Blight 64). “The war’s staggering human cost demanded a new sense of national destiny,” (Faust 268). Drew Faust, an American historian, writes, “one designed to ensure that lives had been sacrificed for appropriately lofty ends”.

Although the Confederacy and its cause to preserve and extend slavery had lost decisively, to maintain their pride and ensure the purpose of their cause, some White Southerners maintained that their defeat was less than complete. That stubbornness was a key part of Southern Confederate identity and representative of the “Southern honor” that White Southern elites sought to maintain. To preserve their Southern honor amidst disillusionment and defeat, some Southerners supported the idea that the Confederacy's motive for secession was an issue of state power rather than the obvious objective of preserving slavery. This was in part to vindicate the unjustifiable Confederate cause, but more importantly, this perspective recast the original Confederate goals to fit the needs of the current white Southerners. In a South where slavery had been decisively abolished, White Southern elites sought to restore the racial order of the Confederacy which involved their political and cultural hegemony over Blacks. In his famous Cornerstone speech, Southern elite Alexander Stephens (1812-1883), former Confederate Vice President, declared that “the cornerstone” of the Confederacy, was that “the negro is not equal to the White man; that slavery subordination to the superior race is his natural and normal condition.” This racial hierarchy according to Stephens, “is the first, in the history of the world, based upon this great physical, philosophical and moral truth (Stephens 1).”

Slavery was the core foundational institution of the South and was a system that not only underpinned the economy of the Confederacy but also created a deeply entrenched racial hierarchy in the culture of the United States. Slavery was removed from the South by force and former slaves were made equal to their masters during Reconstruction (1865-1877). However, this massive change was not welcomed by many in the South and when Reconstruction ended, many Whites sought to reimpose the old racial order. However, the process of reasserting White supremacy over African-Americans would take time and involve a range of initiatives, including the use of public Confederate monuments.

U.S. President Abraham Lincoln (1809-1865) challenged the cornerstone of the Confederacy (as defined by Stephens) through the Emancipation Proclamation, issued on January 1, 1863 (Foner 1). This groundbreaking Proclamation demonstrated the Union’s belief that “all persons held as slaves within any State or designated part of a State, the people whereof shall then be in rebellion against the United States, shall be then, thenceforward, and forever free (The Emancipation Proclamation 1).” Although the Emancipation Proclamation was primarily a means to assist military efforts for the Union cause by encouraging Black cooperation with the

Union, this gave the war a greater moral purpose. Additionally, the document would come to serve as the cornerstone of the African-American civil rights struggle (Randall et.al. 25). Historian Eric Foner noted that the “Emancipation Proclamation clothed national authority with an indisputably moral purpose (Foner 24).”

After Robert E. Lee’s surrender on April 9, 1865, Radical Republicans and other abolitionists expected the North to create a completely new Southern society based upon racial equality (McPherson 848). However, the plan for a new society was ultimately abandoned in the face of opposition in the South and difficulties in realizing the goal of making the United States a multi-racial democracy (Foner 73).

Reconstruction

During Reconstruction, the Republican-dominated federal government sent military forces to occupy and exert control over the South, stripping the South of its political structure, and granting full citizenship to African-Americans (Blight 104). The North had two main goals for Reconstruction: (1) rebuild the destroyed South and (2) definitively change Black status in the South by giving them basic rights. Federal legislative actions, including the passage of the Thirteenth Amendment in 1865 which abolished slavery, begged the question of whether enslaved Blacks were now full U.S. citizens or whether their unique experience in light of the recent war obliged merely a short-lived conditional freedom that demanded federal oversight (Mcpherson 840). While Reconstruction efforts by the North were successful in granting citizenship and rights to African-Americans in the short term, the generic universalist language of the Reconstruction Amendments, granting basic civil liberties to Black Americans, were ultimately unable to be sustained in a deeply antagonistic and stubborn South. Even with the North’s military and political hegemony, the Republican-controlled government failed to reshape the South as evident through the internalized racial hierarchy that remained. As a result, Blacks enjoyed only a fleeting gasp of freedom that was drowned once again by the sustained Confederate White supremacy.

In 1865, Abraham Lincoln was assassinated and his vice president, Andrew Johnson (1808-1875), took office. Johnson, a Southerner sympathetic to the South (Faust 223), proposed a plan that made it much easier for Southern states (all of which were under military occupation and without representation in Congress) to be readmitted to the Union. Johnson’s plan included broad provisions for amnesty and pardons for Confederate soldiers while requiring Southern states to revise their antebellum constitutions, renounce secession, and accept the Thirteenth Amendment (Blight 45). Johnson’s pardon of Confederate soldiers and his accommodating line toward the Confederacy emboldened elements in the South who were resisting the new order (Blight 21).

Reconstruction envisioned the Union completely reshaping Southern society and government, which amounted to a revolution transforming the South from a rigid racial hierarchy to a multi-racial democracy (Blight 32). The grief from the Civil War in the South was not a singular occurrence but rather a broader communal experience. Although both the North and the

South experienced immense grief over the loss of life in the war, the South had to grapple with their loss amidst a political and military occupation and a complete repudiation of the Confederacy's ideas (Blight 47). While those who lost family members in the Union Army had the assurance of a decisive victory to justify their deaths, Southerners were instead left with the anger and sadness of defeat. The distinct Southern hardships of defeat and military occupation led to a drive to collective redemptive identity, one that sought to end what was regarded as Northern oppression and to restore the defeated cause of the Confederacy that thousands of their soldiers had fought for.

This emerging Southern identity based on war and occupation grievances were centered on racism and anti-North sentiment. Southern Democrats initiated a forum of arguments that led to the "redemption" movement of their states beginning in the 1870s. Benjamin H. Hill (1823-1882), a former Confederate senator from Georgia, admonished his fellow Georgians to never surrender. Hill was also one of many Southerners to start using language to create an ideology that argued for the recalcitrance to Reconstruction rooted in the fundamental belief of Confederate principles (Blight 102). This emerging redemptive identity, which prevented Reconstruction policies from making a cultural difference amongst white Southerners, became even more pervasive as Confederate monuments began to be constructed.

The loss of political rights of Whites came at the same time Blacks were newly empowered to vote, which is why so many representatives to Congress in the immediate post-war period were Black. Local governments in the South, too, were controlled by White Republicans and Blacks. Southern Whites were eager for a restoration of their political rights so that they could begin to challenge the new order. In a letter written in 1868 to former General William Rosecrans (1819-1898), prominent Confederate leaders such as Robert E. Lee and Alexander Stephens pleaded on behalf of White Southerners arguing that "they desire relief from oppressive misrule. Above all, they would appeal to their countrymen for the re-establishment in the Southern States of that which has justly been the right of every American -- the right of self-government (Rosecrans 1)."

In the summer of 1865, Black Codes were passed throughout the South in response to Union efforts to expand political rights to newly freed slaves designed to reestablish Confederate goals apart from slavery. Extralegal military groups consisting of mostly former Confederates such as the KKK, perpetrated violence against former slaves fueled by a growing collective defiance to Republican initiatives. While White Southerners found it impossible to overcome the Union army, they embraced a new role of pursuing cultural triumph manifested through a continued model of living defined by sustained racial hierarchies. In reflecting on the South's attempt to restore the Confederacy's purpose and honor, Frederick Douglass responded that "there was a right side and a wrong side in the late war, which no sentiment ought to cause us to forget (Douglass 1)."

Unfortunately for Douglass, a combination of both a collective spirit of fondness for the Confederacy and the redemptive Southern enthusiasm led by efforts of former Confederate leaders and soldiers laid the foundations for a postwar Southern culture reminiscent of the

Confederacy. This was driven even further by the Confederate commemoration in the South and the fervor of monument building.

The Beginning of Confederate Groups and Monuments

Former Confederates weaponized mourning the dead by erecting monuments that glorified the Confederate soldiers and Confederate principles. White control over the cultural landscape excluded the perspective of both Blacks and Union sympathizers in the South. In honor of their Confederate soldiers, memorial groups such as the Ladies' Memorial Association (LMA), established in 1866 (Foster 38), and later the United Daughters of the Confederacy (UDC), established in 1894 (Brown 4), played pivotal roles in weaponizing memorial tools to extend Confederate power by organizing huge public displays of monuments which they organized and funded. Confederate monuments not only shaped new cultural trends, but also, more importantly, they configured a new Southern identity mirroring the racial hierarchy of the Confederacy in three ways: (1) they re-established the cultural significance of the Confederacy throughout the South through an alteration of historical memory, (2) they helped to reconsolidate White political power, and most relevantly in terms of contemporary significance, (3) Confederate monuments became prominent centers for anti-Black collective action.

Despite the immense devastation following the Union's victory in the Civil War, there was a developing narrative known as the Lost Cause which minimized the South's military defeat in favor of pursuing a sustainment of the Confederate values as a benchmark of success. Memorial organizations in the South firmly believed in the Lost Cause narrative which sought to embrace the continuation of the Confederacy as an idea and model for new Southern society. A goal of both the LMA and the UDC was to perpetuate the identity of the Confederacy through the Lost Cause narrative.

Confederate monuments helped the South to collectively embrace the Lost Cause narrative. The Civil War completely upended Southern culture and society. Though many Southerners sympathized with the Confederacy, the Northern occupation and Reconstruction imposed a Northern-centric narrative on the South. The Lost Cause narrative emerged among Southerners to explain the South's subordinacy by restoring the validity of the Confederate leaders and circumventing the notion of defeat altogether. The Lost Cause narrative would begin with adults, but it would be intentionally spread to children, who would subsequently carry on the myth for future generations.

The Ladies' Memorial Associations were the first generation of two major Southern post-war organizations to commemorate the Confederacy and lay the groundwork for the resurgence of Confederate culture (Brown 113). While the federal government provided fallen Union soldiers with proper graves and cemeteries, fallen Confederates were neglected. Given no federal aid to collect or honor the dead Confederate soldiers, groups of mostly Southern women made those efforts instead. This movement to collect the dead abandoned by the Union led to a surge of Confederate nationalism, with Confederate soldiers and their sacrifices mirroring the symbolic influence of martyrs (Janney 93). In describing the importance of cemeteries in 1866, a

Southerner argued in the *Richmond Dispatch*, a prominent Virginian newspaper, that the South “is now united by a band of graves - a tie that can never be sundered (*Richmond Dispatch* 1).” If graves and cemeteries were significant in uniting Southerners, monuments captured the same but did so in a far more personal and profound manner.

The LMA used the Union's neglect of fallen soldiers and Southern connection to these ghosts of the Confederacy to forge an intense connection to the Confederate dead, making their treatment a central part of a broader movement to restore the ideas of the Confederacy. For example, the LMA held services of remembrance on May 10th, former Confederate General Stonewall Jackson's day of death (*Richmond Dispatch* 1). However, understanding that the defeat of the Confederacy contradicted their efforts to restore a new Southern culture, the LMA adopted a revisionist history initiated by Confederate redeemers who felt a need to reshape the meaning of the war and recast the Confederate defeat. Incensed with the end of slavery, the neglect of Confederate graves, and humiliated by the presence of Union troops, former Confederates coalesced to defend the sacrifice of their former soldiers and more importantly to replenish the fallen cultural identity of the South (Janney 75).

The most successful effort to rehabilitate the Confederacy came with the creation and popularization of the “Lost Cause” narrative, which emerged from Edward Pollard's 1866 book *The Lost Cause: A New Southern History of the War of the Confederates* (Cox 15). Pollard argued that despite Confederate military defeat, the cause for which they fought was justified and immortal. The narrative recast the history of the Confederacy's purpose in the war and imagined a persisting struggle in the post-war society to vindicate the Confederacy by restoring Confederate values into Southern life. The Lost Cause sought to reconcile the Confederate cause through a set of paradoxical associations that would restore the validity of the Confederacy, such as the immortality of the Confederacy amidst a South controlled by the North and the triumph of the Confederacy following clear military defeat (Brown 203).

During the intensification of this redemptive ideology between 1865 and 1890, the rise of the LMA was essential in preserving the Lost Cause tradition and cementing a recast historical memory in stone. The emergence of the UDC extended the work of the LMA beyond merely memorializing the past, seeking ways to implement Confederate cultural infrastructure and education while making an effort to preserve Confederate values for future generations (Cox 2). As the second generation of Confederate memorialization movements, the UDC emerged and redefined their efforts to control the historical memory of the Confederacy and restore its significance to Southern society in light of the end of reconstruction. Confederate monuments played an integral role in strengthening the Lost Cause's role in constructing a new South by creating memorial days and centering education around the values of the Confederacy. Doing so helped establish a connection between the Confederate values and the South and recast Southern perception of the war itself from grief to triumph. The emergence of a broad counterrevolution to the changing social climate following the war fostered a strong sense of identity in Southern pride, eliminated the disillusionment of defeat in the South, and preserved the Confederate culture in the South through the acceptance of a recast history.

Fueled by the emergence of the Lost Cause movement, LMA branches across the South shifted the purpose of memorializing to restoring the ideas of the Confederacy in Southern society. To accomplish this the LMA had to not only embrace the belief that the Confederate movement had not ended in military defeat but also find a way to convince Southerners of that narrative.

While monuments had initially been constructed in cemeteries, not occupying a role in daily life, their shift to public spaces, including courthouses, indicated LMA efforts to extend the cultural and political power of monuments to the broader Southern community (Cox 21). The LMA was eager to erect Confederate monuments in downtown areas or on busy streets to maximize the cultural significance of the monuments and the messages they conveyed to more people. One of the earliest examples of these high-profile monuments in the commemorative era was the Augusta Monument, erected in 1878, which was placed in the center of the town square rather than in a cemetery.

Given the success of monuments like the one in Augusta, the LMA embraced a role of replacing the spiritual void caused by the war's defeat with distinct rituals revolving around monuments: "Now, for the first time, at this comparatively distant period, the wives, the children, the parents, the dear friends, the brothers and sisters of these fallen soldiers join in something like funeral obsequies (Brown 26)." Instead of a Southern regret of the failed Confederacy, the LMA emphasized Confederate triumph through their gradual control over cultural icons and cultural architecture like this one in Augusta.

Confederate monuments evolved into weapons for the Lost Cause as foundational symbols that played an important role in restoring Confederate culture in Southern society. A clear example of the success of early attempts to change historical memory in the South to uplift the power of the Confederacy can be seen in Kentucky. The former slave state of Kentucky, one of the only four former Border South slave states that remained loyal during the Civil War, underwent a sweeping cultural shift in the post-war era indicating a state-wide embrace of Confederate mythology and culture (Giguere 56). In 1874, in Lexington, Kentucky, despite federal troops actively exerting military control over the city and enforcing Reconstruction policies favoring Black protection, an LMA faction in Kentucky raised funds and successfully installed a monument of a marble cross carved to make the logs of the cross upholding a broken banner of the Confederacy. The base of the monument was designed to look like a shattered pile of rocks, juxtaposed with the image of the Confederate flag (Marshall 1). By depicting the continued presence and existence of the Confederate flag, the LMA factions across the South not only perpetuated a broad untruthful narrative of triumph for the Confederacy in the South but also shifted the cultural identity of disillusioned Southern by reinstating the importance of the Confederacy in their lives. This monument in Kentucky shows how Southerners tried to grapple with their defeat: atop a shattered foundation sat Confederate values, triumphant.

In this way, Confederate monuments in the South revised the historical memory of the Civil War in its entirety and supported Confederate culture in the South by portraying the Civil War, a military defeat, as a decisive cultural triumph, reinforced throughout the South in the form

of Confederate monuments. The first pictorial newspaper in the United States, Frank Leslie's Illustrated Newspaper, labeled the monument in Kentucky as "probably the most perfect thing of its kind in the South" in part because "it tells its own story -the tragic story of the Lost Cause - without the use of a single word (Leslie 1)." Kentucky's construction of a total of seventy-two Confederate monuments exhibits the impact which the creation of monuments had on the alteration of the historical memory (Giguere 59).

The UDC and its movement to erect monuments were even more important than the LMA had been in exerting cultural influence and perpetuating the Lost Cause narrative throughout the South most prominently throughout the 1890s and early 1900s. The UDC reached 100,000 members by World War I, had 138 local chapters within three years of its initiation in 1894, and was a national organization with interconnecting branches throughout the South (Cox 1). The UDC possessed connections to political power that enabled them to create huge monuments all over the South using funds from donors, local government, and in some cases the federal government. For example, up to \$10,000 was appropriated from the state legislature with \$5,000 a year for maintenance to construct a Confederate Women's Home in Fayetteville, North Carolina, a huge sum of money for a financially devastated South (Cox 1).

The UDC spearheaded the massive proliferation of Confederate monuments that began in the 1890s. As Thomas Brown, an expert in Confederate monuments, frames it, the "second proliferation of monuments assumed a different cast" from the initial memorialization emphasizing the shift from "regeneration to affirmation (Brown 2)." The new association of Confederate monuments with triumph would completely envelop the cultural landscape in the South leading to a sustained Confederate grasp over Southern culture that would have multigenerational implications.

One of the primary goals of the monument movement was to redefine the memory of the Confederacy as an indisputably triumphant, which would be supported by the celebration of towering monuments that took years of planning to build and days of celebration and display to captivate towns. Confederate monuments were often unveiled by children, who in their decorative clothing symbolized the passing of Confederate values to future generations. The structural magnificence and jaw-dropping enormity of these monuments captivated thousands of people. Amidst this new era of Confederate monument ceremonies of unprecedented scope, white Southern culture collectively forged an association that cemented and internalized the belief of Confederate greatness—a triumph of the Lost Cause eternalized through the stone structures. This newfound association showcased through the culture of celebration rather than bereavement surrounding fallen soldiers, notably reshaped Southern historical memory, reinstating the Confederacy's prominence within the cultural fabric of the New South.

A primary goal of the UDC was to preserve the Lost Cause as history, meaning that historical memory would have to be altered and accepted as truth for perpetuity. And given the continued persistence of the narrative to this day, the Lost Cause and the UDC were ultimately successful (Klein 242). The reason for the UDC's multi-generational success can be attributed to their goal of perpetuating Lost Cause heritage to future generations, accomplished by

Confederate monuments in education and the influence of children being involved in monument unveiling procedures. As Brown notes, the goal was for children of the UDC “to come point to the place where this memorial rests and tell of the patriotic organization of Civil War veterans which for years met here in weekly conclave” to their children (Brown 85). After the unveiling of the infamous Robert E. Lee monument in Richmond Virginia on May 29th, 1890 (Cox 44), which brought an estimated crowd of 100,000 people, hundreds of White children wearing red, White, and blue clothing arranged in the shape of a Confederate battle flag right next to the monument (Cox 45). This increased exposure to Confederate monuments not only reflected the current political and social hegemony of the New South but also signified that the historical memory of the Confederacy would be long-lasting: given the prominence of Confederate celebration in children’s lives (Cox 2).

The UDC first accomplished the integration of Lost Cause ideology and Confederate affinity in children by making them integral parts of the grand unveiling ceremonies of Confederate monuments. For example, the organization of Children’s Chapters was a significant activity by the UDC between 1894 and 1919 (Cox 135). The first chapter of the Children of the Confederacy (CofC), was chartered in Alexandria, Virginia in 1896 and was organized for children to be part of commemorative activities. As Confederate soldiers began to pass away, the movement to organize CofC branches expanded to facilitate the transmission of Confederate values from the dying (and dead) to the living. In this way, children became intrinsically linked to the preservation of the Confederacy in the South (Cox 135).

In addition to having prominent roles in monument erections themselves, the UDC sought to spread the Lost Cause narrative more broadly through control over the education system. Hundreds of Jefferson Davis portraits were placed in schools across the South and thousands of White children studied his life in large part due to the UDC’s efforts (Cox 131). The UDC also organized field trips for schools in the South to monuments that they had erected to teach children the importance of glorifying Confederate leaders and embracing the values of the Confederacy.

Another way monuments were utilized to transmit messages to future generations was speeches made at monument unveiling ceremonies. As thousands of children gathered with their families to unveiling ceremonies, speeches made at the ceremony often included references to the importance of the younger generation embracing the values that were being celebrated to retain the Confederate racial hierarchy. For example, Supreme Court Judge Armistead Burwell made a speech at the unveiling ceremony at the Confederate monument in Mecklenburg County on August 4th, 1910 (Henderson et. al. 2), arguing for the importance of the Confederacy:

Men and women of this younger time, heed, we beg you, the lessons he [the Confederate soldier] would teach. Be reminded by this silent soldier - who, great as he was in war, was greater in peace- to be brave when danger appears, to bear with fortitude the ills of life, if ills, under God’s providence, shall come - to love home and its purity - to protect from taint the Saxon blood that courses in your veins - to be, in fine, men and women

worthy of the heritage of fame which this “Ideal Confederate Soldier” won for his Sunny South, and gave to her people, and to the people of all this great nation (Burwell 1).

Burwell’s speech reveals a larger effort to utilize Confederate monuments to portray an idyllic past and recast the history of the Confederacy’s goal to maintain White supremacy.

The Augusta Monument, which had engravings in it with paradoxical words such as “WON” and describing the Confederate soldiers with “FADELESS FAME” was essential in cementing a new legacy of how the war was remembered in the South (Brown 203). The assertion by organizations such as the UDC organizations and Lost Cause enthusiasts that the truth and justice of the Confederacy would outweigh the significance of Confederate loss, took on a whole new level of importance and meaning as Confederate monuments expanded the sphere of influence of that identity across the South (Brown 203). The culture of celebration surrounding Confederate monuments alongside the monument’s physical permanence which served to perpetuate the ideology amongst future generations, only served to eternalize collective Southern identification with the Confederacy, reshaping a new South triumphant in their identity amidst a restoration of Confederate culture.

Ultimately the role children played in unveiling Confederate monument ceremonies coupled with their indoctrination with Confederate ideology in the classroom revealed the intention of UDC to sanctify the Confederacy in the minds of children. Children were exposed to Confederate ritualization and indoctrination in all aspects of their lives in the South. All these rituals and institutions essentially created a civil religion to cement the Confederacy's importance in Southern culture for the coming years (Wilson 238). Growing up in a school system and society where holidays and important events revolved around the Confederacy, Southern youth were bombarded with Confederate ideology from birth. Coupled with the towering Confederate monuments in town squares which depicted tangible visual masterpieces which reaffirmed the greatness of the Confederacy, Confederate monuments served as untruthful yet powerful evidence to future generations of children, of the triumph and greatness of the Confederacy.

Restoring the Living and Dead from Disgrace

In addition to the role Confederate monuments played in reconstructing the Southern cultural identity by recasting the historical memory of the Confederacy, they also served to restore and expand White political power in the South. The creation of the Confederate monuments reflected the economic and political power that Whites wielded. White men formerly in positions of authority in the Confederacy sought to play a role in commemoration to restore their reputations (Cox 38). This meant that the creation of monuments provided a unique avenue for White wealthy Southerners to regain political influence and mainstream acceptability.

Monuments also served to symbolically indicate that the Democratic Party of the Confederacy successfully defended the racial hierarchy in the South which served to countermand the temporary political control of the Republican government. For White Southerners and more specifically Confederate elite, who had been stripped of their power, Confederate monuments restored their sense of pride and purpose across the community

providing them an avenue to command political power through first, a decisive control of the commemorative landscape. George Cable (1844-1925), a prominent Southern writer known for his realism in portraying Southern life, examined the impact of Confederate monuments and their symbolic value of these statues to White Southerners in *The Silent South*:

[A Monument] symbolizes our whole South's better self; that finer part which the world not always sees; unaggressive, but brave, calm, thoughtful, broad-minded, dispassionate, sincere, and, in the din of boisterous error round about it (Cable 43).

The use of monuments as a mechanism to better the “whole,” a reference to the White Southern wealthy citizens who had been stripped of power, demonstrated that Confederate monuments prompted the return of Southern honor to the men whose honor had been taken by their defeat in the Civil War. For example, given input from sponsors as to what source material should be prioritized, the UDC sponsored the construction of public libraries, including a disproportionate amount of textbooks corroborating Confederate greatness and essentially giving sponsors the keys to dictate what became important or not in education (Brown 56).

The power of monument sponsors, however, who were often wealthy former Confederate men, was clear by how they dictated and shaped cultural beliefs and collective knowledge that would serve their interests. For example, 150,000 people were present at the unveiling ceremony for the Lee Monument in Richmond, indicating the importance of monuments as theaters of American memory of the Southern economic elite, who desired a reinstatement of control (Brown 94). In this example at the Lee Monument in Richmond, an idyllic equestrian statue depicting General Lee riding atop a horse, the sponsors of the project made an effort to depict Robert E. Lee as a stalwart of White supremacy and the epitome of Southern Confederate greatness amongst the Southern elite. Designed to showcase the supremacy of Robert E. Lee, a figure who mirrors the sponsors politically, the equestrian design serves as a metaphor for a system of racial repression and hierarchy envisioned by the White Southern elite (Brown 89). Sponsors for the Richmond monument described Lee as an exemplary man of the upper class, perfectly embodied the essence of an upper-class White Southern gentleman who was a symbol of the “fittest” ruling class and a deference for the superior race and class (Glaze 167). The monument further demonstrates a bridge between the old Confederate regime of slavery to a new regime that was defined by a similar White rule, a political hegemony that White Southerners wished to restore through an intentional use of landscape.

This process of reestablishing the political dominance of White Southerners required control of the commemorative landscape. As the federal government moved out of the South, many wealthy White Southerners who had economic power saw a way to dismantle multi-racial democracy in favor of restoring the Confederate racial hierarchy. For example, after leaving a Confederate Monument in Augusta, Georgia, federal soldiers openly celebrated the Confederacy indicating that, as Brown puts it, “the rise of more Confederate monuments across the South as Democrats sought to consolidate political control of the region (Brown 56).”

In addition to wielding the power of selecting inscription messages and the meaning of Confederate monuments, sponsors also dictated the location of where they were to be erected which had symbolic political depth. One prominent location where Confederate monuments were erected was in courthouses. The usefulness of the UDC to employ monuments near courthouses became apparent during the Progressive Era of the 1900s and 1920s. This period marked the growing political prominence of African-Americans, which led to immediate attempts to repress this surge by Southern elites by putting up monuments in courthouses and official government office grounds (Henderson et. al. 3). The appearance of hundreds of these icons glorifying the Confederacy (Brown 24), not only in private places but also in courthouses, shows how the sponsors who supported the erection of monuments used them as a weapon to restore White political power in the South. Thus, the control over what monuments were depicted and where they would be located led to a disproportionate representation of a historical narrative that only served to tell the war from one side.

Denigrating African-American Status

Through the 1890s and the early 1900s, Confederate monuments also served to intimidate African-Americans politically and isolate them. Given the exit of the federal government's military forces in 1877, African-Americans were forced into a position reminiscent of the pre-Civil War South. While laws such as Black Codes served to terrorize African-Americans legislatively, Confederate monuments pervaded public spaces and were places of lynching and extralegal force preventing Black Americans from attaining basic liberties given to them during Reconstruction (Henderson et. al. 1).

A common example of how Confederate monuments demeaned African-Americans was the myth of the faithful slave. Columbia, North Carolina (1902), Chesterfield, South Carolina (1928), and Fort Mill South Carolina (1896) are just three of the many Confederate monuments erected by the UDC that portrayed African-Americans in the South as slaves loyal to Confederate soldiers (Brown 39). Not only did this damage Black status by displaying a misleading narrative of the experience of African slaves and the vast majority of slaves who had deserted or contributed to the Union cause, but it also served as a mild way of expressing Black inferiority. Symbolizing disenfranchisement, segregation, and Black subservience, Confederate monuments were critical in the new establishment of Black inferiority in a post-war South without slavery. As American historian Dan Carter writes, "only now it was black subservience rather than outright slavery that was to be justified (Carter 1)."

Confederate monuments played an important role in the violence visited upon African-Americans after the end of Reconstruction. These monuments were powerful symbols of White power and when groups like the KKK mobilized to attack African-Americans, monuments served as centers of collective action and a powerful symbol repudiating the basic rights of African-Americans in the South.

The KKK was an extralegal organization that was founded in 1866 in Pulaski, Tennessee, by former Confederate soldiers, and by the 1880s and 1890s they had established themselves as a

powerful organization that maintained control of the South (Brown 5). Simply put, the KKK aimed to “rescue” the South from the “negro rule” by protecting the racial order through violence, most clearly through the public lynching of black men (Cox 104).

In 1889 when Republicans briefly sought to restore Black enfranchisement, the KKK embodied the Southern social antagonism against this idea of “negro rule” and organized lynching at Confederate monuments in public spaces (Heather 464). The belief that rights for African-Americans would come at the expense of White rights was widespread and the purpose of the KKK was to maintain the social order of superiority (Cox 107). In 1904, Luther Holbert and his wife were publicly lynched in Mississippi in front of a crowd of 1,000 onlookers (Ifill 1). The normalcy of violence and mistreatment of Blacks through public lynching pervaded the consciousness of White Southerners, emboldening their outspoken White supremacy, and deprived Black individuals, who were subjugated into a position of inferiority reinforced by terror.

The KKK was adamant about their goals and therefore courthouse lawns, spaces where the LMA and the UDC erected Confederate monuments, served as deliberate venues for lynching. The KKK asserted its dominance with the acquiescence of local law enforcement and wielded immense power in the South (Ifill 9). Lynching at monuments and near monuments showed an increase in more outwardly violent and provocative action by White Southerners. Even sheriffs, who were supposed to embody justice, were complicit in lynch mobs initiated by KKK groups (Cox 21).

This signal of a new era was especially notable during the 1900s to the 1920s when Confederate statues became increasingly symbolic reflections of and precursors to Jim Crow Laws (Henderson et. al. 42). Perhaps the most provocative narrative that exhibits this shift is the 1913 speech made by Julian Carr, an outspoken Ku Klux Klan member. Formerly located in Chapel Hill at the University of North Carolina, the statue of a Confederate soldier, Silent Sam, was built by the UDC (which had named many other buildings on the college campus in honor of other Confederate figures) (Watson 3).

Carr utilized the event and the people gathered to his advantage to talk about Lost Cause (Hass 34):

their [Confederate soldiers] courage and steadfastness saved the very life of the Anglo Saxon race in the South – When “the bottom rail was on top” all over the Southern states, and to-day, as a consequence the purest strain of the Anglo Saxon is to be found in the 13 Southern States – Praise God.... One hundred yards from where we stand, less than ninety days perhaps after my return from Appomattox, I horse-whipped a negro wench until her skirts hung in shreds, because upon the streets of this quiet village she had publicly insulted and maligned a Southern lady, and then rushed for protection to these University buildings where was stationed a garrison of 100 Federal soldiers. I performed the pleasing duty in the immediate presence of the entire garrison... (Hass 34)

Initially, Carr explained the concept of “negro rule,” praising the Confederate soldiers for their honorable role in maintaining the supremacy of Whites in the South. In front of thousands of people in a monument unveiling that occurred on the grounds of the University of North Carolina, the fact that Carr found it appropriate to give an anecdote about how he performed such an act underscored Southern acceptance of society’s development of anti-Black normalcy.

In the wake of racial violence and a complete lack of basic civil liberties, Black Americans were further cemented in a permanent state of degradation amidst the towering construction of Confederate monuments which demoralized their hopefulness during the Reconstruction. African-Americans were stunned and silenced during the construction of the monuments. Especially in cultural ceremonies such as the 1890 Robert E. Lee Monument unveiling in Richmond, African-American reaction was dejected (Cox 44). The Richmond Planet, Richmond, Virginia’s leading African-American newspaper, published an article on May 31st, 1890 in reaction to the ceremony of the monument:

Thursday, 29th was a memorable day for Richmond. Never has such a pageant assembled within its confines. Confederates from New York to Texas were in the parade and it took hours for them to pass a given point. We venture the assertion that nowhere in the South has a grander parade taken place... Rebel flags were everywhere displayed and the long lines of Confederate veterans who embraced the opportunity and attended the reunion to join again in the rebel yell” told in no uncertain tones that they still clung to theories that were presumed to be buried for all eternity. These emblems of the “Lost Cause,” many of which had been perforated by Union bullets were carried with an enthusiasm that astounded many... The Richmond “Dispatch” of Thursday placed General Lee even above Washington and Grant. After the unveiling, the artillery fired salute after salute. The unfinished City Hall building was covered with one mammoth Confederate flag which extended the whole length of the building. The South may revere the memory of its chieftains. It takes the wrong steps in so doing, and proceeds to go too far in every similar celebration. It serves to retard its progress in the country and forges heavier chains with which to be bound. All is over (Bonnis et. al. 1).

“All is over” summarized what Reconstruction meant and the fleeting freedom experienced by former enslaved people who had earned freedom and had been subjugated to the same system of oppression all over again. The widespread support for the statue, including the arrival of Confederate sympathizers from New York, showed how White Southern supremacy and Confederate values had pervaded the United States. Furthermore, the ubiquity of Confederate symbols emphasizes the celebratory nature of the unveiling events.

Carr’s speech at Silent Sam’s monument and the Richmond Planet’s crestfallen reaction to the Richmond Monument are only two microcosms indicative of a much wider movement of violence and anti-Black degradation associated with the Confederate monuments. As African-Americans all over the South were expelled from politics and cemented into a new form

of subjugation, monuments served as ammunition for the White South to reassert White hegemony. Placed near buildings of law and education and spaces for lynching, Confederate monuments were powerful tools that both envisioned and created a South for Whites, reminiscent of the Confederacy yet notably different. Southern identity for decades thus became synonymous with disenfranchisement, misrepresentation of Blacks, Black inferiority, and collective authoritative and extralegal violence preserving all but slavery.

While the memorial efforts to construct Confederate monuments in the South were a result of determined efforts by the LMA and UDC, the North and its actions (and inactions) were essential to the ability of Confederate monuments to thrive. Although the North fought the South and sought to transform it, the tribulations of Reconstruction and its end in 1877 marked the end of Northern concern about the goings-on in the South. Paradoxically, over time Northern attitudes shifted from indifference to active support.

Starting in the 1880s, attitudes in the North began to shift when former Union and Confederate veterans resolved sectional differences in veteran reunions, leading to an increased acceptance of the Lost Cause (Brown 8). Although in subtle ways at first, such as mild admiration for Confederate figures, the increasing acceptance of Confederate culture demonstrated the establishment of a White consensus about the narrative of the Lost Cause in both Northerners and Southerners (Hartley 8). For example, the Northern veneration of former Confederate General Robert E. Lee led to a monument of him being put into the U.S. Capitol Building (Brown 11). This shift in Northern attitudes occurred at a time when Confederate monuments were being built at an unprecedented rate, signaling that the South had been triumphant in restoring the pre-Civil War racial hierarchy. While slavery had been abolished, the White supremacy of the South persisted (Henderson et. al. 5). Not only did this lead to the loss of freedom and protection for Black individuals across the South, but it also normalized a distinct post-Civil War degradation in a changing Southern landscape.

Conclusion

While the peak of the monument construction era has long passed, the impact of monuments continues to this day. It is rare to find resistance to these monuments at the time of their construction, but it is important not to overlook the role of Black statesmen and Black freedmen who sought to remove the weaponization of memory for the Confederacy. In addition to efforts from African-American statesmen, prominent African-American scholars such as James Baldwin outlined the injustice of preserving the Lost Cause. He wrote, “The fact that Americans, White Americans, have not yet been able to do this - to face their history, to change their lives - hideously menaces this country. Indeed it menaces the entire world (Baldwin 181).”

The culture of racism that monuments embody seeped into not just Southern society but overall American society. The persistent ideology of the preserved Confederate values reinforced by the monuments and their close connections were felt until the 1970s as segregation in the South persisted for some schools, despite legislative changes (Cox 23). In towns and counties where there existed at least one Confederate monument, the gap in Black to White poverty on

average increased by a scale of 0.1 when compared to counties with zero Confederate monuments (O'Connell 471). This data shows that monuments were reflective of an area's racial and economic hierarchy, with some areas much more heavily favoring Whites. These poverty levels become more extreme given Confederate monuments with Lost Cause inscriptions are located in former slave areas, indicating that in areas where there was an effort to preserve the Confederacy's cause and advocate for its return, African-Americans were hindered even more from achieving basic rights (O'Connell 471). The establishment of Confederate monuments throughout the South and their preservation thereafter bonds the present United States to the past Confederacy. The preservation of a glorified image of the Confederacy and the erection of statues that celebrated the Lost Cause were extraordinarily damaging for Black Southerners in the coming decades.

Today, spaces and landscapes that symbolize racial inequality have camouflaged well into the infrastructure of modern society. Efforts to remove the symbols of the Confederacy and thus disarm the power of Confederate legacy have been an ongoing process bolstered by larger cultural movements such as the Black Lives Matter Movement. As building the monuments reflected society, the efforts of protestors organizing to combat racism reflect a new society in which more voices are heard. While there are many advocates for the continued presence of monuments, most notably former President Donald Trump, the movement to dismantle them in our current society reveals how Confederate monuments and their landscape continue to be contentious (Trump 1).

Removal of Confederate monuments in the 21st century, like the erection of them, has been a tool used to symbolize a tangible form of protest against systematized racial injustices that continue to exist today. Since a racially motivated massacre in Charleston, South Carolina in 2015, over eighty monuments have been removed from public spaces all across the United States (Hartley 5). Whether toppled by protestors forcefully, relocated to museums, or put elsewhere, the significance of removing the Confederate monuments from public sight is a step toward eliminating tolerance of the blatant displays of pride and glorification of the Confederacy and what it stood for. Although it is undeniable that the U.S. has made progress in living up to the ideals of the Founders, there remains much work to be done (Hartley 5).

In hindsight, it's paradoxical that Confederate monuments achieved success even though they celebrate not victory, but defeat. Yet, the extensive memorial efforts for the Confederacy underscored the enduring cultural resilience of the Confederacy and the successful restoration of White power in the South that was pliable to change.

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Public Policy Simulation Using Monopoly By Sheng-Ying Sofia Lim

1. Introduction

1.1 Discussions about Inequalities

Adam Smith states, in *Wealth of Nation*, that “there is great inequality wherever there is great property. For one very rich man, there must be at least five hundred poor, and the affluence of the few supposes the indigence of the many.” That diminishing wealth inequality remains one of the United Nation’s goal is evident it poses a significant obstacle to our society, which has benefitted from Industrial Revolutions and technological advances, and yet, continues to be plagued by millions living below the poverty line. Wealth inequality undermines economic development and social cohesiveness, augments poverty, reduces social mobility, and heightened social unrest. In my investigation into the issue of wealth inequality, I ask the question what determines “who” lives in poverty and “who” manages to escape from poverty. I start by exploring public policies as governmental interventions can be effective tools to tackle social economic issues such as poverty.

I chose MONOPOLY to conduct my investigations, and in this regard, considered the Gini coefficient, a widely used measure of economic inequality. Higher values (closer to 1) show higher levels of inequality. The latest United States (US) Gini Coefficient was 0.47 in 2022, whereas the forecasted values for Singapore and Denmark for 2024 is 0.38 and 0.27 respectively. Relative to other countries, Singapore and Denmark exhibit lower economic inequality rates. I have chosen them as case study countries in my MONOPOLY simulation.

That said, being aware that there is no one-size-fits-all set of social policies, this simulation is only intended to serve as a starting point, and a dynamic pedagogical tool for students to study the effect of governmental intervention policies in closing the wealth gap, in a game environment. It is further hope that my investigation would prompt or contribute to current discussions on public policy responses needed for wealth inequality in our world.

1.2 Background on Monopoly : Using Monopoly as a Simulation

MONOPOLY is an iconic economic themed board game that started off as “The Landlord’s Game” which was created and developed by Elizabeth Magie in 1903 with the aim of showing the negative effects of land monopolism. It was further developed and patented by Charles Darrow in 1935, who then sold it to the Parkers Brother. Today, it is enjoying international popularity and is synonymous with competition, strategy and bankruptcy. MONOPOLY has historical and economic connections, further expanding to different versions spreading across pop culture and historical sites such as the Barbie and British edition.

As a pedagogical tool, MONOPOLY provides a controlled setting to observe various economic events, including assets and debt acquisition, liabilities as renter, mortgage transactions, and bankruptcy. The game illustrates key economic and financial concepts such as monopoly, oligopoly, competition, and bankruptcy through players’ strategies, making

MONOPOLY an appropriate simulation tool to investigate the impact of different social policies, such as housing grants and progressive taxation.

Given MONOPOLY's original design to illustrate negative relationship between landlords and renters, it is appropriate to utilise simulations of MONOPOLY to explore social policies impact on wealth gap closing. Additionally, we utilise data from US to construct the controlled settings of the simulation.

The two simulations aim to show, in a controlled setting, how different social policies impact outcomes of wealth accumulation in a simulated American economy, and thereby contribute to closing the wealth gap. We accomplish this by comparing the wealth each player accumulated over ten rounds of MONOPOLY. Each player's wealth was calculated and defined by the sum of the total liquid MONOPOLY cash (M) each player held and the total value of all assets owned by that player. This included railroads, utilities and 'Get out of Jail Free' cards. If a property was mortgaged, then its value would be symbolically discounted by half.

2. Rising wealth inequality in developed countries revisited - price elasticity and demands in the housing market

MONOPOLY's main goal is accumulating wealth through land and property acquisition. Juxtapositioned against this, we turn to consider obstacles to property acquisition in real life. In this regard, the correlation between price elasticity of housing in demand and supply underscores how equilibrium shifts when increase in supply and demand is not proportionate. **Price elasticity of supply** is defined as the reactivity in the supply of a product to changes in the price of the same product. **Price elasticity of demand** is defined as the reactivity of demand to changes in the price of the goods/service.

The price elasticity of **supply** in the housing market is relatively inelastic. This is because, for example, the time required for a house to be built has a mean of nine months, whilst the mean time to build an apartment block is 18-24 months, the supply cannot react quickly to changes in price. Considering the price elasticity of **demand**, housing is typically a necessity as a "shelter" or "home"- unless it is a second (or more) property (as an investment). Whilst there is a high percentage of home ownership in countries like the United Kingdom and most people need a place to live, the rental market is a substitute for home ownership so therefore housing can be considered to have a higher price elasticity of demand relative to supply. Additionally, the cost of homeownership is extremely high and takes up a substantial proportion of people's income. However, those in a higher income class are likely to have a relatively more inelastic price elasticity of demand than those in a lower income class as housing is likely to take up a smaller proportion of their income. But, if they are buying a second property, they might have a relatively more elastic price elasticity of demand as the second home is an investment, not a necessity, but this will be abstracted from in the future theoretical analysis of government interventions.

2.1 Singapore: Housing Grant

Singapore has developed a unique housing system, with 80% of population living in homes built by the Housing and Development Board (HDB) and over 89% of the population owning a home, making it amongst the highest home ownership economies in the world. Singapore's approach to housing grants through the HDB is aimed to provide financial assistance to first-time homebuyers, especially Singaporeans or permanent residents, who are looking to acquire a new HDB flat. It is designed to help households with low incomes afford a home without financial support. The grant is subject to income eligibility, supply of newly built HDB flats, and is not for resale or private property. The grant comes with certain restrictions and conditions, such as a minimum occupancy period before selling the property. This policy has been pivotal in ensuring social stability and establishing a cohesive national identity. It is anticipated that the expansion of homeownership will moderate real estate prices, elevate living standards, and reduce economic disparities.

2.2 Denmark: Progressive Tax

Denmark, Sweden, and Norway have a progressive tax system where higher income individuals pay higher tax rates. This system aims to promote wealth equality, share wealth, and fund social welfare programs through various tax brackets. In Denmark, progressive taxation plays a significant role in redistributing wealth, reducing wealth inequality, and supporting social welfare programs such as healthcare and education. It aims to create a sense of unity in society by encouraging those with means to contribute more for the greater good. Additionally, progressive taxation helps stabilize the economy by boosting consumer spending by lower-income individuals. That said, it poses challenges such as potentially discouraging entrepreneurship and investment, as well as concerns about tax evasion. Despite these obstacles, progressive taxation is part of the economic fabric of Denmark for promoting social fairness, funding public services, and maintaining economic stability.

3. Methodology of Simulation

3.1 Setting up the Investigation.

The simulations used an altered version of MONOPOLY to test different government policies' effect on the three income classes in the US and represented by different players:

- top 20% income bracket (**Cat**),
- median income bracket (**Duck**), and
- bottom 20% income bracket (**Dog**).

Overview and summary of the MONOPOLY rules.

1. Each player starts off with 1500 ₧ (₧ being MONOPOLY currency) and is represented by a MONOPOLY piece (Cat, Duck or Dog).
2. Once a player lands on a property/railroad/utility, they must buy it, or it goes on auction for other players to have a chance to buy it.

3. If a player lands on another player's property, they must pay them rent (usually 10% of the property's value)
4. Every time a player passes 'GO' they collect 200M as their wage.
5. Win by being the last player standing, with everyone else having been bankrupted.
6. The results were obtained by three players representing three designated income brackets (Cat, Duck or Dog) with the altered rules, settings and variables.
7. For each trial, the game was played until Cat passed 'GO' for the tenth time. After Cat landed on/ passed 'GO' each time, each player's total wealth was recorded.
8. The total wealth was the value of cash that each player held and the total value of all the property they owned.
9. If the property was mortgaged, the value of the property would be halved.

This process was repeated five times for each trial to ensure more reliable and representative overall results.

Some of the settings of the MONOPOLY game had to be changed to fit the purposes of the investigation, such as altering the starting values that each of player receives; altering the wage values, i.e., how much money each player would receive upon landing on or going past the 'GO' block, and making assumptions about the demographic of the population that would be looked at.

Firstly, when choosing the representative age, multiple factors had to be taken into account: the amount of money that people of that age would have saved in a bank account, and whether or not there would be a large range of incomes to be studied and used in the investigation. The age found to be most appropriate and that filled all the necessary criteria was 30 years old. All of this was checked using CNBC and Forbes Advisor which had previously collected data on the amount of money different age ranges had saved in their bank accounts as well as the ranges of annual salaries.

Secondly, when choosing how to allocate the right monetary values to each player, prior research was necessary to understand how large the ranges should be. The result was Cat represents the mean of those in the top 20% income bracket in the US; Duck represents the median of all income, and Dog representing the mean of those in the bottom 20% income bracket. In contrast to the mean used for the top and bottom 20% of incomes for Cat and Dog, the median was used for Duck. This was more appropriate than using the mean because the mean value would be skewed by a small number of people who earned an incredibly high amount in the USA such as billionaires.

Thirdly, for the starting values which were reflected to be the savings value of each income bracket, mathematical coding was used to achieve simplified values to allocate to each income class player. For Cat, the original value, which was taken from Forbes Advisor, which conducted its own research, was US\$131,632. The Value was then converted from US\$131,632 to \$1320M by dividing by 100 and rounding to the nearest 10. They were US\$8,656 and US\$2,223.75 for Duck and Dog which were then mathematically converted in the same way as Cat to \$90M and \$20M respectively.

Fourth, for the wage values which were used to represent the monthly wage of each of the players, mathematical coding was also used to get values which could be used in the MONOPOLY game and would be appropriate considering the prices of each of the blocks. The wage values were used to determine the amount of ~~M~~ that each player would receive once reaching or passing the 'GO' block. In the original MONOPOLY game, this would be \$200~~M~~, however it was changed to more closely resemble the US economy: Since we are interpreting these as wage values, this amount varies from player to player as Cat who represents the top 20% income bracket would not be receiving the same wages as someone in the bottom 20% income bracket. The original values were taken from Yahoo! Finance which did their own survey and published their results. The different players' wage values were all converted from the values taken from Yahoo! Finance in the same way as the starting values. Maintaining a consistent conversion method was crucial to ensure result reliability and making the investigation as realistic as possible. The values were converted from US\$10,878.75, US\$5,416.60 and US\$2223.75 to \$110~~M~~, \$55~~M~~ and \$20~~M~~ for Cat, Duck and Dog respectively by dividing the original values by 100 and rounded to the nearest 5. This had to be done as, if the values were not rounded, the time taken to test each trial would take even longer and would be more prone to errors.

Furthermore, the order of which players would go first was decided by income class. So, Cat would roll the dice first, proceeded by Duck and then Dog. This was decided as in real life, those in a higher income class often hold an advantage when purchasing property due to having more money to begin with as well as information about the property market perhaps through having specialised consultants or agent giving them more information than would be available to the public, whereas those in a lower income class might suffer from information gaps in comparison. Hence leading to Cat going first and Dog going last in the investigation.

3.1 The Control Trials

For the Control trials, which were run with three constant people representing one income class each, some of the basic settings of the MONOPOLY game were altered to provide a baseline to compare the different government intervention policies. There were no policies implemented here but the altered starting and wage values were used to simulate the American economy without implementing any extra government policies.

The results of the Control Trials were that Cat had increased its wealth from \$1320~~M~~ to \$2156.8~~M~~, an increase of 63.39%. Duck increased its wealth from \$90~~M~~ to \$360.6~~M~~, an increase of 300.67%. Finally, Dog showed a decrease in their wealth from \$20~~M~~ to -\$14.8~~M~~, a change of -174.00%. A player could end up with a negative net wealth as this would be the residual amount that they owed after handing over all their assets and cash. In this case, Dog unfortunately landed on one of Cat's properties and was not able to pay the rent. This took place in 4 out of the 5 trials, resulting in the negative mean value.

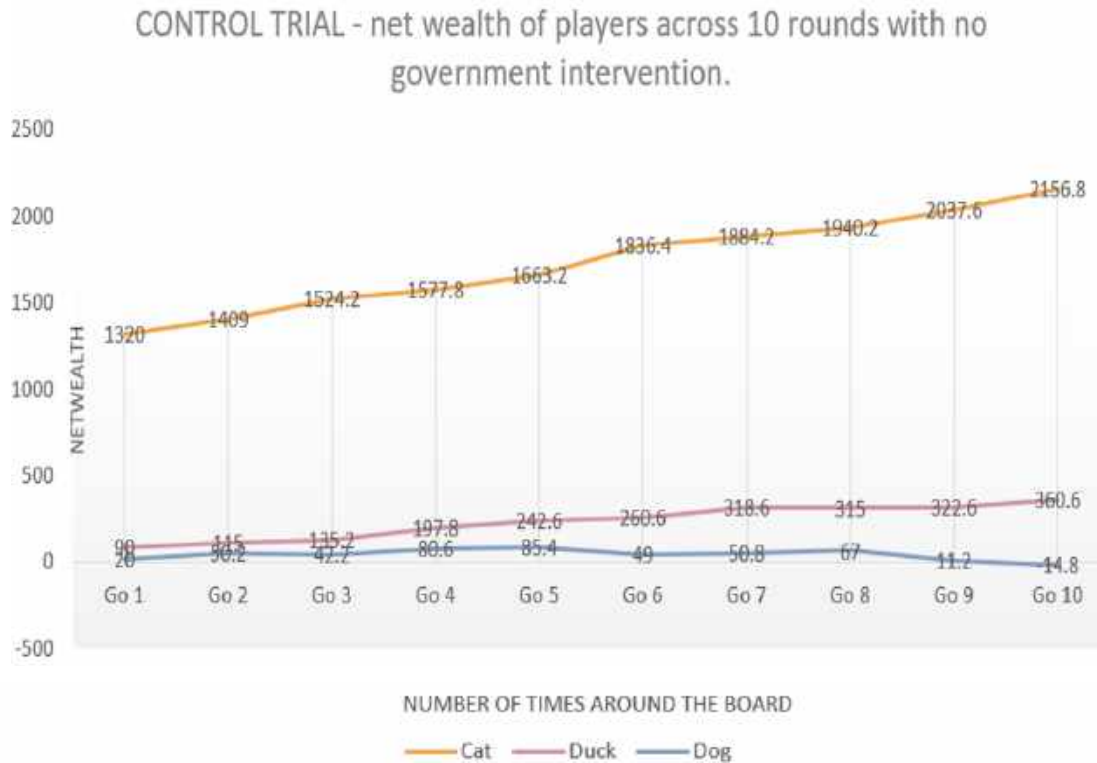


Figure 1: The net wealth of players across 10 rounds without Government intervention

The more property a player owns, the higher the chance that other player would land on their property and therefore the higher their earnings from rent. The results of this are easily seen by the graph above which shows the progression of wealth from the three different income classes.

It was expected for Cat, which represented the highest income bracket to end up with the most wealth at the end of the 10 rounds. This was proven to be true with the results from the investigation as shown in the graph above. For Duck, which represented the median income, the relatively smaller increase in wealth was also expected as they started off with a smaller amount, meaning that they would not be able to afford as many properties as Cat to begin with, which was a limiting factor. For Dog, the result was unfortunate, but also expected considering that Dog started out with less money than required to even buy the cheapest property on the MONOPOLY board which cost 60M.

Furthermore, Cat had an advantage over both Duck and Dog; and Duck had an advantage over Dog in terms of the amount of M that they collected as their monthly wage from passing/landing on the 'GO' block. Since Cat collected the most, followed by Duck, then Dog this meant that as time passed, Cat naturally accumulated more wealth and could therefore increase the income gained from rent as they purchased more properties. The same goes for Duck compared to Dog.

Since the property that was landed on was randomised by the dice, this meant that it was quite hard to involve strategy for any of the players. However, in a situation where Cat or Duck,

who both had the funds to buy the cheapest property should they land on it, did actually buy the cheapest properties (e.g. Mediterranean Avenue and Baltic Avenue), this would push the cheapest properties available for Duck to buy all the way from costing 60M to 100M. Considering that Dog, only earned 20M each time they passed/ landed on 'GO' this would mean that they had to go around the board twice before being able to have the funds to purchase the next cheapest property, and this is on the off-chance that Dog does not land on any properties that are owned by Duck or Cat. Since the chances of Dog not landing on any Cat/Duck owned property are very low especially as the game progressed, the lowest income class are often stuck in a cycle where once they have enough funds to purchase the next cheapest property, the funds are either taken up by necessities such as rent, utilities and food costs, or the property/asset is bought out by someone who readily has the funds necessary, showing the poverty cycle.

An anomaly with the results was when Dog did not end up with negative wealth at the end of the game, instead staying at the same wealth from the beginning to the end. This was caused by an (un)lucky streak where Dog landed in Jail and unfortunately stayed in jail till the end of the game as they could not roll two double numbers in a row. This could also be seen as quite lucky as Dog finished with its individual highest net wealth in this specific trial. The fact that Dog staying out of negative wealth was firstly such a rare occasion and that it came about due to landing in jail shows two extreme and negative outcomes.

3.2 Singapore Housing Subsidies Set-up

This policy was inspired by the CPF Enhanced Housing Grants (EHS) from Singapore which were targeted those who earned a lower income in Singapore so that they could afford housing. Singapore was chosen as considering its small land area, and substantially large population, it would have to find innovative ways to provide housing for its citizens without making it seem unfair to those who had to afford it themselves without the housing grant. This, combined with its relatively high GDP/capita meant that it was an ideal country to look to for a method of decreasing the wealth inequality gap. In Singapore, the CPF EHS is offered to first time home buyers to apply for. When implementing it into the investigation the characters were given the Housing Grant at the beginning of the game. Duck and Dog, who have an average monthly household income of US\$5,416.60 and US\$2,223.75 respectively, each received a housing grant of US\$48,340 and US\$14,840. These housing grant values were then mathematically coded using the same method as the income by dividing by 100, thus leading to Duck and Dog's housing grant values in M terms to be \$148M and \$483M, respectively.

PROPERTIES & THE HOUSING GRANT VALUE	
Average Monthly Household Income (Over a period of 12 months)	Enhanced CPF Housing Grant Amount
Less than \$1113	\$59360
\$1114 to \$1484	\$55650
\$1485 to \$1855	\$51940
\$1856 to \$2226 (Dog fits here)	\$48340
\$2227 to \$2597	\$44520
\$2598 to \$2968	\$40810
\$2969 to \$3339	\$37100
\$3340 to \$3710	\$33390
\$3711 to \$4081	\$29680
\$4082 to \$4452	\$25970
\$4453 to \$4823	\$22260
\$4824 to \$5194	\$28550
\$5195 to \$5565 (Duck fits here)	\$14840
\$5566 to \$5936	\$11130
\$5937 to \$6307	\$7420
\$6308 to \$6678	\$3710



Figure 2: Table showing the Enhanced CPF Housing Grant Amount compared to average monthly household income

In contrast to subsidies which are usually given to suppliers and producers of goods/services, the housing grants would be given to the households, therefore giving a different supply/demand curve compared to the usual subsidy graphs. The relevant subsidy graph can be seen below. The demand curve shifts rightwards as more consumers have the ability to buy the properties, whereas the supply curve does not shift since no new homes are being built. However, it does cause an eventual extension in supply.

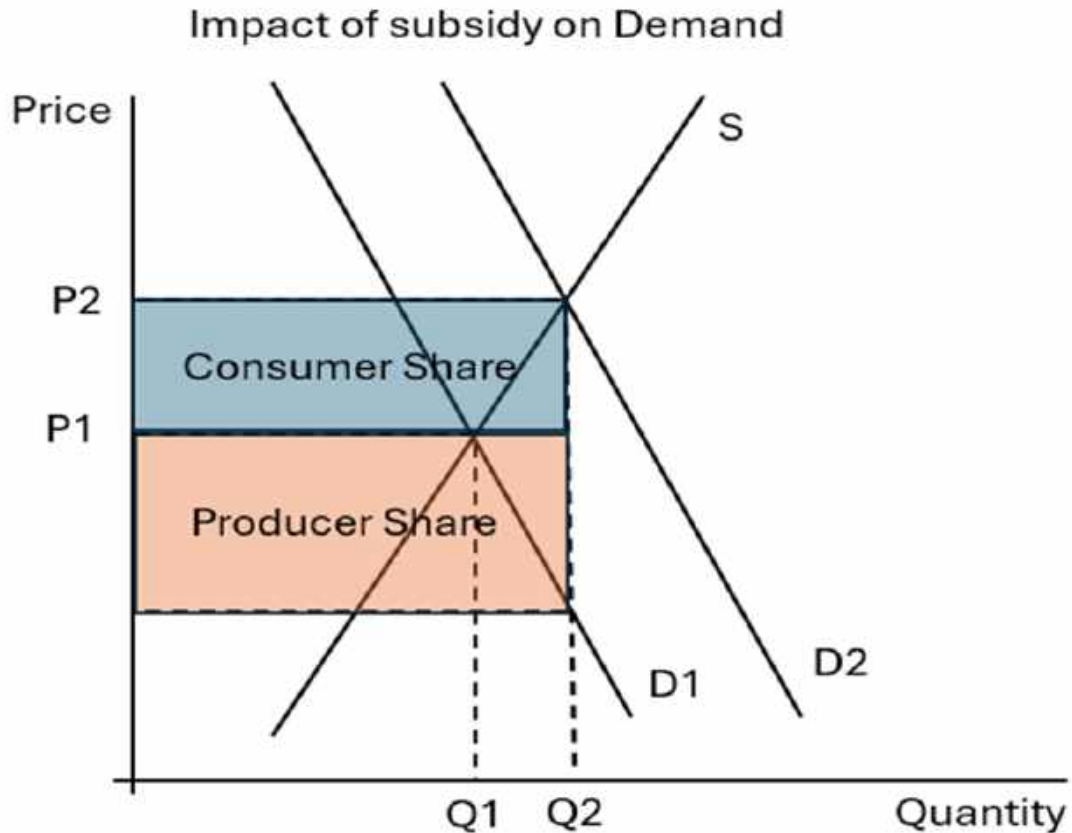


Figure 3: Graph showing a demand-supply diagram with the impact of a subsidy on it

In the subsidy graph shown, the demand curve shifts rightwards. This is different from the typical subsidy graph observed where the supply curve usually shifts rightwards. In this case, the demand curve shifts because the subsidy is given directly to the consumer rather than the producer, meaning that the quantity demanded will be higher for any given house price. This is shown in the diagram above where the demand curve shifts rightwards from D1 to D2 and leads to excess demand at the current price level. This pushes the price upwards from P1 to P2 resulting in an expansion in supply and a new equilibrium at Q2,P2. The graph also shows how the subsidy affects consumer and producer surpluses. Considering that the PES is relatively more inelastic than the PED, the producer takes on more of the subsidy compared to the consumer. So, the subsidy might not have as much of an effect on the consumer as aimed. However, in this investigation, the price of the properties on the MONOPOLY board were not changed. This is because the PES is perfectly inelastic on the MONOPOLY board as new properties cannot be invented and put onto the board. This resulted in the total incidence of the subsidy going to the eligible consumers (Duck and Dog) as can be shown in the graph below where Duck and Dog's wealth increased substantially compared to Cat's. It also led to the interesting observation where Dog's net wealth surpassed that of Cat's.

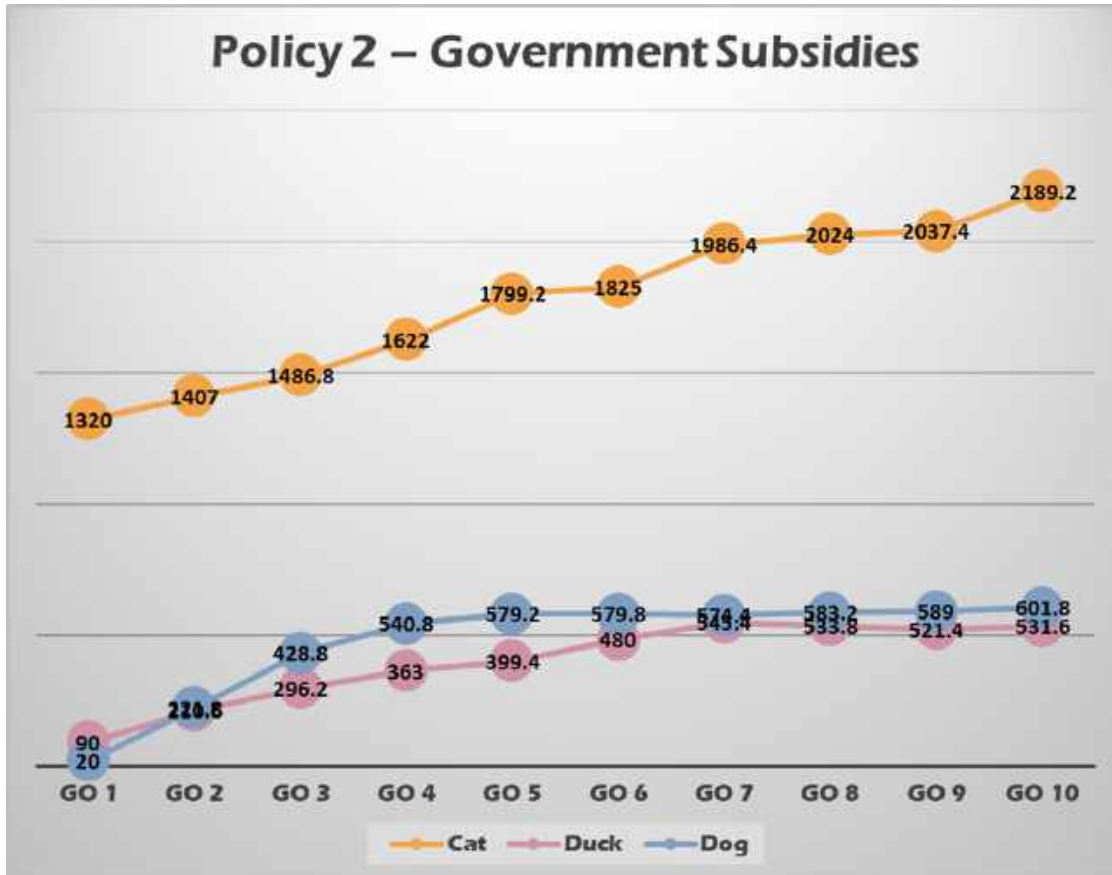


Figure 4: The net wealth of players across 10 round with Government subsidies (housing grants)

3.2 Denmark Progressive Tax Set-up

In this Policy, the tax is a percentage of the price of a property that the government requires for the characters to pay once they reach/pass the ‘GO’ block. In real life, progressive taxes (e.g. in the UK) would work on the basis that there would be a personal allowance which would not be taxed at all, then the tax percentages would increase as a person moved up a tax bracket. The tax percentage, however, would only apply to the additional value that sits within the higher tax bracket. In this MONOPOLY investigation, for the sake of more obvious and observable results, this system was changed such that the tax would not act on the additional value within the higher tax bracket, rather it would act on the entire value of the property. Furthermore, in contrast to real life where the property tax is usually paid once, when the property is bought, the players in the MONOPOLY investigation would pay the tax every time they reached/ passed the GO block similar to a council tax in the UK. This was so that any results from the progressive tax rate could be more obvious and observable. The different properties, their implemented tax rates on the properties and an additional house are shown

below.

PROPERTIES & THE IMPLEMENTED TAX RATES			
Property Name	Property Value (M)	Implemented Tax Rates	Implemented Tax Rates + 1x House
Mediterranean A.	60	1	1
Baltic A.	60	1	1
Oriental A.	100	1	1
Vermont A.	100	1	1
Conneticut A.	120	1	2
St. Charles P.	140	1	2
States A.	150	1	2
Virginia A.	160	1	2
St. James P.	180	2	3
Tennessee A.	180	2	3
New York A.	200	2	3
Kentucky A.	220	7	11
Indiana A.	220	7	11
Illinois A.	240	7	12
Atlantic A.	260	8	12
Ventnor A.	260	8	12
Marvin Gardens	280	8	13
Pacific A.	300	9	15
North Carolina A.	300	9	15
Pennsylvania A.	320	10	16
Park P.	350	11	17
Boardwalk	400	12	18




Figure 5: The different properties on the MONOPOLY board compared to their property values, implemented tax rates, and the implemented tax rate with an additional house

For example, properties valued up to \$200M were taxed at 1%, whereas properties valued above \$200M were taxed at 3%. The tax values for a property along with a house were calculated by multiplying the sum of both the property and the value of a house on the property by the relevant tax rate of 1% or 3%.

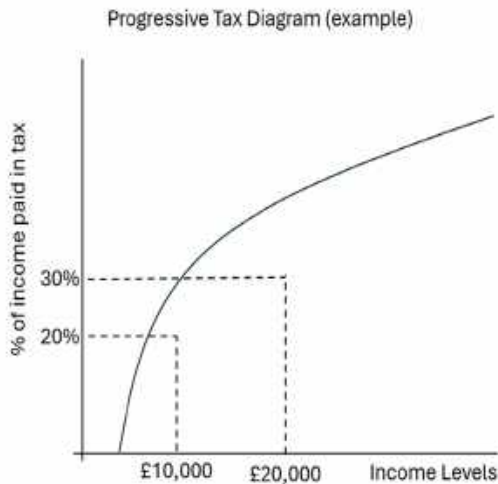


Figure 6: Diagram showing the effect of progressive tax on income levels

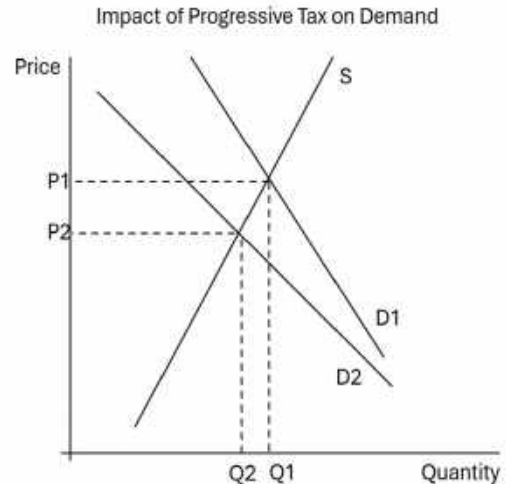


Figure 7: Diagram showing the effect of progressive tax on a demand-supply diagram

A supply-demand graph would show the demand curve shifts rightwards. This is different from the typical ad valorem tax graph observed where the supply curve usually pivots outwards. In this case, the demand curve shifts because the tax is placed directly on the consumer (households) rather than the producers (property developers), meaning that the quantity demanded will be lower for any given property price. This is shown in the diagram above where the demand curve shifts leftwards and pivots outwards from D1 to D2 which leads to insufficient demand at the current price level, pushing the price downwards from P1 to P2, resulting in a contraction of supply and a new equilibrium at Q2,P2. The graph also shows how the progressive tax affects consumer and producer surpluses. Considering that the PES is relatively more inelastic than the PED, the consumer takes on more of the tax than the producer. So, the tax has quite a large effect on consumers. However, in the investigation, the price of the properties on the MONOPOLY board were not changed. This is because the PES is perfectly inelastic on the MONOPOLY board as new properties cannot be invented and put into the board. So the total incidence of the tax fell onto the consumers (all three players: Cat, Duck and Dog), which emphasised the results more.

For the first variable that was tested: Denmark's Progressive Property taxes, all variables were the same as the control trial, except that whenever the players reached/passed the 'GO' block, they would firstly receive their monthly wages, then pay the applicable taxes on their properties back to the MONOPOLY bank.

This policy affected Cat and Dog the least. This made sense as Cat had the most funds and was the only one able to buy the most expensive properties which also came along with higher rents and the higher tax of 3% compared to the regular 1% on other properties. This can be seen through the results of the trials as shown through the graph below.



Figure 8: The net wealth of players across 10 rounds with progressive property taxes

During these trials, Cat’s growth in wealth was a lot more limited. In contrast to the mean original growth in wealth of 63.39% in the control trials, Cat’s mean wealth growth with the progressive tax policy was 51.48%, going from \$1320M to \$1999.60M. The progressive tax rate also benefitted Duck and Dog more as they both experienced higher rates of wealth growth. Duck had a mean wealth growth of 372.44% from \$90M to \$425.2M compared to the previous mean wealth growth of 300.67%. Dog had the most noticeable change out of the three different income classes, completely changing from being left in negative wealth, to rising to have a positive wealth with a mean wealth growth of 1,597% going from \$20M to \$339.40M. Compared to the previous mean wealth growth of -174.00%, this is a substantial change, showing positive effects of the progressive tax rates.

4. Analysis and Conclusion

4.1 Control vs. Singapore

Due to the nature of the housing grants, they mainly benefitted Duck and Dog as they were the only two players eligible for the housing grant. However, Cat was indirectly affected. Since Duck and Dog were able to afford more properties during these trials, more properties were bought up by them. Wealth redistribution occurred and Cat accumulated property at a much slower rate, as seen through Cat’s wealth lines in the different graphs. There is a decrease in the wealth inequality from both ends using the housing grants.

4.2 Control vs. Denmark

In the trials where the progressive property taxes were tested from Denmark, they affected all three players because every player bought property, they were all subject to

progressive tax. That said, the tax did not affect Cat as much and the only negative impact is reduced wealth accumulation as contrasted to the controlled trial by -7.29% (3 sig. figs).

4.3 What Do These Results Suggest?

4.3.1 Comparing the simulation of the two government policies.

Specifically, a progressive tax scheme modelled on Denmark's and a housing subsidy scheme modelled on Singapore. The results of the experiments showed that there were substantial changes in the final accumulated net wealth of the three different income classes, with the median and lower income class having greater net wealth than in the control trials. However, the player represented by playing piece Cat, who represented the top 20% income bracket, still ended up with substantially higher net wealth in all trials.

Between the two, housing subsidies (Singapore scenario) appear to support both social equity and economic vitality better than the progressive taxation model (Denmark scenario). Subsidies facilitated more inclusive economic participation without the destabilizing effects observed with high tax rates.

The control setup and the Singapore scenario were directly compared to evaluate the impact of housing subsidies. The Singapore setup resulted in higher overall asset accumulation and fewer bankruptcies, suggesting that such subsidies can provide economic stability for lower-income classes without reducing the financial incentives for property acquisition and development.

When comparing the control setup with the Denmark scenario, the introduction of progressive taxation led to a significant **reduction in total assets and an increase in bankruptcies**. This indicates that while progressive taxation can effectively minimise wealth disparities (as seen by the smaller cash differences between classes), it may also dampen economic incentives if not implemented with careful balance.

The two different government intervention policies and the control trials provided different results regarding the three players; Cat, Duck and Dog.

In the trials where the progressive property taxes from Denmark were applied, they affected all three characters: Cat, Duck and Dog. Because every single one of the players bought property, they were all subject to the tax. However, the tax did not seem to affect Cat that much even though their net wealth was lower here in contrast to their net wealth in the control trial.

On the other hand, when the housing grants from Singapore were tested, due to the nature of the housing grants they mainly directly affected Duck and Dog as they were the only two players eligible for the housing grant. However, Cat was indirectly affected. Since Duck and Dog were able to afford more properties during these trials, more properties were bought up by them. This meant that Cat was not able to increase their wealth as much as they were not able to buy up as much property as they previously did. This resulted in a decrease in the wealth inequality from both ends using the housing grants.

4.3.2 Comparison to Real-life Results

The effectiveness of Singapore's housing policies in real life, such as broad homeownership and social stability, is mirrored in the simulation outcomes. Conversely, while Denmark's real-world application of progressive taxation supports extensive social services, the simulation highlighted potential risks of economic contraction, which are also debated in economic literature.

5. Limitations and Implications

The results of real-life policies can be skewed by external factors such as global economic trends, political decisions, and cultural attitudes, which are not accounted for in this simulation.

One main limitation was that many assumptions had to be made about the choices that each income bracket would make when buying properties on the MONOPOLY board. In MONOPOLY, players have the choice to either buy the property or leave the property to go onto auction, whenever they land on it. Within the MONOPOLY investigation, whenever a character landed on a property, it was assumed that they would buy it, under the condition that they had enough money to do so. However, if the trials were to be more realistic, different preferences would have to be considered. For example, some players might choose to save their money rather than buy a property the moment they can afford to do so as they might be preparing for future events (e.g. recession/ future necessary emergency funds in case of unemployment). These different preferences obviously could not be implemented into the investigation as it would make the process too time consuming and difficult.

Another limitation was that some of the 'community chest' cards such as 'Money Grab' were unrealistic to anything that could happen in real life. The Money Grab community chest card allows for all players to grab as much money as possible when all the reserve money in the Bank is thrown into the air. In one instance, a player 'grabbed' \$800M. When mathematically coding the MONOPOLY values back into real money terms, it translated to US\$80,000, which would be unrealistic and potentially undermine the effect of the policies. In future trials, this card could be taken out to prevent any unrealistic scenarios.

The amount of housing subsidy given to each player was potentially inappropriate as after the ten rounds of MONOPOLY, Dog surpassed Duck in terms of net wealth by \$70M which when mathematically coded back to USD would be around \$70,000 USD, which is a substantial amount and is highly unrealistic. This was an unexpected result and when implemented in real life might cause discontent. Furthermore, the housing grants given might have been disproportionate compared to the property prices on the MONOPOLY board. The property prices on the MONOPOLY board ranged from \$60M to \$400M and the housing grants given to Duck and Dog were \$148M and \$483M respectively. This means that Dog who represents the lowest 20% of income earners would have been able to afford the most expensive property on the board and more with the housing grant. This is extremely unrealistic. Ideally, the prices of each of the properties on the board would have been changed to reflect real life property prices as well.

However, this could have led to another problem of the properties being too expensive even for Cat who represents the top 20% of income earners. This would have led too little to no results coming out of the investigation regarding increases in wealth from property. In contrast, this might have demonstrated the issue of high property prices where even Cat would not be able to afford some of the most expensive properties.

Additionally, each round ended whenever Cat landed on/reached the 'GO' block. This meant that the results of the investigation were highly reliant on the player behind Cat's dice rolls. For example, if the player behind Cat was extremely lucky the entire game and continuously rolled double sixes, a single round would be over within 4 of Cat's turns. This meant that the other players: Duck and Dog would have very little opportunity to buy properties and increase their wealth. This could have also affected the reliability of the investigation as different individual games of MONOPOLY would have had different lengths of playtime, which could have affected the final results of the investigation. This effect could have been somewhat mitigated by counting the dice rolls rather than counting the number of times Cat went around the board.

Future simulations could include more dynamic elements like economic shocks, policy changes, and behavioural responses to more accurately mimic the complexities of real economies.

6. Conclusion

6.1 Summary of Findings

The investigation has demonstrated that government intervention policies such as progressive taxes and housing grants can be effective in reducing wealth inequality even when implemented in a simple set-up such as MONOPOLY. Based on the results from the investigation, the housing grant was the most effective in reducing wealth inequality. Whilst the progressive taxation system did decrease wealth inequality, the change was less than that of the housing grant. Whilst governments would have to consider the implications of implementing taxes and subsidies through cost-benefit analysis, this investigation suggests that they would have a positive impact for those on lower and middle incomes.

6.2 Cost Benefit Analysis of Government Intervention Policy

Housing subsidies are generally beneficial in fostering economic participation among lower-income individuals without large-scale negative economic impacts. In contrast, progressive taxes, while promoting fairness, must be carefully calibrated to avoid discouraging wealth creation.

Cost Benefit analysis can be used to analyse whether a government intervention policy should be implemented (e.g. the progressive taxing and housing grant systems used in the investigation). The steps of using a cost benefit analysis are as follows in the following paragraphs.

First, when choosing a formula to conduct the key calculations, the Net Present Value (NPV henceforth) formula is a common and applicable choice for this investigation. The formula is as follows:
$$NPV = \frac{B}{1+r} - \frac{C}{1+r} - K$$
 Where B represents the benefits, C represents the cost and K represents the initial investment. If the resulting value of NPV is larger than 0, then the service should be carried out and implemented.

Second, all the costs and benefits to substitute into B, C and K must be identified. The Costs and Benefits can be separated along two dimensions: direct and indirect costs/benefits, and tangible and intangible costs/benefits. For example, the administrative costs of implementing a housing subsidy are direct, tangible costs, whereas the societal benefits of having more people owning their home would be an indirect, intangible benefit.

Third, the costs and benefits identified need to be valued. Both the costs and benefits have to be valued so that the numerical values can be substituted into the NPV formula. Valuing tangible costs/benefits are relatively easy as they are simply the market price, whereas valuing intangible costs/benefits is harder as they do not have a set price and hence a value must be given to them based on potential benefits. Usually, market prices for the costs and benefits would be used when available and applicable. However, market prices often are not available or do not accurately reflect the marginal social costs and benefits. So, there are alternative methods to measuring the opportunity costs and benefits of a resource. There are two main methods: revealed preference methods which use information from actual consumer behaviour to infer the value of the goods/services in question, and survey-based methods which ask consumers to rank theoretical goods in hypothetical markets. Examples of revealed preference behaviour include market behaviour, hedonic pricing and travel costs. Whereas an example of a survey-based method is contingent valuation.

Fourth is the aggregation of individuals. Governments have to consider the effect of a policy across all the individuals affected (most of the country's population in the context of this experiment). The effects of policies on each individual are often different as each person lives a different sort of lifestyle which can depend on their incomes and preferences. Governments would want to undertake a project if it improves social welfare, but it can be difficult to choose a social welfare function to measure this, so a more simple rule is the potential Pareto improvement rule where if the sum of the change in the income of all individuals is positive then in theory the winners from the project could compensate the losers and everyone would be better off compared to before.

The fifth step is deciding the discount rate. The discount rate is particularly important as in the NPV formula it grows exponentially over time. The government would use a social discount rate rather than a private discount rate. An ideal social discount rate has two features: to allocate efficiently over time using the social time preference discount rate but also efficiently allocate between different sectors using the social opportunity discount rate. A social discount rate of 3.5% is used by the UK treasury to evaluate policies.

However, there are some issues with cost benefit analysis. First, it is almost impossible to identify all the costs and benefits of a policy, in particular it can be hard to identify general

equilibrium effects. Second, whilst using revealed preference and survey-based methods to value certain costs and benefits is useful, the values may not be that accurate. Third, it is difficult to calculate the social discount rate, which due to the sensitivity of the net present value formula to this variable, can have big impacts on what policies cost-benefit analysis suggests are worth pursuing. Despite these limitations, it is worthwhile for governments to conduct cost-benefit analysis to try and assess policies ahead of potential implementation.

Considering the results from the perspective of Government Fiscal Policy

Regarding the different government intervention policies and which ones or which combination works best, it depends on the aims of each individual government. For example, governments for developing or lower income countries (LICs) would likely be more concerned with decreasing poverty in general and decreasing wealth inequality would not be their biggest priority. On the other hand, wealthier countries generally have a larger wealth gap and hence would be more likely to have decreasing wealth inequality as a priority. Also, different governments have different government budgets and so certain government intervention policies might be harder to achieve for some than others. For example, if a government has a budget deficit, they could find it hard to implement housing grants as they would have to trade off other policies against the housing grant given the fiscal constraints. Being in a budget deficit means that the government is spending more in expenditure (e.g. on social welfare benefits) than they are receiving in taxes (e.g. income tax, corporation tax). The amount borrowed by the government has to be paid back with interest, so being in a budget deficit would likely lead to higher taxes in the future, having implications for future generations. Finally, elected governments may also have political motivations to implement certain policies over others in order to keep themselves in power by appealing to their voting demographic.

6.3 Revisiting Inequality and Monopoly Rationale

The simulation underscores the usefulness of Monopoly as a pedagogical and research tool in economic policy analysis. A visual and interactive means to evaluate the potential impacts of complex policies on diverse socioeconomic groups. This report offers a foundational exploration and suggests that while both policy types have merits, the balance and design of such policies are crucial to achieving desired economic and social outcomes. At the basic level, public policy that enables redistribution of wealth, by progressive taxes facilitates closing the gap between wealth inequality. Also, housing grants as “pre-distribution” tool gives lower income families a head start to wealth accumulation.

The simulation yields exploratory questions from students and also throws open further related questions to be answered, as we encounter more myriad of complex variables as economic paradigm shifts with technological advances, such as digital economy. The question of what determines who lives in poverty and who manages to escape from it remains a pressing deliberation to explore.

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Meta-Analysis on the Positive Correlation Between Insomnia and False Memories

By Maya Sammanna

Abstract

Insomnia is a prevalent sleep disorder that impacts approximately 30% of the whole population in the United States. It is identified by challenges with falling or asleep and has been associated with various cognitive dysfunctions, including issues with memory formation. In this work, we conduct a meta-analysis involving two data sets to analyze the relationship between insomnia and false memory formation (memories of events that did not actually occur), shedding light on the consequences of sleep deprivation. In the first data set, participants engaged in a simulated crime scenario and were assessed on their ability to identify the perpetrator from both lineups after a period of sleep or wakefulness. In the second data set, participants were presented with themed word lists and, after sleep or wakefulness, tested for memory of words on the list. The data underwent processing using R, and meta-analysis techniques were utilized to integrate findings across these two studies. We used various techniques, such as random-effects models and subgroup analyses, to combine the findings from the studies. However, we were unable to assess the variability between studies due to the limitations of working with binary data. The results show a connection between insomnia and an increase in the formation of false memories, with similar effect sizes across studies. Further research is anticipated to deepen the understanding of the link between insomnia and cognitive health, offering valuable insights into sleep disorders and memory.

1. Introduction

Insomnia is a prevalent sleep disorder that affects approximately 30%, 30-50 million, of individuals in the United States (Morin et al., 2015). It results in chronic sleep deprivation, which has well-documented negative effects on cognitive function, particularly in the area of memory. Sleep plays a crucial role in the consolidation of short and long-term memories, and numerous studies have demonstrated that the feeling of a lack of adequate sleep can impair memory performance (Walker, 2008). One aspect of concern is how sleep disorders, such as insomnia, may contribute to the formation of false memories—instances where individuals recall events inaccurately. For example, someone might vividly remember attending a specific event that they never actually went to. False memories can affect various types of information, including both narrative details (like stories) and factual details (such as numerical data) (Reyna et al., 2002). These false memories can have significant implications for our everyday lives and decision-making processes (Wang et al., 2016).

1.2 Insomnia and Sleep Deprivation

Insomnia is a sleep disorder characterized by persistent difficulties in falling asleep, staying asleep, or achieving restorative sleep, despite having abundant opportunity to do so (Van

Someren, 2021). There is no fixed amount of sleep deprivation that defines insomnia, as the severity and impact of sleep disturbances can vary widely among individuals (Ohayon & Roth, 2001). This condition often leads to daytime impairment or distress, such as fatigue, difficulty concentrating, and mood disturbances. Insomnia can manifest in several forms, the most common being initial insomnia, where individuals struggle to fall asleep at the beginning of the night; middle insomnia, involving frequent awakenings during sleep; and terminal insomnia, marked by early morning awakening with an inability to return to sleep (Perlis and Gehrman 2013). Diagnosis typically involves assessing these symptoms over time, such as tracking sleep patterns, self-diagnosis, and sleep studies, ruling out other medical or psychiatric conditions, and evaluating specific criteria related to sleep onset, maintenance, and quality. Patients typically present to a primary care physician or general practitioner with complaints of sleep disturbances. From there, they may be referred to a sleep specialist or sleep clinic for further evaluation. The journey to a diagnosis often includes a detailed medical history, maintaining a sleep diary, physical examinations, and sleep studies like polysomnography (Krystal et al., 2019). Insomnia is also classified based on its duration specifically, transient insomnia refers to brief episodes lasting less than one month, often triggered by situational factors such as stress or changes in routine, like a new job or travel across time zones. Short-term insomnia persists between one and six months and is often due to ongoing stress or lifestyle changes, including starting a new exercise regimen or adjusting to a significant diet modification. Chronic insomnia is severe and persistent, lasting more than six months, and is commonly associated with underlying medical or psychiatric conditions like depression or chronic pain (Yang et al., 2013). The causes of insomnia can vary but commonly include stress, anxiety, or depression, which can disrupt sleep patterns. Additionally, poor sleep habits, such as irregular sleep schedules and excessive screen time before bed, or an uncomfortable sleep environment, such as a noisy room or an uncomfortable mattress, as well as medical conditions such as chronic pain or neurological disorders like depression and epilepsy, can also contribute to insomnia (Stiefel and Stagno 2004). Treatment approaches for insomnia can include cognitive behavioral therapy (CBT, a structured, short-term therapy that helps individuals identify and change negative thought patterns and behaviors) which addresses sleep hygiene and modifies negative thoughts about sleep, or medications like eszopiclone (Lunesta), benzodiazepines or non-benzodiazepine hypnotics for short-term relief (Ramakrishnan, 2007). However, medications can come with potential side effects, such as dizziness or gastrointestinal issues, and risks of dependency, making non-pharmacological interventions preferred for long-term management (De Crescenzo et al., 2022). Despite this, non-pharmacological interventions, such as CBT, are difficult to access due to the small of psychologists offering these treatments (Soong et al., 2021).

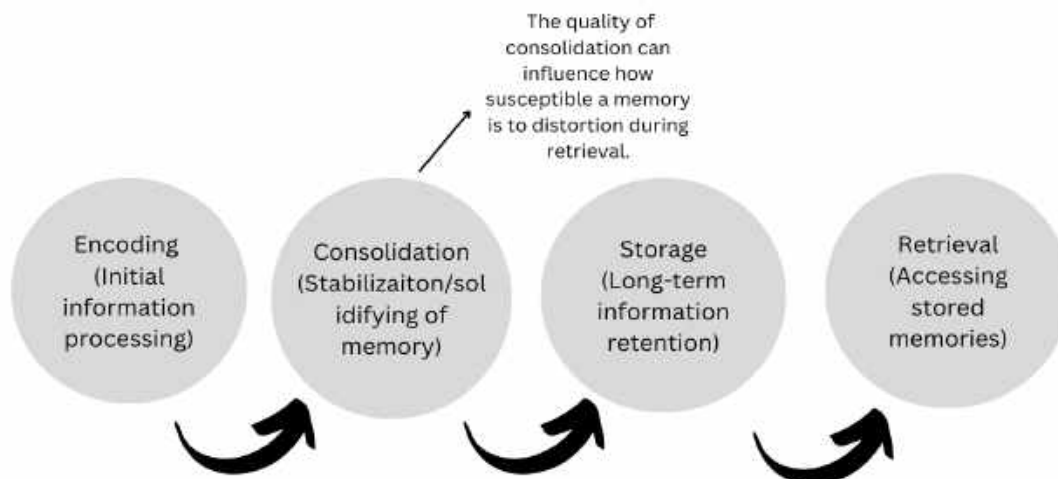
Chronic insomnia can have serious consequences on overall health, increasing the risk of cardiovascular disease, obesity, and mental health disorders if left untreated (Riemann et al., 2010). In contrast, sleep deprivation refers to a state where individuals do not obtain sufficient sleep to meet their physiological needs. This condition can stem from lifestyle choices, such as staying up late for work or social activities, or from work-related factors like shift work or

irregular schedules (Bandyopadhyay and Sigua, 2019). While sleep deprivation can result from insomnia, insomnia is a treatable condition, whereas sleep deprivation, particularly due to lifestyle or occupational factors, may require changes in habits and environment to address effectively. Environmental factors, such as noise or light pollution, can also disrupt sleep patterns and contribute to sleep deprivation. The effects of sleep deprivation are profound and can include cognitive impairment, such as reduced concentration and memory, mood disturbances like irritability or mood swings, and an increased risk of accidents both in the workplace and during daily activities (Killgore, 2010). Managing sleep deprivation involves prioritizing good sleep hygiene practices, creating a conducive sleep environment, and addressing underlying factors contributing to poor sleep quality (Reddy, 2024). Unlike insomnia, which is a diagnosable sleep disorder with specific criteria for diagnosis and treatment, sleep deprivation is often managed by improving lifestyle choices and environmental conditions conducive to sleep (Nollet et al., 2020).

1.3 Memory

Memory is a complex cognitive function enabling encoding, storage, and retrieval of information. It starts with encoding, where sensory input is processed into a storable form, involving attention, perception, and initial processing. The hippocampus is crucial for consolidating new information and transferring it from short-term to long-term memory (Fokuhl, 2007) (Figure 1). Long-term memory includes explicit (declarative) memory, which consists of episodic (personal experiences) and semantic (facts and knowledge) memory, and implicit (non-declarative) memory, such as procedural memory (skills and tasks). Retrieval involves accessing and bringing stored information into conscious awareness, reactivating neural pathways used during encoding. Factors like context, emotional state, and cues can influence retrieval (Gabrieli, 1998).

Figure 1: Flowchart of Memory Processing Stages



The flowchart above illustrates the stages of memory processing. This flowchart was adapted by Main, 2023.

False memories are inaccuracies in recalling or interpreting events. They arise from the brain's constructive and reconstructive nature of memory. The hippocampus and prefrontal cortex play roles in false memory formation. Normal individuals might generate false memories for approximately 5 to 10 false items for every 100 items they recall (Nash et al., 2016). The hippocampus may confuse the source of information, while the prefrontal cortex can influence the acceptance of incorrect details as true (Loftus, 1996). Real memories are based on actual experiences and the accurate encoding, storage, and retrieval of information. They are typically more vivid and detailed, with a stronger sense of confidence in their accuracy. In contrast, false memories are distortions or visions of events that never occurred or are remembered differently from the actual event. False memories can arise from suggestive questioning, misinformation, or the blending of real experiences with imagined details. Several psychological and neurological disorders can increase the susceptibility to false memories. Individuals with post-traumatic stress disorder (PTSD) may have fragmented memories of traumatic events, which can lead to false memories during recall (Bedard-Gilligan & Zoellner, 2012). Conditions such as dissociative identity disorder (DID) involve disruptions in memory and identity, increasing the likelihood of false memories due to altered states of consciousness and identity fragmentation (Dorahy et al., 2014). People with schizophrenia may experience delusions and hallucinations, which can blur the line between real and imagined events, leading to false memories. Depressive states can affect memory consolidation and retrieval, sometimes resulting in the incorporation of negative or distorted details into memories (Kensinger & Ford, 2019). Age-related cognitive decline and conditions such as Alzheimer's disease can impair memory accuracy and increase the risk of false memories due to neural degeneration and impaired cognitive functions (Malone et al. 2018). Understanding the biological and psychological mechanisms underlying false memories can help in developing strategies to mitigate their occurrence.

1.4 Sleep and Memory

Multiple studies have demonstrated that sleep plays a crucial role in memory consolidation and retrieval (Chambers, 2017). Acute sleep loss impairs memory retrieval, often leading to false memories. Insomnia can cause mild to moderate impairments in cognitive functions such as episodic memory, problem-solving, and working memory. A study by Fortier-Brochu and colleagues found no significant differences in general cognitive function, perceptual processes, or executive functioning (Fortier-Brochu et al. 2012). However, their findings suggest that while these cognitive areas may not be significantly affected, insomnia may still impact memory and executive functions, indicating a need for further investigation into these specific effects. Another study involving college students (18-22 years old) revealed that sleeping soon after learning improves both true and false memories, with slow-wave sleep (a deep stage of non-REM sleep characterized by slow brain waves) reducing false memories (Pardilla-Delgado and Payne, 2017). Furthermore, a study by Lo et al. showed that post-learning sleep (sleeping after learning new material) decreases false memory and enhances memory accuracy in healthy older adults, particularly with increased slow-wave sleep (Lo et al., 2014). In

an experiment using the DRM paradigm, individuals with insomnia exhibited higher false memory production and intrusions in free recall (incorrect or irrelevant information recalled during a memory task), along with lower working memory performance, compared to good sleepers. No differences were found in recognition tasks between the two groups. The study indicated a link between poor sleep, executive function deficits, and false memories (Malloggi et al. 2022). Another study using fMRI examined sleep's impact on recollections. Participants who slept after studying word lists showed better accurate and false recollections during a retest fMRI session three days later. Both types of memories were linked to hippocampal activity post-sleep, suggesting that sleep aids in overall memory consolidation, including false memories based on initial encoding processes (Darsaud et al., 2011).

This meta-analysis aims to explore the relationship between insomnia and the likelihood of developing false memories in adult participants using publicly available data (Mak 2024) and (Stepan 2015). By investigating this connection, the research seeks to elucidate how chronic sleep deprivation might lead to cognitive issues related to memory distortions. This meta-analysis found a positive association between insomnia. These findings are crucial for understanding the intricate interplay between sleep and memory and could lead to strategies to mitigate the impact of insomnia on memory and decision-making in affected individuals.

2. Materials and Methods:

2.1 Study Selection

A literature search was conducted using Mendeley Data to identify relevant studies examining the relationship between sleep and false memories. The search criteria focused on studies that included groups classified as "insomnia" or "sleep deprived" compared to those without sleep issues. The inclusion criteria were studies involving adult participants with insomnia or sleep deprivation alongside a control group with normal sleep patterns, research specifically measuring false memories as an outcome. Based on these criteria, the studies provided the most comprehensive and relevant data for analysis.

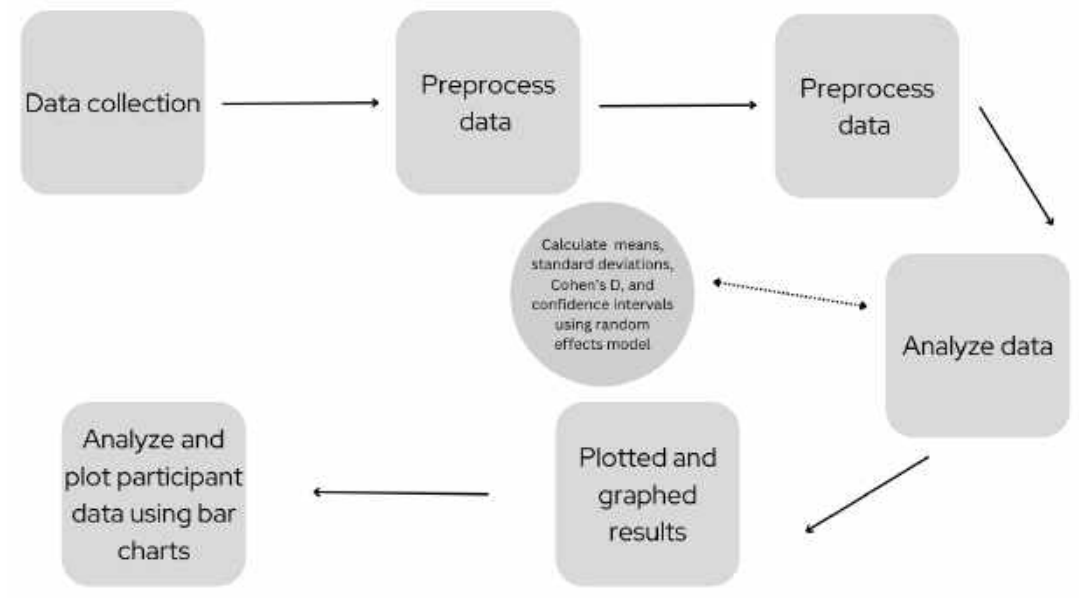
2.2 Data Extraction and Coding

The focus of the analysis was to explore the correlation between "false memories" and "sleep." In two selected studies, sleep deprivation was induced by a period of no sleep for twelve hours to mimic insomnia (Mak, 2024) (Stepan, 2015). Both studies compared participants who had twelve hours of sleep with those who experienced twelve hours of sleep deprivation. Since one dataset was originally binary and the other was not, it was necessary to transform the data into a binary format for standardization and equal comparison. Participants undergoing sleep deprivation were labeled as 0, while those with regular twelve-hour sleep were labeled as 1. Similarly, participants with false memories were labeled as 1, and those without were labeled as 0. Standardizing the data into a binary format facilitated consistent comparisons across the studies.

2.3 Meta-analysis in R

For conducting the meta-analysis in R, several essential packages were utilized, including dplyr, readr, metafor, ggplot2, and epitools (R Core Team, 2023). The primary objective was to interrogate the relationship between false memories and sleep. The preprocessing phase involved reading and cleaning the datasets, and included tasks such as removing unnecessary columns, and recoding variables into a binary format for standardization across studies. In the analysis phase, relevant statistics such as means, standard deviations, and Cohen's d effect sizes were computed to quantify the relationship between sleep patterns and false memories (Figure 4). For instance, Cohen's d was calculated to measure the effect size between sleep conditions (sleep deprivation vs. regular sleep) and false memory occurrences. The results were then synthesized using the metafor package to perform random-effects meta-analyses, accounting for variability between studies. Confidence intervals were calculated to assess the robustness and generalizability of the findings. Visualizations such as forest plots were generated using ggplot2 to illustrate the effect sizes and their confidence intervals across studies. To explore the composition of the participant pool within the available dataset (demographic data from the second dataset was unavailable), an analysis of participant characteristics (e.g., age, gender, ethnicity) was conducted. The distributions of these variables were then visualized using bar charts.

Figure 2: Flowchart of Methods



The following flowchart presents the methods used for this analysis.

3. Results

To be considered for this meta-analysis, studies were required to incorporate both a measure and manipulation of sleep. Specifically, this involved comparisons between conditions such as sleep versus no sleep, insomnia versus healthy sleep, or varying protocols of sleep

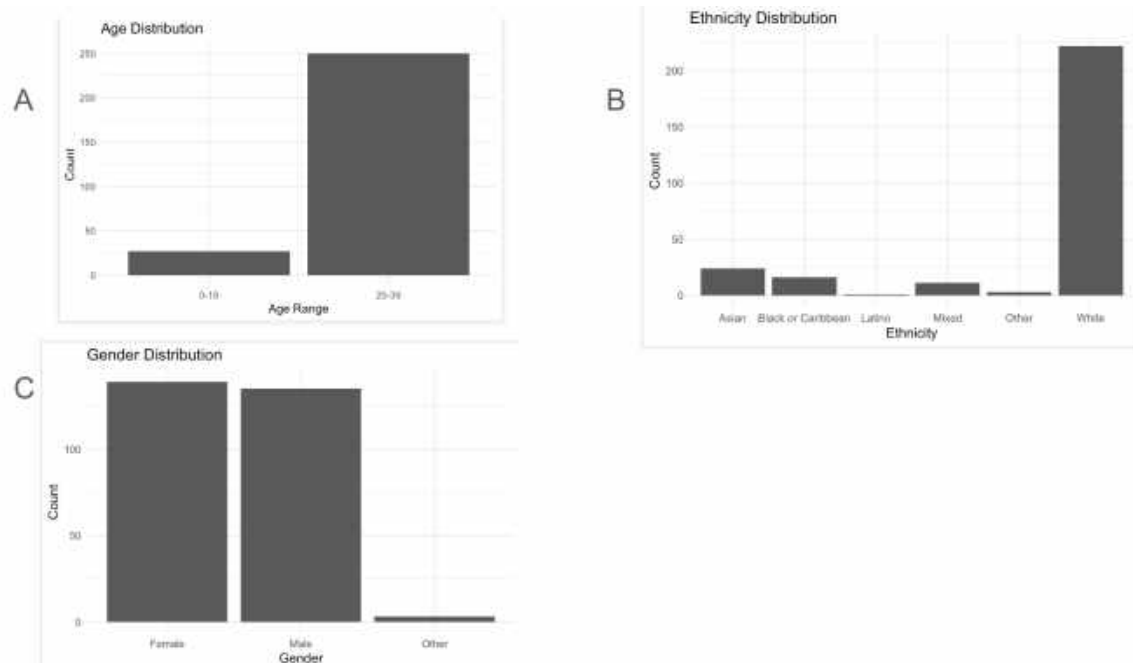
deprivation. Studies needed to employ a valid and reliable measure of false memory formation. This typically entailed participants engaging in tasks designed to assess memory accuracy or recognition, with subsequent evaluations of their performance to determine the presence of false memories. The studies were conducted from 2015-2021 and had 50,044 participants in total (Mak, 2024) and (Stepan, 2015).

Table 1: Study Summary

Study:	Measure of Sleep	Insomnia Definition	Type of Memory Test	Timeline for Sleep	Timeline for Memory Test
Stepan, M. E. (2015)	Recorded number of hours asleep	12 hours of sleep deprivation	Memory tested on similar words from a list.	12 hours (slept at night)	Within a period of 12 hours after the presented lists.
Mak, M. H. (2024)			Identification of perpetrator from mock crime scenario.		After a period of 12 hours from the video

For the second study, there was no available demographic data (which constitutes a limitation of the analysis). In the second study, regarding age distribution, there were 27 participants aged 0-19, 250 participants aged 20-39, and no participants above the age of 39 years (Figure 3A). The ethnicity distribution included 24 Asian participants, 16 Black or Caribbean participants, 11 mixed-race participants, 222 White participants, and 3 participants of other ethnicities (Figure 3B). The gender distribution consisted of 139 female participants, 135 male participants, and 3 participants who identified as 'Other' (Figure 3C).

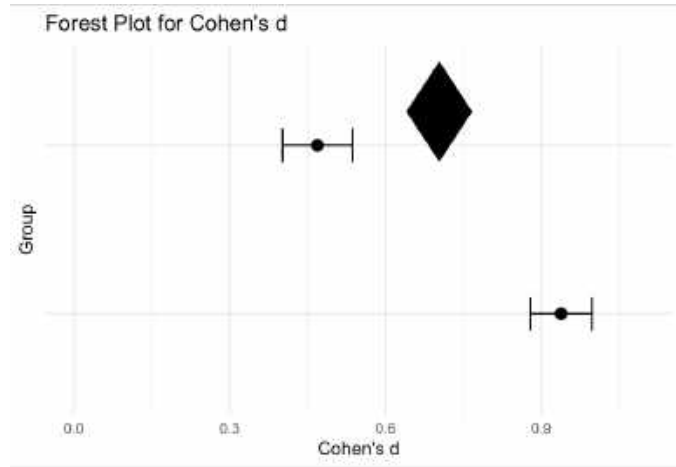
Figure 3: Demographic Data of Analyzed Data Set



The demographic data is depicted above for one of the sets for ethnicity, age, and gender (Mak, 2024). Demographic data for the other data set was not available and therefore was not analyzed (Stepan, 2015).

Two studies were used in the meta-analysis to investigate the connection between sleep or insomnia and the formation of false memories. Both studies indicated a significant positive correlation. In the first study, the effect size (using Cohen's D) was $d = 0.94$ (95% CI: 0.8782 0.9972, $p < 0.0001$), with a standard error of 0.03 (Table 2). The second study reported an effect size of $d = 0.47$ (95% CI: 0.4017 0.5359, $p < 0.0001$), and a standard error of 0.02 (Table 2). Combining these studies resulted in a pooled effect size of $d = 0.68$ (95% CI: 0.6867 0.7758, $p < 0.0001$) with a standard error of 0.02 (Table 2), suggesting a moderate positive association between insomnia and false memory formation, meaning that an individual experiencing insomnia is more likely to exhibit false memories than someone with sufficient sleep. Heterogeneity was not assessed due to the constraints of binary data. In this case, sleep deprivation primarily disrupts memory consolidation, the stage where memories are stabilized for long-term storage. This disruption leads to errors during retrieval, increasing the likelihood of false memories (Prince & Abel, 2013).

Figure 4: Forest Plot of Analyzed Data



The forest plot, which is a graph that compares the effect sizes (Cohen's D), for the meta-analysis, is shown above. The diamond represents the average effect, helping visualize how much more likely people with insomnia are to have false memories compared to those with sufficient sleep.

Table 2: Results Summary

Study	P-value	Confidence interval (95%)	Cohen's D	Standard Error	n
Stepan, M. E. (2015)	p < 0.0001	87.82 to 99.72%	0.94	0.03	49860
Mak, M. H. (2024)	p < 0.0001	40.17 to 53.59%	0.47	0.02	184
Combined	p < 0.0001	68.67 to 77.58%	0.68	0.02	50044

4. Discussion

4.1 Results in the context of insomnia literature

This study aimed to investigate the impact of insomnia on the formation of false memories. By analyzing data sets from two studies, the research found a consistent pattern of increased false memories associated with sleep disturbances (around 48.6%). The findings suggest a significant link between insomnia and memory accuracy, highlighting the importance of sleep in cognitive

processes. This research emphasizes the critical role of sleep in preventing the incorporation of false information into memory.

The biology of insomnia and its impact on false memories reveals the crucial role sleep plays in memory consolidation and retrieval. The observed increase in false memories among individuals with insomnia suggests a disruption in cognitive processes, likely affecting the prefrontal cortex. This brain region is responsible for source monitoring (distinguishing between the source of a memory) and executive control (managing conflicting thoughts and memories) (Fuster, 1998). Disruptions in these processes due to insomnia could lead to the formation of inaccurate or distorted memories. During sleep, the brain undergoes synaptic consolidation, strengthening neural connections involved in memory formation. Sleep also supports synaptic pruning, optimizing neural networks for efficient memory storage and retrieval (Clopath, 2011). Additionally, sleep aids in waste product removal from the brain. Byproducts of neuronal activity can accumulate during wakefulness, potentially impairing cognitive function. Sleep allows the glymphatic system, the brain's waste disposal network, to clear these byproducts, promoting optimal brain function and memory accuracy (Luisetto et al., 2019). Insomnia may disrupt these processes, contributing to increased vulnerability to false memories. Specifically, impaired synaptic consolidation and inefficient waste clearance could explain why individuals with insomnia experience higher rates of memory inaccuracies and distortions. Enhanced understanding of these mechanisms underscores the importance of addressing sleep disorders to improve cognitive health and memory reliability (Wafford, 2021).

4.2 Limitations of Study

However, while this research suggests a link between insomnia and increased false memories, other experiments present discordant results. Some studies suggest that sleep can enhance both true (accurate) and false (incorrectly remembered/inaccurate) memories, while others show that insomnia doesn't significantly impact recognition tasks (Fortier-Brochu et al. 2012), (Pardilla-Delgado and Payne, 2017). These contrasting findings may stem from methodological differences between studies, such as the use of different paradigms (e.g., DRM) and technologies (e.g., fMRI) to assess memory. In this meta-analysis, the first study utilized the Deese-Roediger-McDermott (DRM) paradigm to test recognition memory, while the other study assessed recall memory using different protocols. In this meta-analysis, the second study used the Deese-Roediger-McDermott (DRM) paradigm to assess recognition memory, while the first used different protocols for recall memory. This methodological difference is a limitation, as it may affect the comparability of the results. Variations in sample size and participant demographics across studies could have also contributed to the observed differences in outcomes. Moreover, the diverse methodologies in previous research underscore the complexity of understanding the relationship between sleep and memory. Some studies found that sleep enhances both true and false memories due to the consolidation process, whereas others reported that sleep deprivation specifically impairs source memory, a crucial component for distinguishing false from true memories (Newbury and Monaghan 2018). Additionally, the use of different memory tasks and

assessment tools can lead to varying results. Some studies employing fMRI technology have demonstrated that sleep deprivation leads to reduced activity in the prefrontal cortex during memory tasks, directly linking biological disruptions to memory distortions. In contrast, behavioral studies without neuroimaging support might not capture the underlying neural mechanisms, resulting in different interpretations of the impact of sleep on memory. The variations in sample sizes and participant demographics, including age, health status, and baseline cognitive function, further contribute to the inconsistencies in findings. Larger, more diverse samples can provide a more comprehensive understanding of how sleep impacts memory across different populations.

4.3 Significance and Future Directions

This research sheds significant light on how sleep deprivation, particularly in relation to false memory formation, impacts cognitive function. By highlighting the crucial role sleep plays in memory consolidation and overall mental health, it underscores the importance of adequate sleep for reliable memory recall and well-being. These findings enhance our understanding of the effects of insomnia, which may inform future therapeutic interventions and contribute to the development of more effective treatments. Demonstrating the cognitive risks associated with insomnia advocates for more comprehensive sleep health education and interventions for adolescents, adults, and the elderly. This can lead to improved mental health outcomes, enhanced memory reliability, and ultimately, greater overall well-being and functionality across various aspects of daily life.

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The Fascinating Facts of Exoplanets By Dylan Blackmore

Abstract

An exoplanet is a planet that is located outside of our solar system. These planets are so fascinating because of the possibilities that they hold. The four types of exoplanets are based on the planets in our solar system: gas giants, neptunian planets, super earths, and terrestrials. The five methods that astronomers use to detect such planets are the radial velocity method, the transit method, direct imaging, gravitational microlensing, and astrometry. For an exoplanet to be habitable to life as we know it, it must lie in the habitable zone of its star where liquid water is able to be present on the surface of the planet. The ideal type of star for an exoplanet to be habitable is a K-Dwarf star that has a long lifespan and does not endanger life on the planet. These methods on how we can detect and classify them, along with the possibility that there could be life on some of these planets add interest to the research in exoplanets.

Introduction

With the universe being approximately 93 billion light years in size and constantly growing, the idea of life on an exoplanet somewhere in our universe is very much a possibility. An exoplanet is defined as any planet that is outside of our solar system. Exoplanets come in all different forms and sizes, and there is so much information we have yet to discover about exoplanets all over our universe. They are truly one of the most fascinating things to study in our universe. In this paper, we explain how detecting, observing, and studying exoplanets all play a significant role in the ability to determine the habitability of exoplanets and the classification of exoplanets.

Types of Exoplanets

First, exoplanets are split into four main types based on the planets that we have in our own solar system: gas giants, neptunian planets, super earths, and terrestrials (Bolles and NASA).

Gas giants are planets similar in size to Jupiter and Saturn, and they are extremely large. This classification is very broad and has many specific types. For example, hot Jupiters were among the first planets found and they are a specific type of gas giant. Hot Jupiters are extremely close to their star causing the temperature to soar (Bolles and NASA). Additionally, gas giants are useful in their ability to be used as a unique laboratory for studying the thermal and chemical properties of hydrogen and helium dominated atmospheres. An extreme case of this is a hot Jupiter, HD 80606b, that is orbiting a sun-like star. It experiences an increase in incident flux of nearly three orders of magnitude as the star-planet separation decreases (Sikora et al.).

Neptunian planets are planets close in size to Neptune and Uranus. Most of these planets have rocky cores with hydrogen and helium dominated atmospheres (Bolles and NASA). Among Neptunian mass planets, it is very rare to find a puffy hot Neptune, which is a Neptunian planet

that orbits close to their respective star. Because these puffy hot Neptunes have such a low mass combined with an extended radius, they have a very low density. In the past ten years, very few puffy hot Neptunes have been detected and precisely characterized with the transit and radial velocity observations. One example of a puffy hot neptune that has been detected is TOI-1173 A b, which is a low density super neptune that is in a near circular orbit around the primary G dwarf star in the wide binary system TOI-1173 A/B (Galarza et al.).

Super Earths and terrestrials are both very similar to Earth in terms of their composition. The main difference between super Earths and terrestrials is their size. Super Earths are much bigger than Earth, while terrestrials are similar in size to Earth or even smaller (Bolles and NASA). Terrestrial planets in the habitable zone of their stars are the main focus of the next generation of powerful space telescopes. In simulations under two alternate regimes, being a mantle convection regime called mobile lid and the alternate stagnant-lid regime found on Mars and Venus, it was found that the fraction of planets that possess climates consistent with surface water differ by less than 10%. Scientists predict that a mission capable of detecting atmospheric carbon dioxide abundance in 25 terrestrial exoplanets is extremely likely (Affholder et al.).

Exoplanet Detection Methods

There are five main types of detection methods to find exoplanets. These five methods include radial velocity, the transit method, direct imaging, gravitational microlensing, and astrometry. In the following subsections, I describe each of these methods in turn.

Radial Velocity: For radial velocity, the exoplanet gravity causes the star to wobble, changing the color of the light that astronomers observe. This method has been used successfully to find 1,092 planets (NASA). As previously mentioned, the radial velocity method has been very successful in detecting and characterizing many planets. Until recently, the radial velocity signals imprinted by rocky planets in the habitable zone of their stars have been out of reach for most precise spectrographs (Rescigno et al.). Radial velocity surveys could have been used to detect nearby Earth-like exoplanets and provided additional information regarding these Earth-like planets (Salvador et al.).

Transit Method: For the transit method, exoplanets pass between the star and the observer, causing the star's light to dim. According to NASA, 4,224 planets have been found using this method (NASA). Additionally, the Mid-Infrared Instrument (MIRI)'s medium resolution spectrometer, which is an instrument on the James Webb Space Telescope, could have important advantages for the transit method. This medium resolution spectrometer could be used to detect carbon dioxide absorption from the atmosphere of the temperate planet that is orbiting Proxima Centauri (Deming et al.). Likewise, planetary systems that have multiple transiting planets are very beneficial when it comes to understanding planet occurrence rates and system architectures. Scientists have simulated transit timing observations of the planets in our solar system as viewed from a distance. Then, they compared the results of the simulation to the actual orbital motions

of the planets, which will help future missions in detecting and characterizing systems of exoplanets that are similar to our own solar system (Lindor and Agol). Furthermore, two exoplanets have been detected by the Transiting Exoplanet Survey Satellite (TESS). These two exoplanets are TOI-2374 b and TOI-3071 b, and they orbit a K5V star and an F8V star, respectively. Scientists are able to confirm and characterize these two exoplanets with a plethora of ground based and follow up observations including precise radial velocity monitoring, photometry, and high resolution imaging (Hacker et al.).

Direct Imaging: Direct imaging is quite self explanatory, with the method being performed by taking a picture of the exoplanet by removing the glare from the star it orbits. Scientists have found 82 planets with this method (NASA). Although direct imaging may seem straightforward and simple, it is not, and there are plenty of challenges that come with it. Directly imaging exoplanets has many requirements for high contrast and spatial resolution that include effective coordination of wavefront control, which is the subsystem that is required to sense and correct any errors in the telescope's optics; coronagraphy; observation techniques; and post-processing algorithms. The ability to identify and retrieve the signals from the exoplanet is very difficult because of the increased noise of scattered light off the circumstellar disk, which is a ring shaped disc of matter composed of dust, gas, asteroids, planetesimals, or collision fragments in orbit around a star, and the potential misinterpretation of the true nature of the detected signal (Li et al.).

Gravitational Microlensing: To use the method of gravitational microlensing, scientists observe the waves of light from the star; however these waves of light are bent by the gravity of the exoplanet. Because the waves of light are being bent by the exoplanet gravity, the appearance of the light will be different, so scientists know that an exoplanet is there. This method has been used to discover 224 exoplanets (NASA). The method of gravitational microlensing has a very big problem, which is why it has only been used to discover 224 exoplanets. Because the distance of the detected planet from Earth is known only by rough approximation, scientists are more likely to make errors of thousands of light years due to the planets being so far away (The Planetary Society).

Astrometry: For astrometry, the orbit of an exoplanet can cause the star to wobble relative to other objects in space. This method has only been used to successfully find three exoplanets, but scientists are hoping for more success with this method later in the future (NASA). In addition, direct imaging using astrometry could possibly provide constraints on orbit and phase angle of the planet detected. It is extremely important that we understand the impact of prior mass and orbit information on planetary characterization to efficiently recognize exoplanets suitable for life (Salvador et al.).

Exoplanet Habitability

Finally, I talk about exoplanet habitability. There are many factors that play into habitability including the host star, the ability to observe them, and the obstacles that we face when attempting to find habitable planets. So far scientists have found many exoplanets that could potentially be habitable.

Impact on Observations: First, I discuss our ability to observe and characterize exoplanets that could potentially be habitable, as well as our goals when talking about exoplanet habitability. The main targets for detection and observation by the next generation of powerful space telescopes are terrestrial planets that lie in the habitable zone of their respective star. Additionally, we need to understand the underlying dynamics and chemistry to interpret the efforts to simulate the atmosphere of potentially habitable terrestrial exoplanets (Sainsbury-Martinez et al.). Furthermore, habitability and survivability depend on the evolutionary path and life adaptation to environmental conditions. Scientists study the interplay between the temperature adaptation and environmental fluctuations induced by solar activity and orbital dynamics (Weintraub and Perets).

Impact of Host Stars: Second, I discuss the significant impact that the host star can have on a potentially habitable exoplanet. Exoplanetary science is prioritizing efforts toward the detection and characterization of potentially habitable exoplanets. However, a challenge in the preparatory work for the Habitable Worlds Observatory's search for exoplanets that could be habitable is the selection of stars that could be suitable (Kane et al.). For example, exoplanet habitability significantly depends on the space weather for exoplanets hosted by M-Dwarf stars. Scientists use simulations to determine the habitability of Proxima b when it is in both calm and extreme space conditions. They study stellar wind and planetary magnetic fields, and determine the radio emissions that come from the interaction between the stellar wind of Proxima and the magnetosphere of the planet Proxima b (Peña-Moñino et al.). Also, F-type stars spend significantly less time on the main sequence, but they still offer a unique set of features, which could allow for the principle possibility of exolife (Patel et al.). Overall, the ideal type of star to foster life is a K-Dwarf star. Stars like our sun are very short lived and somewhat rare in our galaxy. On the other hand, red dwarf stars last a very long time and are common, but flares, which are brief eruptions of high energy radiation from the star's surface, could sterilize life in its early stages (NASA, The Habitable Zone - NASA Science).

Examples of Potentially Habitable Exoplanets: Third, I provide some examples of exoplanets that could potentially be habitable. For example, exoplanets that could potentially foster life include Kepler 186-f, Kepler 452-b, Proxima Centauri-b, Kepler 62-f, the Trappist-1 system, and many more (Stirone). Additionally, for the exoplanet Trappist-1E, scientists explore the effect of the inclusion of an Earth-like land-ocean distribution with orography that could possibly shape the dynamics and chemistry of terrestrial planets (Sainsbury-Martinez et al.). Likewise, in 18

systems, the planet spends at least some of its orbit within the habitable zone of its star, and in one case, the exoplanet 38 Vir is situated inside the habitable zone of its star at all times (Patel et al.).

Obstacles to Habitability: Ultimately, I discuss the obstacles that come with exoplanet habitability. For example, a planet must be in the habitable zone of its star to be considered habitable. The habitable zone is the perfect distance from the star where liquid water is present on the surface, and it has perfect conditions that are not too hot or cold for humans to survive (NASA, The Habitable Zone - NASA Science). Other factors that determine the planet's habitability come into play as well, such as its size, its atmosphere, and its surface. For example, we would need a rocky planet that does not have a huge atmosphere crushing people down (Stirone). In an analysis by scientists, it was revealed that in 11 out of 30 systems, less than 50% of the habitable zone is viable. The habitable zone is not viable in these systems primarily because of the presence of giant planets whose orbit passes near or through the habitable zone (Kane et al.).

Conclusion

In this paper, I have discussed the specific types of exoplanets, along with the five ways to detect an exoplanet. These methods include the transit method, the radial velocity method, direct imaging, gravitational microlensing, and astrometry. I have also talked about how exoplanets could be habitable.

The importance of studying exoplanets in the present day is to advance our abilities, so that one day we might be able to discover a new home for the human race. Earth will not last forever, and although we still have a lot of time, finding a new planet to foster our species is very important.. Scientists still need to work heavily on this topic of exoplanets. Specifically, scientists should focus on even more new ways to find exoplanets, and even try to improve the current methods. Also, scientists should hone in on the habitability of exoplanets, so that if we do one day find a planet that checks all the boxes, we know whether or not we can even survive on the new planet. Scientists need to constantly study and find every possible way that we could be endangered by something on an exoplanet, so that if we find a new planet, we can study it and make sure there is absolutely no threat to our existence on it. To conclude, scientists still have a long path to gaining all the knowledge they need in this area, but if they stay with it and keep gradually making advancements, it will all pay off in the future.

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Financial Literacy in Low Income Households

By Raudel Delgado & Jericho Finona

Abstract

In this paper we define financial literacy, its benefits, and analyze the implications of it in low-income households. Utilizing a variety of past research on financial literacy, we make connections on the low levels of financial knowledge in low income households and the challenges faced by it. Findings from the research show a high correlation between the challenges and the perpetuation of poverty. We then state possible solutions to mitigate these circumstances and conclude that the improvement of financial literacy rates could reduce poverty and carry on financial well being.

Introduction

In today's market there are a vast number of wealth building opportunities presented to the public. Periods of economic crisis, such as the 2008 Great Recession or the Covid 19 Pandemic, often affect the financial safety of a person's future. Specifically, during the Covid 19 Pandemic, the unemployment rate reached catastrophic heights of 14.8% (Weinstock, Lida R. 2021). Demographic groups throughout America were impacted by the aftereffects of this pandemic, leaving the population vulnerable to an uneven economic recovery (Li, Joanne 2021). Low-income households are often the ones who are left at crisis after absorbing an economic shock.

According to Klapper et al, Financial literacy can help individuals face certain negative effects of these shocks (Klapper, Leora F, et al. 2012). Financial literacy is the understanding an individual has on a variety of important financial skills and concepts (Fernando, Jason 2024). A strong foundation of financial literacy supports an individuals' goals, builds financial welfare, and prepares for retirement (Chu, Zhong, et al. 2017). Overall, individuals who foster financial literacy navigate economic challenges more efficiently, and develop the building blocks for economic security.

Low-income families are those whose household income is 80% or less of their geographical area's median (LII 11). Commonly, these families endure hardships such as inadequate healthcare, limited education, and check-to-check living. Due to these hardships, low-income families often prioritize basic needs (Feeding America), leaving deficient amounts of income for investments in their future financial stability, further perpetuating poverty within these households.

Significance of the Study

In this study, our goal is to express the importance of financial literacy, specifically in low-income households. Low-income households often face many financial challenges that could be mitigated with a higher financial literacy intellect. We want to bring attention to this problem by highlighting the challenges these communities face and expressing the benefits of

financial literacy. By doing so, we hope to communicate the importance of improving accessibility to the learning of financial knowledge in these financially insecure communities.

Financial Literacy Overview

Financial literacy helps households build a safe relationship with money, often mitigating the risk of a future economic crash by making informed decisions. Households that are financially literate generally utilize credit with greater caution and manage debt more efficiently (Disney & Gathergood 2013). In addition, financially literate households have shown a greater likelihood to participate in the stock market and save for future retirement planning (Lusardi & Mitchell 2014); both of which are essential for long-term financial stability. Overall, financially literate households engage in more favorable financial decisions that contribute to the household's fiscal stability.

On the other hand, low financial literacy is often linked to poor financial decision making (Lusardi & Mitchell 2023). According to Hastings et al. (2013), research has documented widespread and avoidable financial mistakes by consumers, some, with nontrivial financial consequences (Hastings, Justine S. et al 2013). In other words, these financial mistakes can lead to significant losses. For example, households in the low-financial literacy category often make poor decisions in their equity investments (Chu, Zhong, et al. 2017), retirement planning, credit usage, and debt management. Specifically, in regards to equity investments, individuals may lack the understanding of the importance in the diversification of assets, or the general risks of the market, resulting in losses. When it comes to retirement planning, research from Choi et al. 2011, has found that individuals often make the financial mistake of contributing less in their 401(k) plans than the amount the employer would match (Choi et al.2011). As a result of these mistakes, households often put strain on their financial stability, negatively impacting a household's economic future.

How are financial literacy levels in low income households? A nationwide study in the United States conducted by FINRA evaluated households' financial literacy knowledge using a 6 question quiz. The results showed households making an income of less than \$25,000 answered on average only 2.2 of the questions correctly (FINRA Foundation 35). The same study showed, in incomes higher than \$75,000, an average of 3.6 questions answered correctly. Like the previous study, many others will show a gap in financial literacy between low and high-income families. This gap becomes problematic once we dive into the various financial challenges low-income families are exposed to due to their inability to comprehend financial literacy.

Challenges

One of the challenges faced due to low levels of financial literacy in low income households is debt accumulation. Debt accumulation is the holding of debt for an extended period of time (Cambridge Dictionary Accumulate, Debt). To find out how impactful debt is, research from the Urban Institute explained that the median debt to income ratio of low income households sat at just about 20% (Carasso, McKernan 2008). A distressing part of the research

done in this study found that 27% of all those with low income, had debt-to-income ratios greater than 40% (Carasso, McKernan 2008). In addition to this, in 2006 a study found that low income households held an average total debt of 27.9% in comparison to their total assets, while high income households in the study (earning more than \$250,000 yearly) only held about 7.5% (Ozawa MN;Kim J;Joo M Pg. 215).

One of the main causes of high debt accumulation in low income households is their credit card misuse. One report testing a variety of characteristics when it comes to credit card usage, found that 56% of participants who made less than \$25,000 a year were given the label of “expensive credit card behaviors” (FINRA Investor Education Foundation 27). Individuals given this label often partake in wrongful use of credit cards; they receive late fees, exceed credit lines, and use the card for a cash advance. To put this into perspective, the Survey of Consumer Finances 2022 found that credit card debt in low income households reached heights of up to 85% in ratio to their monthly income (Survey of Consumer Finances 2022). This number is concerning due to credit card debt being one of the highest interest receiving debts overall (Yu-Ting Chiang, Mick Dueholm 2024). This problem is exacerbated due to those same interest rates rising at concerning speeds. In 2021, interest rates of credit cards averaged at 15% and personal loans at 9%. However, by 2023, personal loans were at 12%, while credit cards peaked at 21% (Survey of Consumer Finances 2022). This, in addition to the large ratio of credit card debt-to-income, gives low income households a severe disadvantage as well as a piling exponential interest of payments.

Another challenge low income households with low financial literacy face is inadequate saving. Inadequate saving leaves low income households vulnerable to emergency expenses and hinders their ability to save for retirement. For instance, according to the National Financial Capability Study, an average of 23% of low income households were found to have set aside a three-month emergency fund (FINRA Investor Education Foundation 16), leaving the other 77% in danger of accumulating debt if any sort of financial shock were to occur.

In contrast, those of the high income category (earning more than \$75,000 yearly), showed that an average of 69% of households had set aside a three-month emergency fund. In addition, inadequate savings make it difficult for a household to contribute income for long-term investments, such as retirement. In the study previously mentioned, research indicated that only 19% of the households making below \$25,000 of yearly income had any type of retirement account. These low percentages of retirement planning are worrisome, as those who do not partake in retirement planning are often forced to deaccumulate assets to finance consumption after retirement (Smith 2003). Even with the deaccumulation of assets, these households can be left with insufficient funds. In 1992, the total financial wealth holdings of those considered low income in their 50s was \$10,000 (Smith 2003), which is not enough to afford a comfortable retirement, as the average cost of living was around \$30,000 (United States, Bureau of Labor Statistics). Due to insufficient funds when approaching retirement age, most low-income individuals are forced to work past the average retirement age of 65 (Piburn 2023). In fact, a survey based study, performed by the Pew Charitable Trusts, found that two thirds of workers in

the United States expressed the need to work past the age of 65, this being most prevalent in low-income households (Pew Trust 2018).

Lastly, one of the most concerning challenges low income households with low financial literacy face is the perpetuation of poverty. The perpetuation of poverty, also known as the cycle of poverty, as defined by the Oxford Reference, is "A vicious spiral of poverty and deprivation passing from one generation to the next," (Oxford Reference). Studies have found that adequate financial literacy is linked to desirable financial decisions (Chu, Zhong, et al. 2017). For example, paying bills on time, budgeting, adequate savings and diversifying investments (Hilgert et al. 2003). These decisions can shape the households' financial behavior, thus reducing the risk of falling below the poverty line. But how are the low income households who do not possess adequate financial literacy? As stated before, individuals without that capability struggle in a variety of financial decisions, which can be attributed to the households financial behavior. Financial behavior is the level of a household's ability to manage financial resources, including the planning to earn money, managing and controlling finances, and practices related to cash and credit management(Winarta & Pamungkas , 2020). Financial behavior is often derived from the cultural factors developed by the household due to long lasting poverty (Wang et al, 2022). Households that develop these financial behaviors surrounding poverty often mitigate risks, create information barriers, and become poverty-prone (Wang et al, 2022), which in effect causes each household to fall into a poverty trap. How does this turn into a cycle? This happens because financial behavior has been proven to be affected by genetic factors (Barnea et al., 2010; Cesarini et al., 2010; Cronqvist and Siegel, 2014,2015) and the environmental conditions surrounding an individual. A recent study which analyzed the financial behavior of twins found that 25% of their behavior towards risk can be attributed to genetic factors (Cesarini et al.,2010).

Furthermore, collective research performed on a variety of individuals in different environments, such as stressful or relaxed, has shown an impact in their decision-making proficiency (Schwartz et al, 2017). This situation can apply to people's financial decision-making, as according to the study, stressful environments tend to increase cognitive thinking, thus avoiding intuitive, potentially erroneous decisions (Schwartz et al, 2017). These findings correlate with other research which studied parent-child similarity when it comes to risk tolerance; finding there to be a connection between the behavior of both parent and child (Charles & Hurst ,2003; Dohmen, Thomans, et al. 2011), which leads to the conclusion that financial behavior may have have a genetic and environmental component. This demonstrates that there is an importance in the level of financial literacy surrounding individuals, as this trait is likely to be passed down, further perpetuating poverty.

Solutions

According to Hastings. et al. 2013 , education, governmental support & interference , all have constructive effects when it comes to the increase of financial knowledge (Hastings, Justine S. et al 2013). In addition, according to Omar & Inaba financial inclusion has been shown to decrease poverty within a population (Omar and Inaba, 2020).

According to the U.S. National Strategy for Financial Literacy in 2020, they defined governmental support and interference to be actions taken by the federal government, such as policy making, study development, and resource production, in order to support, inform, and provide for Americans' need or access to financial education (National Strategy 2020). As for the effects of these actions, according to Thaler & Sunstein, it was determined that the elimination of forethought decision making when it came to practical saving, was deemed better recommended compared to allowing citizens the ability to decide (Thaler & Sunstein 2008). In other words, giving people less decisive abilities when it comes to their savings showed beneficial results. According to multiple case studies, such as Madrian, Shea 2001 and Beshears et al. 2008, it was found that the mandating but voluntary action of retirements savings in which a certain amount of money is automatically put into savings accounts, was shown to have higher contributions compared to those who were under “non-participation”, otherwise no default savings (Madrian, Shea 2001; Beshears et al. 2008). Another related study done by Thaler and Benartzi in 2004, determined that automated savings similar to those previously mentioned fostered likewise results. The method they used in the study applied an increasing amount of savings over a four year time span, showing higher rates of engagement and more savings (Thaler, Benartzi 2004), so successful that it led to specific changes within the Pension Protection Act of 2006 (Hastings, Justine S. et al 2013). A policy made specifically leaned towards workers protection and benefits, as well as retirement savings and accounts (Appleby, 2023). This act further encouraged US citizens to apply and register to automatic contribution and gradual escalation within their savings plans (Thaler, Benartzi 2004; Hastings, Justine S. et al 2013). These changes provide a constructive path as to what exactly works and reasons to go about in utilizing federal policy and support.

The most employed approach taken towards the improvement of financial literacy is financial education. This approach is developed using programs and improved teaching methods. For both schools as well as the work place, studies have shown higher financial literacy rates and thus the relevance of financial education (Mitchell, Lusardi 2015). According to the Federal Reserve Board, when students were faced with state mandated ‘rigorous’ financial education programs in a concise and coherent way, it was found to raise credit scores and lower risky credit activity (Brown, Collins, Schmeiser, Urban 2014). As for workers, research was done on a project named “Five Steps” by Heinberg et. al. in 2014 whose main goal was to instruct and assist on retirement planning (Heinberg et. al 2014). This program, packaged in short and understandable three-minute videos, was shown to produce short-term and medium-term effects applicable to a member’s knowledge about retirement planning (Heinberg et. al.2014). In addition, a 2001 program called “Money Smart”, financially supported by the Federal Deposit Insurance Corporation, was created for the purpose of developing and refining any age groups’ skills, knowledge, and confidence on the financial subject (Money Smart, 2024). It was later determined that after six years of progress, members within the organization were reported to have better decision making as well as a more positive mindset when it came to their finances (FDIC 2007). Surveys conducted 6 to 12 months after the program concluded, showed higher

involvement in financial practices such as budgeting and creating savings accounts. Specifically, results showed that 69% of people increased their level of savings after the program, on the other hand there was an increase of 61% in people who used budgeting/planning skills for their finances because of this program (FDIC 2007). The results of these studies give a strong indication of why it is important to push and advocate for an improvement in the financial teaching methods.

Finally, the last approach taken towards increasing financial literacy is financial inclusion. Financial inclusion is the process of ensuring financial education, services, and products to be easily accessible to all members of society (Sarma, Pais 2010). A study done by Md Abdullah Omar & Kazuo Inaba, has shown a beneficial impact of financial inclusion when it comes to poverty and income disparity. Using a grouping of annual panel data from 2004–2016, they concluded that results showed a negative correlation between financial inclusion and poverty/income displacement (Omar and Inaba, 2020), which means when financial inclusion is introduced and implemented, poverty and income inequality deplete. However, even though we know how effective financial inclusion can be, how do we know there's a need for it? According to the Federal Reserve System, there is a lack of access to basic financial services for low income households. (Federal Reserve 2022). The same institution conducted a study in which they split United State Citizens into 3 categories, Fully Banked, Underbanked, and Unbanked. The main difference between the categories is the owning of a bank account, and if they use alternative financial services such as payday loans and pawn shops. While Fully Banked and Underbanked include the access to a bank account, Unbanked means you commit no use to one, and strictly use alternative financial services. Problems begin to surface when specifically looking at the percentages between low income (<\$25,000 a year) and the ratio of the 3 categories. 17% of all low income citizens involved in the study were labeled unbanked, compared to the next income slot (\$25,000-\$49,000) who only had 4%, and the rest less than 1. To put this into a better perspective, the low income recorded during this study represented more than 78% of the unbanked individuals total. Breaking this down, those within the low income are not only more likely to use alternative financial resources compared to any other category, they're less likely to use a bank account (Federal Reserve 2022). These findings indicate a significant outlook on the gravity of how well financial inclusion has performed. Furthermore, these studies help simplify how productive as well as how important it is for there to be more financial inclusion within our communities, specifically those under the \$25,000 yearly income bracket.

Conclusion

In summary, research reviewed showed that higher financial literacy has numerous benefits: from improving a person's financial satisfaction to guaranteeing a better retirement. In contrast, lower financial literacy shows inadequate financial decisions which negatively impact a person's financial wealth. According to the research analyzed in this paper, a high percentage of low-income families have low financial literacy. Thus, they commonly make mistakes when managing their finances, further perpetuating the poverty surrounding them. The effects of these

mistakes range from insufficient funds when retiring to accumulating debt in the household. Using research showing the effectiveness of strategies used in the United States to raise financial literacy, we recommended possible solutions to these circumstances. Our recommendations to raise financial literacy in these vulnerable communities is to increase financial inclusion, make efforts to improve financial education, develop and utilize adequate governmental support and interference.

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Unraveling the Similarities Behind Deposit Accumulation in Alzheimer's Disease and Age-Related Macular Degeneration By Raffaella Rosadio

Abstract

Dry Age-related Macular Degeneration (dry AMD) affected approximately 20 million people in the United States in 2022. It is characterized by the accumulation of deposits composed of lipids including amyloid-beta and other proteins in the eye's retina. These deposits, called drusen, accumulate both under and above the retinal pigment epithelium (RPE), which can facilitate photoreceptor loss, eventually leading to blindness. Similarly, Alzheimer's disease (AD) which affects an estimated 2.7 million in the US is also marked by the aggregation of proteins and lipids in the brain. Amyloid-beta ($A\beta$) plaques and tau neurofibrillary tangles (NFTs) within the brain parenchyma form contribute to cognitive decline and memory impairment. However, despite these differences, both diseases share similar qualities in pathogenic processes such as oxidative stress, and dysfunctional complement activation. This review will explore the compositional resemblance of the deposits in dry AMD and AD, focusing on shared constituents: $A\beta$, other lipids, and proteins. Additionally, we will discuss one of the mechanisms underlying plaque formation: dysfunctional complement activation. By untangling these similar features, this review aims to provide broad insights behind plaque accumulation in pathogenic processes within the body.

Significance of AMD and AD

In 2019, AMD was found to affect an estimated amount of 12.6% of Americans aged 40 or older (Bressler et Bressler). Furthermore, it has been estimated that 90% of AMD diagnoses are in the dry form, rather than wet ("Age-Related Macular Degeneration: Facts & Figures"). AMD has early, intermediate, and late stages. As AMD progresses to a more advanced form, it is classified into two types: the more common-form dry AMD, and wet AMD both of which can lead to blindness (Vaughn N, Loveman E, Colquitt J, et al.). Dry AMD is classified by the accumulation of drusen extracellular deposits in the retina, without choroidal neovascularization (CNV), the growth of new blood vessels into the retina causing blindness (3). Geographic Atrophy (GA) is a more advanced late-stage dry AMD, where the accumulation of lipofuscin, a lipid residue, and a known constituent of drusen contributes to oxidative stress and damage to the macula. Lesions form throughout the macula, eventually covering the fovea which leads to irreversible vision loss (Bakri et al.) GA is not only limited to dry-AMD but also can develop in wet-AMD cases as well (Robinson). Dry AMD can cause vision problems, with GA causing problems seeing colors, visual acuity, and difficulty seeing in low light ("Geographic Atrophy"). There are currently no cures for dry AMD, and the accumulation of drusen in size and number over time increases the risk of progression to the wet form of AMD (Boal, Nina, et al). About 10% of AMD is wet, however, 90% of blindness caused by AMD is due to wet AMD rather than dry ("Age-Related Macular Degeneration (AMD) Fact Sheet"). These facts therefore

necessitate uncovering the mechanisms of drusen formation in AMD to slow down or hinder the progression of the disease to its wet form.

In 2023, it is estimated that over 6 million people, mostly 65 and older in the United States have AD ("2023 Alzheimer's Disease Facts and Figures"). This number could grow to over double by 2060 if measures to prevent, or treat AD haven't been well-established (2023 Alzheimer's Disease Facts and Figures). AD is the most common cause of dementia and a neurodegenerative disease that impacts cognitive functions like memory, and reasoning, eventually affecting day-to-day life("Alzheimer's Disease Fact Sheet"). AD has three main stages: early, intermediate(moderate), and late, but some articles have considered there to be five total, with preclinical preceding the early stage and the early stage being separated into mild cognitive impairment and mild dementia (Mayo Clinic Staff). The progression through the stages for patients is marked by a decline in cognitive functions, with the accumulation of NFTs made from tau proteins and amyloid plaques in various parts of the brain. The preclinical stage is marked by a lack of behavior change, however, the deposits in the brain are beginning to accumulate. Mild cognitive impairment is when the patient begins to have difficulty with decision-making, and memory. The next stage is mild dementia when the patient begins to have more severe behavioral changes and cognitive issues. Mild dementia is diagnosed when it becomes clear that the mild cognitive impairment is on account of AD, and the symptoms start to affect the patient's day-to-day life. Moderate dementia is characterized by the advancement of earlier symptoms which may require the patient to seek outside help to carry out functions. The last stage, severe dementia, is when the patient is entirely unable to function on their own. The patient will most likely not be able to communicate coherently and possess problems with physically moving (Mayo Clinic Staff).

Drusen & Plaque Location and Characterization

Brusch's Membrane (BM) is located underneath the RPE cells on the basal side and is often modeled using a penta-laminar model. Drusen, which are sometimes called basal linear deposits accumulate between the inner collagenous layer and the RPE Basement Membrane (Brm) (Despotovic). To properly study drusen accumulation in the retina, it is therefore essential to have a real or synthetic model for the BM to simulate real AMD-like conditions. Drusen also fall into different classifications based on their size: soft, intermediate, and hard drusen. Typically, hard drusen(put range here) is more common to see when imaging the retina with Optical Coherence Tomography (OCT) and is not normally a cause for concern (Despotovic). Unlike hard drusen, soft drusen lacks clear borders and is larger, as well as an indicator of AMD. Intermediate, or "medium" drusen falls in between the two and should be monitored for any changes in size. It is therefore important to further study the composition of drusen due to its significant role in the progression of dry AMD.

Plaque deposits and NFTs in AD spread throughout the cortex of the brain. Plaques are made out of beta-amyloid peptides, particularly beta-amyloid 42. Beta-amyloid clumps together in the brain when there is an excess amount and becomes neurotoxic which forms the

characteristic plaques in AD. The accumulation of these plaques are slow. Before, visualization of these plaques was only possible through autopsy. However, recently technology has made it possible to use techniques to visualize the plaques on live patients. It is now possible to use a Positron Emission Tomography(PET) scan for these plaques. Radiopharmaceuticals make it possible to see the amyloid plaques. Additionally, a new blood test has been developed which reliably has produced results of elevated amyloid levels in the brain.

Neurons typically are stabilized by tau proteins in microtubules when tau binds at the interface through residues(Kadavath et al.). However, in AD, tau's binding mechanism becomes impaired(Kadavath et al.), and instead of stabilizing the neurons tau starts to bind to each other ("What Happens to the Brain in Alzheimer's Disease?"). These form the characteristic tau tangles that ultimately impair neuronal signaling.

Complement Activation & Shared Constituents

Both dry age-related macular degeneration (AMD) and Alzheimer's disease are associated with specific molecules that appear in both drusen and amyloid plaques, respectively, highlighting overlapping pathological features. For instance, complement components are found in both conditions, The complement system is a series of proteins and proteases that activate each other in a cascade to activate an inflammatory response to an infection (Janeway CA Jr, Travers P, Walport M, et al.). It is composed of 3 pathways: the alternative, lectin, and classical pathways (Janeway CA Jr, Travers P, Walport M, et al.). The classical pathway is mediated by antibody-antigen complexes and begins with the binding of C1q to a pathogen's surface ("Classical Pathway"). This binding ultimately cleaves C2 and C4 and fragments C2a and C4b bind together to form the C3 convertase for the classical pathway("Classical Pathway"). Similarly, the lectin pathway forms the C3 convertase the same way except it is initiated through the binding of mannose-binding lectin (MBL), collectin 11 (CL-K1), and ficolins (Beltrame et al) The alternative pathway uses cleaved C3 from an amplification loop to form the C3 convertase. Once the C3 convertase is formed, a series of steps occur to cleave other complement proteins 5-9 to ultimately form the MAC complex or C5b-9 (Janeway CA Jr, Travers P, Walport M, et al. Immunobiology). Drusen in dry AMD commonly contains complement proteins such as complement factor H (CFH) complement C3, and the membrane-attack complex (MAC) (Boon et al, Nozaki et al.). Similarly, complement components are associated with Alzheimer's disease amyloid plaques, with plaques staining strongly in AD brain samples for both MAC and CFH(Morgan). In AD, formation of the MAC has been associated with synapse loss which affects cell signaling negatively (Cribbs et al.). In AMD, MAC can form channels that lead to lysis (Mullins et al.).

Amyloid-beta and amyloid-beta peptides, which are a primary constituent of Alzheimer's plaques, are also found in the deposits of drusen, although in smaller amounts (Prasad, T., Zhu, P., Verma, A. et al., Hampel, H., Hardy, J., Blennow, K. et al.). In Drusen, amyloid beta has been found *in vitro* to decrease cell viability, and increase VEGF expression in RPE cells(Joet al., Wang et al.). VEGF is a growth factor that stimulates the proliferation of endothelial cells under

Bruch's membrane, which can ultimately lead to choroidal neovascularization (Kwak et al.). Furthermore, both conditions feature apolipoproteins, particularly Apolipoprotein E (ApoE). In dry AMD, ApoE is present in drusen and influences lipid accumulation (Yamazaki, Y., Zhao, N., Caulfield, T.R. et al.), while in Alzheimer's disease, ApoE is a key factor in amyloid plaque formation and neuronal damage (Raulin, A.C., Doss, S.V., Trottier, Z.A. et al). The overlap of these molecules suggests common underlying mechanisms.

Oxidative stress in AMD and Dry-AMD

To perform its main functions, the RPE is enriched with mitochondria to maintain high metabolic activity (Jabbehdari et Handa). The mitochondria produce 90% of reactive oxygen species, which are unstable molecules that can accumulate in cells (ROS) (Jabbehdari et Handa). This activity keeps photoreceptor cells in the retina healthy, as well as enables the role of the retina in transforming light into vision (Ruan et al.). Several factors can induce oxidative stress in the retina: exposure to light when ROS exceeds the concentration of antioxidants and aging. The macula, a spot in the center of the retina, is exposed to light consistently and absorbs the light, causing additional oxidative stress (Ruan et al.). ROS generation during oxidative stress from light exposure has been proven to damage the cellular components that makeup drusen: lipids, proteins, and lipofuscin (Ruan et al.). Perpetual oxidative stress is a suggested trigger factor of AMD, which can cause tissue damage of the lipid-rich photoreceptor outer segments and lead to lipid peroxidation due to ROS (Kushwah et al.). Lipid peroxidation ends up damaging membranes and other cellular components as the carbon-carbon bonds in lipids are destroyed during this process through oxidation (You, W., Azuma, K., Iwagawa, T. et al.). Additionally, oxidative stress may have a role in drusen formation and complement activation, as lipid peroxidation products have been implicated as drusen constituents (You, W., Azuma, K., Iwagawa, T. et al.). Lastly, oxidative stress has been associated with complement dysregulation in AMD, and has been directly implicated in causing deposition of complement in drusen (Sivaprasad).

In AD, oxidative stress is similarly associated with aging. In the brain, the imbalance of antioxidants and oxidants results in the environment which also results in ROS generation. The mitochondria is a major contributor to ROS generation and under normal conditions support the balance between oxidants (Huang et al.). However, under abnormal conditions, excessive ROS generation can oxidize RNA, DNA, proteins, and lipids by damaging their cellular structures and can also lead to chronic inflammation (Huang et al, Markesbery et Carney). Complement proteins present in AD are markers of inflammation (Markesbery et Carney). Interestingly, these oxidatively damaged structures have been used as biomarkers of Alzheimer's (Buccellato et al.). Neurodegeneration has been suggested to be heavily associated with ROS generation (Buccellato et al.). ROS generation can occur as a result of A β deposition through interaction with mitochondria or the microglial surface, or increased levels of metals in the brain (Buccellato et al.). Oxidatively associated damage in Alzheimer's has been shown to decrease motor activity as well as lipid peroxidation (Markesbery, Forster et al.). Furthermore, lipid peroxidation has been

associated with amyloid β -peptide, a neurotoxin that contributes to the formation of plaques(Butterfield, Rukmangadachar et Bollu).

Conclusion

While dry age-related macular degeneration (dry-AMD) affects the eyes and Alzheimer's disease (AD) impacts the brain, their shared pathological features reveal intriguing parallels. The presence of amyloid-beta and other lipids in deposits of both diseases suggests a potential overlap in their underlying mechanisms. Additionally, chronic inflammation, oxidative stress, and dysfunctional complement activation characterize both diseases, indicating these factors play crucial roles in their progression. By examining these shared characteristics, this review highlights the potential for cross-disciplinary insights that could lead to novel therapeutic strategies targeting these common processes. Understanding the compositional and mechanistic similarities in plaque formation may provide a more integrated approach to addressing these complex conditions, ultimately improving prevention and treatment strategies.

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How do VR Tools Contribute to the Cognitive Rehabilitation of Athletes Who Have Suffered Concussions? By Ryan Cao

Abstract

This paper explores the recent integration of virtual reality (VR) tools in the rehabilitation of concussed athletes. Concussion is a traumatic brain injury that presents unique challenges in diagnosis, treatment, and recovery due to the diversity of symptoms and individuality of recovery from injury. Recent advances in VR technology offer promising new ways to improve the concussion rehabilitation process. This study synthesizes current research on the effectiveness of VR tools in the diagnosis, monitoring, and rehabilitation of concussion injuries in the sports population. Through a comprehensive literature review and case studies, this article highlights how VR can simulate real-life environments and situations for both cognitive and physical therapy, providing a controlled, adaptable and engaging platform for rehabilitation. VR's ability to tailor scenarios to an athlete's specific rehabilitation needs, from balance and coordination exercises to cognitive function and reaction time improvements. Additionally, this study provides insight into the psychological benefits of VR in athlete recovery, including increased motivation, engagement, and a positive outlook on the recovery process. There are also challenges and limitations of implementing VR in concussion rehabilitation, such as accessibility, cost, and the need for further research to establish standardized protocols. Despite these obstacles, preliminary findings suggest that VR tools have significant potential to transform traditional rehabilitation approaches, providing concussed athletes with a more comprehensive and effective path to recovery. Lastly, this study highlights the importance of interdisciplinary collaboration between technicians, physicians and sports professionals to optimize the use of VR in sports medicine.

Introduction

Concussion in sports is a significant public health problem due to its high incidence and potential long-term neurological consequences. A concussion is a traumatic brain injury caused by a blow to the head or body that causes the brain to move rapidly within the skull, this can lead to a variety of clinical symptoms that affect physical, cognitive, and emotional functioning. This paper presents information on the prevalence, impact, and rehabilitation strategies for concussions, the challenges and history of VR in rehabilitation, and future technologies and methods for applying VR in concussion rehabilitation.

Prevalence

The prevalence of concussions varies by sport and performance level, but certain sports are particularly known to have higher risks. There are evidences showing that contact sports such as football, hockey, rugby and soccer have higher incidence rates, for example, in the United States, soccer is one of the leading causes of sports-related concussions, the concussion rates are comparable to or even exceed those of other contact sports, with as many as 22% of all soccer

injuries being concussions (Larson, PubMed). The issue of concussions in soccer is significant, considering the sport's global popularity and the serious long-term consequences of such injuries, as will be discussed in the following. However, concussions are not limited to contact sports, they also occur in activities such as cycling, skiing and gymnastics, due to falls and crashes, highlighting the widespread nature of the problem.

Sport	Concussion Rate (out of 100000)	Reference
American Football	610	Orthopaedic Journal of Sports Medicine
Basketball	25	Journal of Athletic Training
Soccer	41	American Journal of Sports Medicine
Cycling	34	American Journal of Sports Medicine
Skiing	23	British Journal of Sports Medicine
Gymnastics	12	Journal of Athletic Training

Table 1: Concussion Rate in Different Professional Sports

The prevalence of concussions in youth sports is an increasing concern because recent studies have suggested that children and adolescents are more susceptible to concussions and may take longer to recover than adults. The Centers for Disease Control and Prevention (CDC) emphasizes the importance of monitoring concussions in young athletes to prevent serious long-term effects (Heads Up, CDC).

Impact

The effects of a concussion extend beyond the immediate physical symptoms and include headaches, dizziness and nausea. Cognitive impairments, such as difficulty concentrating, memory, and decision-making, may also occur; mood symptoms such as irritability, depression, and anxiety are common and impact quality of life.

Repeated and prolonged concussions can lead to more serious neurological conditions, such as Chronic Traumatic Encephalopathy (CTE), which is seen in athletes with a history of multiple head injuries, this raises serious concerns about the long-term health and well-being of contact sport athletes. For example, studies have shown that former American football players with a history of multiple concussions are at a higher risk of developing depression and other neurodegenerative conditions like Alzheimer's and Parkinson's disease later in life. Moreover, the presence of CTE has been confirmed in the brains of 110 out of 111 former NFL players who donated their brains for research, illustrating the severe impact of repetitive head trauma (CDC, Queensland Brain Institute, UofMHealth).

An article from the NCBI website discusses concussion, in sports, it's often resulted from direct impacts to the head or body, causing the brain to move rapidly within the skull, this can lead to cognitive repercussions such as difficulties with concentration, memory, and processing speed. Traditional rehabilitation methods may include cognitive rest, physical rest, and gradually increasing activity. Limitations include the challenge of measuring cognitive rest and the variability in individual responses to treatment. The University of Michigan Health's article discusses the complexity of concussion recovery, which includes acute symptomatic, recovery, and fully recovered phases. It emphasizes individualized and expert-managed care. The Return-to-Play process is gradual, starting with symptom-limited activities and progressing through stages of increasing physical and cognitive demands, always under medical supervision. The article also acknowledges the risk of long-term complications from repeated mild brain trauma, highlighting the importance of proper management and the need for ongoing research.

Rehabilitation Strategies

Effective rehabilitation strategies are critical to ensuring a safe return to play and minimizing the long-term effects of a concussion, including:

- Immediate response: Immediately recognize any signs of concussion and respond, including removing the player from the game until appropriate evaluation can occur.
 - Recognition and Immediate Action: Early identification of a concussion is pivotal. This involves recognizing symptoms like confusion, headache, dizziness, visual problems, and balance issues immediately after a hit or fall. Immediate action includes the athlete's removal from play, adhering to the "when in doubt, sit them out" principle to prevent exacerbation of the injury.
 - Sideline Assessment Tools: Tools like the SCAT5 offer a standardized method for evaluating suspected concussions. This quick assessment covers symptom evaluation, cognitive testing, and physical examinations, such as balance and coordination tests, to determine whether a more thorough medical evaluation is necessary (Echemendia).
- Medical Evaluation: A comprehensive medical evaluation to assess the severity of the injury and design a recovery plan.
 - Comprehensive Assessment: Following the sideline evaluation, a detailed medical examination by a healthcare provider with expertise in concussions is crucial. This may include neurological exams, cognitive testing, and sometimes imaging studies like MRI or CT scans to rule out more severe injuries.
 - Personalized Recovery Plan: Based on the evaluation, a tailored recovery plan is developed. This plan considers the athlete's symptoms, sport, and position played, addressing both physical and cognitive aspects of recovery.
 - Detailed Assessment by Healthcare Professionals: After an initial sideline assessment, a comprehensive evaluation by a healthcare provider with concussion expertise is essential. This may involve detailed neurological exams, cognitive

testing to assess memory and concentration, and balance assessments. Advanced imaging techniques, though not always necessary, can be used to exclude more severe injuries. Such as neurological exams, cognitive testing (used in 80% of cases), and balance assessments (used in 70% of cases). Advanced imaging, like MRI scans, is used in about 15-20% of cases to rule out severe injuries (Bazarian, Echemendia, Riemann).

- Development of a Personalized Recovery Plan: Based on the severity of the concussion and the individual's symptoms, a personalized recovery plan is devised. This plan includes specific recommendations for physical and cognitive rest, followed by a gradual return to school and sport activities, tailored to the individual's progress.
- Rest and Recovery: Initial physical and cognitive rest is critical to reduce symptoms and promote healing.
 - Initial Rest: The first step in recovery often involves a brief period of physical and cognitive rest, typically 24-48 hours after the injury, to allow symptoms to subside. This means avoiding activities that can exacerbate symptoms, including screen time, reading, and physical exertion.
 - Importance of Initial Rest: The first 24-48 hours after a concussion should involve rest, both physically and cognitively. This rest period helps in symptom management and recovery. Activities that may worsen symptoms, such as screen time, studying, or even physical activities, should be minimized.
 - Guided Resumption of Activities: Following initial rest, activities can be gradually resumed in a controlled manner, based on the individual's tolerance. The process is symptom-limited, meaning any activity that exacerbates symptoms should be halted, and the level of activity adjusted accordingly.
- Gradual return to activity: A gradual approach to returning to physical and cognitive activities, carefully monitored by a health care professional to avoid worsening of symptoms.
 - Stepwise Protocol: Returning to full activity follows a structured, stepwise approach, starting with light aerobic exercise and gradually increasing to more sport-specific activities, non-contact training drills, and finally, full contact practice and competition.
 - Monitoring and Adjustment: Each step should be closely monitored by a healthcare professional, with a minimum of 24 hours between steps to ensure the athlete does not experience a recurrence or worsening of symptoms.
 - Structured Return-to-Play (RTP) Protocol: A step-by-step RTP protocol is employed, starting with light aerobic exercise and progressing through stages that gradually increase the athlete's activity level to include sport-specific exercises, non-contact training drills, and eventually, full contact practice. Each step should

be at least 24 hours, ensuring the athlete does not exhibit or worsen symptoms before moving to the next level.

- Continuous Monitoring: Healthcare professionals should continuously monitor the athlete's progress through the RTP protocol, ready to adjust the recovery plan based on the athlete's response to increased activity levels.
- Education and Prevention: Educate athletes, coaches, and parents about the risks, symptoms, and management strategies of concussions to prevent initial and subsequent injuries.
 - Concussion Education Programs: Education on concussion awareness for athletes, coaches, parents, and sports staff is crucial. This involves understanding concussion signs and symptoms, the importance of reporting injuries, and the steps for safe return to play.
 - Implementing Preventive Measures: Preventive strategies include enforcing sports rules aimed at reducing head impacts, using proper protective gear like helmets, and teaching techniques to minimize the risk of concussion. Regular equipment checks and safety workshops can further aid in prevention efforts.

By addressing each of these areas comprehensively, it's possible to manage concussions effectively, ensuring athletes can safely return to their sport while minimizing the risk of long-term effects.

Background

VR technology has evolved significantly and is being applied in medical and rehabilitation settings to provide immersive, controlled environments for patients. In cognitive and neurological therapies, VR can simulate real-life scenarios for therapeutic purposes, aiding in the recovery of cognitive functions, studies are increasingly exploring the use of VR in concussion rehabilitation, looking at its effectiveness in improving cognitive and motor functions through engaging, task-specific exercises.

Virtual Reality in Rehabilitation

Virtual reality (VR) technology in cognitive rehabilitation, specifically concussion rehabilitation, utilizes immersive and interactive environments to aid cognitive recovery, VR creates simulated real-world scenarios that users can interact with, providing a controlled environment for cognitive therapy, these environments are designed to engage a variety of cognitive functions, such as attention, memory, and information processing, which are often affected by concussions.

VR tools and programs specifically for concussion recovery focus on simulating real-life tasks and environments, these tools are designed to improve cognitive function by allowing patients to practice daily tasks in a safe virtual environment. This approach helps retrain cognitive processes while providing clinicians with a way to assess progress and adjust treatment options accordingly.

The effectiveness of VR in cognitive rehabilitation is supported by multiple studies, these studies suggest that VR interventions may be effective in treating cognitive deficits in patients with neurological diagnoses, such as stroke, traumatic brain injury, and Alzheimer's disease. Innovations in this area include the use of rich virtual environments that provide multiple sensory inputs (visual, auditory, and tactile) and the use of commercially available gaming systems for telerehabilitation services. However, it is important to note that more research is needed to fully understand the effectiveness of these interventions. Recommendations for future research include improving the effectiveness of rehabilitation, increasing the scientific rigor of rehabilitation research, and expanding access to evidence-based treatments.

Empirical Evidence

Research on the effectiveness of VR tools in cognitive rehabilitation, particularly for concussed athletes, has shown promising results. A review by Soraya et al., conducted on this topic included ten studies using various types of VR-based interventions, including randomized controlled trials (RCTs), retrospective cohort studies, quasi-experimental studies, and case studies; interventions include immersive, semi-immersive and non-immersive VR technologies, often using Computer Assisted Rehabilitation Environment (CAREN) technology.

Together, these studies demonstrate an overall positive impact of VR intervention on a variety of cognitive and functional outcome measures, such as balance, gait, and function, demonstrating improvements in all areas from pre- to post-intervention. However, the quality of the evidence varied, with some measures receiving moderate quality ratings and others receiving low quality ratings. Furthermore, these studies highlight certain methodological limitations, such as the lack of group allocation or concealment of blinded assessors in randomized controlled trials, the lack of control groups in some studies, and the underreporting of adverse events in case reports.

Another study by Madeira Health Service in Portugal conducted a randomized controlled clinical trial in 18 stroke patients compared VR-based interventions with traditional interventions, the VR group conducts cognitive rehabilitation through a simulated urban environment, Reh@City, designed to train various cognitive areas such as memory, attention, executive functions and visuospatial skills. This VR-based approach offers an ecologically more effective approach to rehabilitation, allowing for comprehensive and personalized cognitive training. Patients interact with the virtual environment using a simplified interface, making the technology accessible even to people with motor impairments or limited computer skills. Therefore, VR-based interventions can provide a comprehensive cognitive rehabilitation experience that effectively bridges traditional paper-and-pencil tasks and real-life activities.

These findings suggest that VR is an effective tool for cognitive rehabilitation in athletes after concussion, with significant benefits in balance, gait, and functional recovery, however, more research is needed to fully determine the effectiveness of VR relative to traditional rehabilitation methods and to address the methodological limitations observed in some studies.

Challenges and Limitations

Challenges in Implementing VR in Rehabilitation

1. **Clinical Acceptance and Therapist Training:** One of the primary challenges is gaining clinical acceptance due to limited data on VR's medical efficacy. Additionally, therapists may require specialized training to effectively utilize VR technologies, which could be an obstacle due to the intricacies of computers, interfaces, and networks involved.
2. **Accessibility and Infrastructure:** Lack of computer skills among therapists, inadequate support infrastructure, and the need for an appropriate communication infrastructure, especially for telerehabilitation in rural areas, pose significant challenges. Accessibility issues also extend to patients living in rural areas who might benefit from telerehabilitation but face connectivity and infrastructure barriers.
3. **Costs:** Initial expenses for VR equipment can be high, which might hinder widespread adoption. However, VR rehabilitation has the potential for economy of scale, as the same VR hardware can be used for various types of patients and exercises, potentially reducing costs in the long run.

Potential Limitations of VR Tools

Cybersickness: The risk of cybersickness, which includes symptoms like nausea and dizziness, can be a limitation for some patients. This aspect needs careful consideration, especially in designing VR environments and selecting suitable patients for VR-based interventions.

1. **Need for Personalized Programs:** Rehabilitation often requires personalized approaches to address the specific needs and abilities of each patient. While VR offers adaptability, developing and adjusting VR programs to meet individual patient needs can be complex and resource-intensive.
2. **Data Privacy and Safety:** With the increasing use of telerehabilitation and remote monitoring, ensuring data privacy and maintaining patient safety becomes crucial, transparent data storage and secure online access need to be guaranteed to protect patient information.
3. **Patient Motivation and Engagement:** While VR can enhance motivation through interactive and engaging exercises, maintaining patient engagement over time, especially for home-based VR rehabilitation, can be challenging, strategies to keep patients motivated and engaged in their rehabilitation programs are essential for the success of VR interventions.

In conclusion, while VR in rehabilitation offers numerous benefits, including increased patient motivation, adaptability, and potential cost reductions, it's important to address the challenges and limitations to ensure safe, effective, and equitable access to VR-based rehabilitation services.

Future Directions

Advancements in VR technology hold significant promise for enhancing the effectiveness and accessibility of cognitive rehabilitation, especially for concussed athletes, the integration of Augmented Reality (AR) and Artificial Intelligence (AI) with VR can offer more immersive, interactive, and personalized rehabilitation experiences, these technologies can adapt in real time to the user's performance and provide immediate feedback, which is crucial for cognitive recovery processes. Moreover, the use of standardized assessment tools within VR platforms can facilitate the objective evaluation of rehabilitation outcomes, ensuring that the interventions are meeting the intended rehabilitation goals.

Additionally, investigating how VR rehabilitation can be integrated with other therapeutic modalities, such as physical therapy and neuropsychological interventions, could provide a more holistic approach to recovery for concussed athletes. This multidisciplinary approach could address the complex nature of concussions, which often affect both physical and cognitive functions.

Emerging VR technologies, such as those incorporating haptic feedback, biofeedback, and even olfactory cues, could further enhance the realism and effectiveness of virtual environments used for cognitive rehabilitation, these multisensory experiences could help in creating more engaging and effective rehabilitation sessions, potentially leading to better adherence and outcomes.

Conclusion

Virtual reality (VR) tools play an important role in improving cognitive rehabilitation in concussed athletes, highlighting the immersive and interactive environment provided by VR to promote recovery by simulating real-life scenarios and activating cognitive functions affected by concussion. Although the results are encouraging, the article highlights the need for further research to overcome challenges such as clinical acceptance, accessibility, and methodological limitations. The integration of advanced technologies such as augmented reality (AR) and artificial intelligence (AI) is considered a future direction for enriching the rehabilitation experience, and a multidisciplinary approach is recommended to achieve more comprehensive rehabilitation.

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Basics of Bioprinting: A Comprehensive Review on Current Developments and Challenges in Bioprinting

By Chloe Lim, Jordyn Lim, Su Hay Thi Lin

Introduction

Bioprinting has shown major potential for elevating how we treat patients. It simultaneously deposits living cells and biomaterials in precise layers to construct bioengineered products (Yaneva et al.). The products can be different biological structures made with precision that are personalized for the patient, reducing other various risks after transplantation (Yaneva et al.). Personalized parts have shown an accelerated skin tissue regeneration process and reduced patient waiting time (Yaneva et al.). This technology can also be used to create printed models to test different drugs and treatments, as well as comfortable prostheses that are more comfortable and personalized to the wearer (Yaneva et al.). This review will highlight the different ways to print, bioink selection, tissue engineering, skin regeneration, an introduction to use in cancer and drug research, and some drawbacks to the recent technology.

Process of Bioprinting

In any application, bioprinting can be broken down into three basic, distinct phases (Agarwal et al.). In the preparatory phase, a Computer-Aided Design (CAD) or Computer-Aided Manufacturing (CAM) model of the desired construct is generated and a suitable bioink is chosen for the application. This may take into consideration the mechanical and rheological—measurement of deformation—properties of the bioink. Next, the CAD or CAM model, along with the chosen bioink, is loaded onto a bioprinter in the printing phase. Lastly, in the post-processing phase, when printing is done in vitro, the construct is placed in a bioreactor while researchers monitor its maturation, and finally implanted into a living organism.

Scaffold-based and Scaffold-free Bioprinting

In general, the two main strategies in bioprinting depend on whether scaffolds are used, and each strategy affects the larger process of bioprinting. Scaffolds, printed using biomaterials like hydrogels, are supporting structures on which cells can be deposited onto during printing (jennifer89582, “Scaffold-free Versus Scaffold-based Bioprinting”). In scaffold-based printing, the scaffolds are designed to structurally mimic the extracellular matrix (ECM) surrounding the cells in order to avoid hindrance to cell-to-cell interactions (Agarwal et al.). This requires a CAD model to be generated for the scaffolds in the preparatory phase. In contrast, in scaffold-free bioprinting, cells are deposited in droplets inside of a temporary mold (Agarwal et al.). Bioink selection becomes essential in the preparatory phase for this strategy as cells with the ability to secrete proteins and enzymes needed to form their ECM must be incorporated into the bioink.

Methods in Bioprinting

Inkjet Bioprinting

Resembling modern-day printers (that print on paper), inkjet bioprinters are known for their speed and affordability. At its basic level, inkjet bioprinting involves the discharge of droplets of biomaterial onto a build platform, the surface on which the print will be constructed.

In continuous inkjet (CIJ) printing, the inkjet continuously discharges a conductive bioink using a constant pressure (Agarwal et al.). Then, an electric field deflects the ink onto either the platform, when the droplets are needed to form a construct, or into the gutter to be reused.

Another inkjet bioprinting process, drop-on-demand (DOD) printing uses pressure pulses to trigger the discharge of droplets “on-demand”. DOD printers commonly use thermal energy to form the bioink droplets, and, though less common than thermal energy, piezoelectricity—electricity generated from mechanical stress—can also be used.

Inkjet printers are the most widely-accessible bioprinters thanks to their low cost. They are also able to print at high resolutions and with reliable speed. However, these printers are limited to lower viscosity bioinks, as the risk of nozzle damage increases with the high pressure needed to discharge a high viscosity substance. Low viscosity bioinks also make cell encapsulation, the process in which living cells are immobilized in a bioink to prevent organ rejection upon implantation, much more challenging (Agarwal et al.).

Extrusion-based bioprinting

Using a method almost identical to today’s 3D printers, extrusion-based bioprinting uses pressure generated from mechanical (threads) or pneumatic (piston) mechanisms to dispense bioink continuously from a nozzle. From the printing of skin to cardiac tissue, this method is preferred over others due to its cost-effectiveness and ability to print high viscosity bioinks and high cell densities (Agarwal et al.).

However, the drawback of this method mainly comes in its lack of precision. For instance, limits to the size of a nozzle mean extrusion methods cannot be used to print at low resolution. Additionally, extrusion-based printing means that porosity, a property that distinguishes the types and functions of various tissues, is only controlled by the negative space between infill layers, not the geometry of the infill layers themselves. This limits the shapes and sizes of gaps that can be printed. Due to the small contact area between each layer, extrusion-based bioprinting is also less ideal for printing organs that endure high pressure (such as blood vessels), as the layers can easily get separated and cause the printed construct to rupture when placed under stress. Lastly, due to the nature of using pressure to dispense bioink, cells also run the risk of being damaged or destroyed in the process of being dispensed from the nozzle of the printer (“Extrusion Bioprinting vs DLP Bioprinting, Explained Simply - CELLINK”).

Light-assisted Bioprinting

Laser-assisted Bioprinting, commonly referred to as LAB, uses the method of laser-induced forward transfer (LIFT) to create a biological construct using biomaterials. LAB's main component is referred to as a ribbon, or a target. The ribbon has a core with a transparent material (often glass or quartz), used as support for the other layers, and needed to ensure that the laser is both unobstructed and unable to directly interact with the bioink layer, which can cause cell damage or death. The transparent core is then covered with a metal that can absorb the laser. Lastly, the uppermost layer of the ribbon is a coat of bioink.

During printing, with the help of several reflecting mirrors, the laser is directed into the core of the ribbon. The metal then absorbs the laser, heating up this layer locally, and leading to vaporization. This then creates a high-pressure bubble underneath the bioink layer, triggering a small droplet of bioink to be deposited onto the receiving surface, often called the substrate, at a desired location. The process is then repeated many times, with the laser angle adjusted to precisely control the location of bioink deposition on the substrate (Chang and Sun).

The main advantages to using LAB stems from the fact that this method is nozzle-free, allowing printing at a higher resolution and with much more precision. However, the mechanisms involved in LAB, including the complex system of mirrors that reflect the laser at a predetermined angle to initiate LIFT, as well as the metal layer that absorbs the laser, must be assembled and calibrated with high precision. This, along with the cost of these printers, limits the size of objects printed, and makes LAB printers accessible to only a handful of researchers (Kačarević et al.).

Stereolithography (SLA) and Digital Light Processing (DLP) Bioprinting

Both SLA and DLP bioprinting depend on the utilization of photosensitive bioinks, which include photoinitiators, chemicals that initiate the curing process that can harden liquid bioinks. Printers usually consist of a vat, into which bioink flows, a light source, used to cure the bioink in selected areas according to the geometry of each layer, and a building platform, which is submerged in the bioink during printing and is moved along the z-axis after each layer is printed. While SLA printers use a light source (often laser or UV) that scans the surface of the building platform, curing the bioink at selected areas, DLP printers are equipped with a digital micromirror device (DMD), which is able to project the geometry of the entire layer onto the surface of the printing platform, making the curing process much more time-efficient.

SLA and DLP bioprinting are known for their efficiency and capability of printing at high resolutions. However, as these printers rely on photocuring, bioinks are limited to only those that are photosensitive (Li et al.).

Method of printing	Resolution	Cell viability	Viscosity of bioinks printed	Relative Cost
Inkjet printing	<5-50 μm	85-95%	3.5-12 mPa/s	low-moderate
Extrusion-based printing	> 5 μm	50-90% (varies based on nozzle type and diameter)	30 to $>6 \times 10^7$ mPa/s	low
Laser-assisted printing	> 100 μm	90-100%	1-300 mPa/s	high
Stereolithography	> 50 μm	85-90%	1-300 mPa/s	moderate
Digital Light Processing	<50 μm	75-90%	1-300 mPa/s	moderate-high

Table 1 – Comparing printing resolution, cell viability, viscosity of bioinks printed, and relative cost of various bioprinting methods (Cui et al.; Miri et al.; Tripathi et al.; Malekpour and Chen; Gopinathan and Noh; Ioannidis et al.; Pérez-Cortez et al.; Tong et al.; O’Neil; Gama et al.).

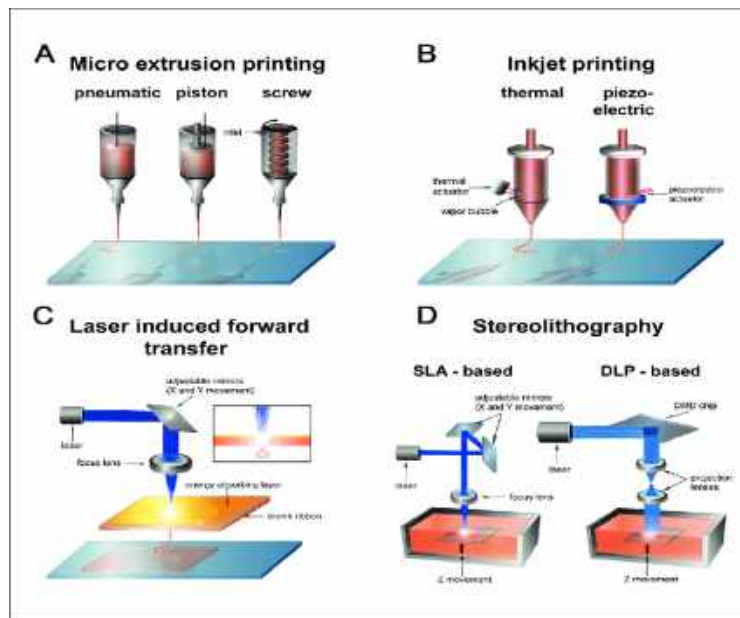


Fig 1: "Schematic representation of the most commonly used bioprinting technologies (A) Extrusion bioprinting, (B) inkjet bioprinting, (C) laser-induced forward transfer (LIFT), and (D) stereolithography. SLA, stereolithography; DLP, digital light projection" by Johanna Berg is licensed under CC BY 4.0

Bioink selection

Biomaterials

Biomaterials contained in bioinks are chosen based on various factors including, but not limited to, gelation process, crosslinking density, rheology, chemical composition, and compatibility with the printing process and any cells in the bioink.

Gelation is the process of crosslinking materials to form a gel-like substance impermeable to water. Two main techniques are used to crosslink materials: physical/reversible

crosslinking, which utilizes naturally occurring phenomena—such as thermocondensation or self-assembly—to link one polymer chain to another, and chemical/nonreversible crosslinking, constituted by the formation of covalent bonds. The latter is often preferred in gelation as the covalent bonds offer much stronger mechanical properties than those resulting from physical crosslinking.

Rheology is an important factor to consider for inkjet and extrusion bioprinting. Not only do these types of bioprinting warrant the usage of a shear-thinning bioink, a bioink whose viscosity decreases as the force applied on it increases, but bioinks must also harden swiftly once dispensed from the nozzle to allow the printed construct to keep its stability and shape.

In many applications, hydrogels, crosslinked hydrophilic polymer chains, are the most commonly used materials (jennifer89582, “Choosing a Bioink for 3D Bioprinting”). Natural hydrogels, such as alginate and hyaluronic acid, usually mimic the ECM of the cells, and are further modified chemically or combined with another polymer to enhance physical and/or mechanical properties. For instance, a substance known as GelMA (gelatin methacrylate) is a result of chemically modifying gelatin to introduce methacrylate groups, which form covalent bonds between polymer chains when light interacts with the substance. As a result, GelMA is a common bioink component in light-based bioprinting (jennifer89582, “Choosing a Bioink for 3D Bioprinting”).

Cell sources

In various bioprinting applications, cultured cells may be incorporated into the bioink to ensure that the printed construct integrates smoothly into the native tissue. However, as specific cells are difficult to culture and isolate from the patient, stem cells—often from bone marrow, fat, and perinatal stem cells from the amniotic fluid—are cultured to be used in autologous, patient-specific applications. Similar to biomaterial selection, physical forces, such as those applied on the bioinks, and thus the cells in it, by bioprinters during the printing process should be taken into account, as cells may be damaged or killed as a result of such forces. In addition, the proliferation and differentiation rates of stem cells are also closely monitored after the construct has been implanted into the human body; in normal conditions, proliferation in the initial stage should be high, but, over time, proliferation should enter and remain at a stable range to prevent hyperplasia (Xie et al.).

Type of Biomaterial	Advantages	Disadvantages
Natural Polymers	Mimics ECM well	requires modifications to achieve desirable mechanical properties
Synthetic Polymers	easily modifiable chemical and mechanical properties	poor biocompatibility
Cells	allows for autologous transfers	short lifespan; cannot withstand shear force in certain printing techniques

Table 2 – The Advantages and disadvantages of using natural polymers, synthetic polymers, and cell sources in bioprinting (Xie et al.).

Applications

Tissue Engineering

By enabling researchers to print at high precision and customize the materials of the printed construct, bioprinting has proven to be advantageous in a wide-range of tissue-engineering applications. Among others, bioprinting has been used in the fabrication of small-scale bone, lung, and skin constructs.

Bioprinting, which allows customizable geometry and materials of a construct, has been used to create scaffolds with improved bone regeneration. For example, in a 2017 study by Qi et al, researchers utilized bioprinting technologies to mitigate the effects of bone damage, such as from trauma, infections, and genetic abnormalities, on patients. Extrusion-based bioprinting was used to create scaffolds made of calcium sulfate hydrate (CSH) and mesoporous bioactive glass (MBG), and these scaffolds were tested against traditional scaffolds made only out of CSH. 3D printing technology, especially in the preparatory phase, was particularly advantageous for this application as researchers were able to precisely control the geometry of the scaffold, including the size, shape, and pattern of its pores, which greatly affects osteogenesis on the scaffolds. After statistical analysis comparing the CSH and MBG scaffolds against CSH scaffolds on various factors, the researchers noted that, in in vitro environments, a higher level of MBG in the scaffolds correlated with higher levels of pH in the surrounding environment, thereby mitigating inflammation caused by acidic environments, as well as that the level of apatite, the main inorganic component of hard tissues—such as bones—in the body, improved with increasing MBG content in the scaffolds (Qi et al.). Micro-CT and histological analysis in rats with calvarial defects after 8 weeks post-implantation also revealed significantly higher bone mineral density and bone volume in groups treated with the CSH/MBG scaffolds compared to those treated with the CSH scaffolds (Qi et al.).

In addition, the precise control over geometry and incorporation of cell sources into bioink has enabled the bioprinting of structurally and functionally accurate lung tissue. For instance, in a more recent study in 2021, Kang et al, used drop-on-demand inkjet printing to

create a physiologically accurate model of the human respiratory system to aid in researching high mortality pulmonary diseases. The team printed a three-layered alveolar barrier model, intended to mimic the alveolar-capillary barrier that controls the gas exchange between air and blood, using four distinct alveolar cell lines. The researchers determined that the bioprinted model more accurately mimics the structure, morphology, and functions of lung tissue compared to prior 2d cell cultures and 3d models consisting of only one cell type (Kang et al.). This again highlights the unique capabilities of bioprinting in creating high-resolution, precise geometries and customizable cell sources, and its usefulness in tissue engineering. The alveolar barrier model was also found to accurately reproduce the response of human alveoli to influenza infection at the tissue level, leading researchers to believe that this bioprinted technology will aid in further research on respiratory diseases, drug screenings, and toxicology (Kang et al.).

Lastly, bioprinting has also been advantageous for skin regeneration technologies, as the incorporation of cells into bioink lowers the risk of rejection upon implantation. For instance, in treating skin damage from burns, traditional methods, such as grafting and using skin substitutes, can lead to donor site morbidity and rejections. On the other hand, bioprinted skin can incorporate multiple cell types found in the three distinct layers of the skin, reducing the risk of cell morbidity. In addition, as discussed before, bioprinting also allows researchers to customize the construct to the patient by culturing stem cells, reducing the risk of rejections (Varkey et al.). Currently, the main bioprinting methods used to construct skin are inkjet, extrusion-based, and laser-assisted bioprinting (Augustine).

Cancer

The microenvironment for cancer is very complex, making it difficult to study with two-dimensional cell culture models. Advances in three-dimensional tissue engineering have allowed for more accurate models (Datta et al.). The three-dimensional models have the potential to precisely define the position of cell types so it is more accurate to the cancer microenvironment (Datta et al.). Two dimensional models are oversimplified and cannot address many physiological questions.

Most deaths related to breast cancer, the most diagnosed cancer for women, result from the cancer spreading to other parts of the body, so the time of diagnosis and treatment is important. Using bioprinting, scientists can create the reliable breast cancer models needed (Parodi et al.). Scientist Cambell uses bioprinter to print the breast cancer cell line MCF-7 so they can observe the aggressive properties in the cancer spreading which also shows potential in models for drug discovery (Parodi et al.). Other cancer cells and healthy cells can be printed to see how they react to different treatments or lack of.

Drug Testing

Three-dimensional printing has also been applied to drug testing. This allows for the development of customized drug screening and delivery systems that are personalized to the patient (Gao et al.). Currently, drugs are tested with animals, which raises ethical concerns and

does not properly represent human tissue, leading to about half the drugs tested being toxic to humans (Gao et al.). To develop a drug, the potential drugs go through a drug screening and then clinical trials to check that it is safe for humans to use and it does its purpose (Gao et al.). Approximately half of the drugs tested are failures because of unpredictable drug toxicity and inefficiency (Gao et al.). Three-dimensional printing accurately deposits the biomaterials like cells from the patient so the environment is as close to a human as possible (Gao et al.). The printed materials also allow for individually controlled doses that are customizable and match the patient better (Gao et al.). This technology has been shown to print organs like livers in order to study the substance exchange during drug metabolism (Gao et al.).

Drawbacks in Bioprinting

Most of the challenges that have been researched are in tissue engineering. One major issue in tissue engineering is the need for autologous cells, which are cells derived from the patient the tissue is for. These are the most appropriate cells to use compared to cells from other humans or animals in order to avoid being rejected from the body (Ikada). The main issue with these cells is that it may be difficult to harvest a sufficient amount in elderly patients or patients suffering from severe diseases (Ikada). Once it is determined that enough cells can be safely harvested, the cells are expanded by cell culture, which comes with more risks. This included the time consuming process of expanding cell culture and the requirement of a clean cell-processing center to avoid contamination (Ikada).

Choosing a material for creating scaffolds for the tissues has remained a challenge in this field. The materials that have recently been used are biodegradable metal alloys that are not only biodegradable but still have the properties of metals to help reduce inflammation and osteolysis (Liebert). The challenging part is the specific alloy that should be used. Magnesium-based alloys have been seen in many different medical settings such as cardiovascular and orthopedic surgery because it is absorbable and can help many cell functions such as intracellular transport, signal transduction, and energy metabolism (Liebert). The draw back of this material is the fast corrosion that cannot be controlled. A suggestion has been to incorporate zinc alloys to moderate the corrosion rate of the magnesium, but this is still being researched (Liebert).

When using animals to assist in tissue engineering, it is important to be aware of their well-being to avoid exploiting and abusing animals. Scientists have been aiming to reduce the amount of animals needed in an experiment by using one large animal as opposed to small animals and continuously monitoring each animal (NIH).

Human tissue is handled very carefully to be considered ethical. Consent must be very thoroughly explained in all procedures and should be voluntary (NIH). It may be difficult to obtain consent, for example, in patients that are impaired and may not be able to consent. Doctors have to be willing to give resources to help people understand what they want to do with the tissue and avoid coercing patients into making decisions by explaining the benefits and risks involving tissue engineering (NIH).

Conclusion

Various strategies and materials are used in bioprinting, each with its benefits and drawbacks. However, bioprinting has become increasingly important in the medical field as it allows accurate modeling of the structure, morphology, and functions of small-scale human organs and tissues. This not only allows researchers to model diseases and test drugs in vitro, but also opens up the possibility of printing partial and full organs for transplantation in humans. Specifically, progress in modeling different cancers has been made, creating an accurate environment for better understanding and studying. Similar progress has been made for drug testing, replacing unethical animal testing with more accurate human tissue models.

Before attempting tissue engineering, it is important to consider all of the potential challenges and drawbacks, including but not limited to, a limited supply of autologous cells, challenges in selecting materials, and ethics when handling biomaterials. However, these potential issues can be avoided by using the proper research and implementing protocol to protect animals and humans affected by research.

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How Has Generational Trauma Affected How Society Judges Beauty in the POC Community? By James Nguyen

Abstract

Beauty is an amorphous concept that is constantly discussed for its bewildering ambiguity that manages to penetrate into the real world with real life effects. Thought to be forever changing and stagnant all at once, beauty is an abstraction that remains uncaptured and impossible to originate. This research paper will detail the history of beauty and more, specifically aiming to answer if familial relationships influence one's standards of beauty greater than that of social or societal ones. Though eurocentric standards of beauty induced by the media have been vocalized clearly, it is much less common to see someone blame the people they are around most for their aesthetic attractions. In an attempt to answer this unorthodox question, this essay will consist of a Literature Review, a Methodology plan, and an Analysis and Conclusion. The literary examination will be divided into four key ideas of Generational Trauma and History, Pseudoscience and Inherent Values, Science and Data, and Beauty Culture and the Cosmetic Industry. To collect data, three methodologies were proposed and enacted, of which being a survey, a set of interviews, and data collection. This study is ultimately in pursuit of the absolute origin to beauty and how it remains a conundrum of shifting perspectives and stagnant ideals. All the archival data and collected information conducted will be encompassed by an analysis and conclusion of the question: How has generational trauma, inflicted primarily through parental influence, affected how society judges beauty in the POC community and has it changed how current and future generations are raised?

Literature Review

Introduction

In a society upheld by the avaricious nature of greed, the beauty industry, and thus society as a whole, generations before and after have invariably been afflicted with absurd standards of beauty that do not follow the respective cultural or individual identities of the people they claim to benefit. This excessive critical criterion is constantly and consistently conveyed through means that are only being noticed now in the twenty-first century. Found in mediums such as television, social media, and expensive products, the beauty industry preys on men and women, boys and girls, and young and old alike. However, a new thesis can be found within this predatory use of technology---one much older and more inherent than the capitalism of the new age.

In this thesis, a new yet familiar conclusion can be uncovered: the constant and constrictive power of guardians. Contradicting the supportive ideals that uphold parental figures, it is possible that the high bars set for adolescents are actually constructed by the very people who raise them. Though eclipsed by the cries against social media, many sources, both scholarly and casual, support this surprising conclusion of hereditary authority and trauma. Though the

evidence is concrete, it is incredibly sparse, and as such skepticism runs rampant in an argument such as this. To combat the idea that beauty is based purely on societal standards and rather familial ones, this paper will examine the influence of guardian relationships through four key perspectives, that of historical trauma, pseudoscience, science, and ‘pretty’ culture, all of which are encompassed by the overarching question: How has generational trauma, inflicted primarily through parental influence, affected how society judges beauty in the POC community and has it changed how current and future generations are raised?

History/Generational Trauma

The indoctrination of beauty standards, western or other, throughout the world is a product of history and generational influence passed along a tumultuous, ancestral assembly line. Though beauty may be “in the eyes of the beholder”, to some extent, it is largely a societal fallacy to exhibit this cliché to its fullest. In risk of creating another cliché, it can be said that beauty is not in the eyes of the beholder, but in the eyes of those who have held you. It is clear, upon closer examination, that the most important individuals in a life, often parental figures, are the ones that affect said individual the most. Beauty standards are no different, and while a guardian’s well-meaning advice can provide aid at times, it is possibly detrimental in many other ways. The media often basks parental influence in a positive light, but it fails to discuss the shortcomings of being stuck to a single ideal for the majority of one’s formative years. The feeling of being trapped as a child is one that is understandable to many, and translates well into the realm of beauty, specifically, for the ‘beauty’ of the colonized. Colonization is a facet that remains a constant pressure in the POC community and is the crux of the conflicting and confusing standards of attractiveness.

To understand the effect of colonization, firstly, there must be a preface of its events. Though there are far too many instances of colonization to completely recount, the Western form of it, called occidentalisation, is the one this essay will most commonly discuss. Hannah Carlan, a literary critic, summarizes the harmful effects of occidentalization in her book review on Sabrina Strings’ “Fearing the Black Body: The Racial Origins of Fat Phobia”. The novel itself details how even traits thought to be inherent, such as fatphobia, are in actuality societal, and originated from Western indoctrination, rather than a bias towards the seemingly healthy. Though much of the article’s content is mainly attributed to Strings’ book, it is nonetheless a fascinating peek into how invariably the West has affected the world. Writing about the roots of fatphobia and how they inevitably lead to the anti-Black sentiment, Hannah Carlan notes how easily fatphobia captured the world, and how remarkable it is no one understands its origins of racial, not bodily prejudice. The standard of skinny and ‘healthy’ began much more recently than most would expect, illustrated upon the canvases of High Renaissance painters “where shapely white Venuses were prized and plumpness preferred” (Carlan), and the Black slaves seen as thin and sickly were discarded. However, this standard is quickly flipped as fatphobia within African racial categorization becomes a late 17th century issue. With the rising abundance of food, and its eventual decline as a status symbol, slaves were increasingly painted as stupid, gluttonous,

and ultimately fat, traits all absurdly tied to the warm climate of their origins. As such, the thin physique came into fashion, with it no longer being tied to the sickly slaves, but the dedicated and intellectual Europeans. Many tumultuous events follow this period, however, by the early 20th century, the fear of the fat solidifies, and all fields, cultural, scientific, and religious deem being plump to be a “sign of racial Otherness, intellectual inferiority, and moral debasement, [setting] the stage for a century that culminated in the newest moral panic around fat” (Carlan). The abundance of evidence and information piled around Black bodies alone show the extreme influence of colonization and how deeply they affect ideals that seemed previously inherent.

The standards of the colonizer are different than those of the colonized, a juxtaposition that can be perceived even in modern-day society and the modern-day generation. The cruelty of colonization is not in its erasure, but its permanence; an inescapable hand that grips onto the future to take the culture of the self, their children, and their children’s children. Tonya Russel is a perfect example of this broken self, a sentiment that she illustrates in her article *The Beauty Standards We Inherit*. As she puts it, “Sometimes, those we love can be the cause of our most painful insecurities” (Russel). Writing as a Black woman, she recounts her experiences in trying to fit into a world that does not want her, an experience she refers to as ‘aesthetic trauma’. This trauma was egged on by her own family members until her own reflection would become a struggle to identify with the ideals of skin tone, hair texture, and hair length that were all found in conflict with Russel’s own desires. To even be seen, she was forced to blow-dry her hair ‘into submission’, and when she stopped, her grandmother inquired as to why she would purposefully make herself look ugly. Aesthetic trauma does not merely stay within, it materializes into relationships, platonic and romantic, as well as physical scars. With hair being possibly the most convenient facet of beauty to change, acts such as ‘excessive pulling, and burns from styling hair with heat or chemicals’ have changed what many have agreed to be internal. Inflicted by the very people they choose to love, these flaws deemed to be physical, have become trauma manifesting not only mentally, but physically as well.

Occidentalisation is a term previously referenced in this essay, (see paragraph 4) yet it has remained truly unexplored up to this point. In a report similar to this, the International Socioeconomics Laboratory in Harvard writes about the surprisingly diverse beauty standards throughout Asia and the extent to which eurocentrism has affected the aesthetic culture of Central Asia, South Asia, East Asia, and the Middle East. Though the volume takes a primarily backseat approach to eurocentrism, utilizing an archival approach rather than an experimental one, it remains wholly fascinating in how it weaves European history with Asian culture, showing scholars how easily change occurs in realms as complex as beauty through geography and media. Central Asia, for instance, was partly isolated from the world due to their connection to the Soviet Union. As such, they adopted a heavy reverence for light skin, dark eyes, and dark hair, with disregard for darker skin as it was a sign of a low, urban status. Unsurprisingly, the cultural clash with Central Asia’s two dichotomies, those touched and untouched by the Soviet Union, caused a strange divide between the growing generations following the fall of the Soviet Union. This gap was only widened by modern media, which acted as a poor medium for those

who struggled with the heavy contrast between European beauty and Central Asian beauty (ISL Harvard). The team ultimately elaborates on other Asian identities as well, however their final conclusion states that the influence of “modern [eurocentric] beauty standards [is primarily] due to the influence American culture holds on the rest of the world” (ISL Harvard).

Pseudoscience/‘Inherent Values’

Though the origins of beauty standards can now be tied to the afflictions of family and the criticisms harbored by colonialism, there is still not a clear answer as to why these values have persisted for so long. How have values that are so clearly clashing found their home in the minds of a demographic that does not even want them? As stated previously, generational pressures are a sizable factor of this, forcing families to follow a certain mold in fear of being deemed even more different than they already are already perceived as. Carried through familial generations, they are consistently told that it is fact the White ‘look’ usurps their own, from their hair to their culture. These fabrications are clearly not made by virtue of fact, so how did they entrench themselves into one of the deepest connections known to man? Science, or in this case pseudoscience. Indoctrinated to be considered inherent to humanity’s origins and history, the pseudoscience of beauty utilizes the oxymoron of false math to support the very real false standard.

Evidence of mathematical beauty is seen quite prominently today, made real through three-dimensional renders and ‘scientific’ equations. The criticism of the encroachment of science onto subjective concepts such as beauty is one that is not taken as seriously and widely as one would expect. So common is the advancement of science today that planetary discoveries are seen as commonplace, with the proclamation that the world’s ‘most beautiful’ person is White seeming almost lackluster in comparison, and ultimately overlooked. That is not to say that everyone agrees with this sentiment, however, as student and journalist Summer Noblé states in their commentary titled What Do the ‘World’s Most Beautiful People’ Have in Common? They’re All White, that scientific experiments in pursuit of “a visual representation of what beauty means, [instead just reinforce] Eurocentric beauty standards that have long been valued over other traits” (Noblé). Opening their article with the methodology used by British scientist Dr. Christ Solomon in his experiment, Noblé notes how thoroughly the participants were examined, from their natural hair shape and color, to their facial symmetry. Even before this radical attempt at pinning beauty, there were numerous attempts to instill mathematical perfection into Western beauty---such as the British cashier Florence Colgate, who was deemed as having “the most beautiful face” by the Daily Mail---that used the ancient Greek concept of the Golden Ratio to determine her face to be the closest to flawless proportion. Dr. Christ Solomon follows these Golden footsteps West, as, he too, uses the ‘most beautiful’ traits determined by 100 surveyors to create renders that display the European standard at its fullest.

However, there emerges another doctor to counter the harmful results of Dr. Christ Solomon’s survey---a woman by the name of Dr. Furaha Asani---who writes that There is No Such Thing as a ‘Most Beautiful Person According To Science’. In her commentary on the many

‘Top 10’ lists that seem only to present Whiteness as the beauty standard through ‘scientific’ findings, she questions whether these lists are actually constructed with concrete evidence or fabricated to further America’s economic agenda. Her identity as a Black woman gives Dr. Furaha Asani a deeper connection with the argument for POC representation, doubting those who take the generalization of the White standard as The standard, and going past what is shown at face value. With her PhD in hand, and her position as a Biochemist in the other, she scrutinizes the ‘science’ behind these coveted lists. Conclusively, she discovers that though the experiments themselves are empirical in their observations, they are not replicable, transparent, or even objective in their mapping techniques. Dr. Furaha Asani concludes these claims made in accordance with ‘science’ are all disputable for the fact that they do not, in fact, utilize scientific principles but rather convoluted technology that only serves as a more credible medium of Westernization, and ultimately indoctrination.

Scientific Standpoint

Though the criticism of aesthetic pseudoscience may prove that some aspects of beauty cannot be purely explained mathematically---at least not yet---it is certainly untrue to claim that all perspectives of beauty cannot be explained through scientific terms. Pseudoscience is but a mere outlet for beauty industries and does not represent the capabilities of science in its unbiased, forever shifting entirety. As previously stated, society has not yet developed to the point where it can properly define abstractions such as what pleases the eye---nor will it ever. As such, this section of the literary review will only recount sections of beauty that can be properly measured, and even then, this report will tread carefully on beauty as a sign of intelligence, and further, innate evolution.

The idea that the more beautiful a person is, the more unintelligent they will be is a stereotype that is both harmful and incorrect. Likely rooted in a sense of insecurity against those who are deemed more attractive, it is commonly thought that the good looking spend more time on their appearances than their scholarly studies. Another cliché widely spread is that ‘beauty is in the eyes of the beholder’, and though this is true to some extent---evidenced by the research done in previous sections of this essay---the idea that beauty is objective also holds true. Written by Satoshi Kanazawa and Jody L. Kovar, the article titled “Why beautiful people are more intelligent” addresses both contentions in an empirical analysis on the correlation between physical attraction and intelligence. In order to properly carry out this study, Kanazawa and Kovar establish some key assumptions that, though logical, create possible fallacies that could detriment their experiment. Though their experimental process may contain some fallacies, experiments tackling specifications of beauty cannot be without faults, and therefore it is vital to still take into consideration Kanazawa and Kovar's analysis, using it as scientific reasoning despite its potential fallacies. In their paper, the authors suggest that beauty is an inherent factor, one that can be societally altered, but innate nonetheless. This can be evidenced by infants---who many consider as humans ‘untainted’ by the world---who are shown to stare at adults perceived to be physically attractive for longer. Additionally, infants aged twelve months display more

visible enjoyment and delight when playing with strangers wearing attractive masks than those wearing unattractive ones. Dolls that are higher quality, or more pretty, are played with more often and for longer periods than unattractive dolls. All this shows that, to a certain degree, the concept of beauty is innate, as an infant aged two-twelve months old cannot be properly exposed to media long enough to be properly 'influenced'. They also find that data from the Intergenerational Studies of Development and Aging "demonstrates that facial attractiveness significantly ... correlated with IQ among both men and women throughout the life course ... except late adulthood" (Kanazawa and Kovar). When examining correlational strength, the relationship between IQ and facial attractiveness is greater than that of education level and facial attractiveness. This data ultimately amalgamates to dispel the theories of beauty being skin deep, and that beauty is only in the eyes of the beholder.

Though the correlation between beauty and intelligence may not be very surprising to some, it is nevertheless a case of evolutionary advancement, and hereditary influence (PNAS). However, a research article published by the Proceedings of the National Academy of Sciences, titled "Human preferences for sexually dimorphic faces may be evolutionarily novel," may prove that an evolutionary aspect pertains to not only the advancement of beauty and intelligence, but also the societal perception of beauty, specifically in that of sexually dimorphic features. Sexual dimorphism is the exaggeration of masculine and feminine traits in the faces of their respective genders. Though it sounds obvious, most perceive women with highly feminine features and men with very masculine features to be more attractive (PNAS). It may appear as a strange bit of genetic chance that the features of masculinity and femininity materialize as they do, but studies by the PNAS indicate otherwise. Animals such as peacocks and deer also have sexually dimorphic features, indicated by their large feathers or antlers. Each of these evolutionary traits are a reflection of "a long evolutionary history of sexual and social selection" (PNAS) that stipulate aggression and attraction. Similarly, humans, surveyed through an extensive methodology on twelve different demographics, show that they too are attracted to the sexually dimorphic features of their preferred sex. Conclusively, this means that humans have been evolved to develop these attractions, thus showing that it is not just the societal or even hereditary values that affect beauty, but in fact a deep, and innate evolutionary draw towards dimorphic features.

'Pretty' Culture/Privilege/Beauty Industry

While the analyses completed in the above sections of this essay were fashioned to preface the discussion of beauty through an analysis of eurocentrism, 'standardized' values, and attempts at scientifically measuring beauty, this section of the literature review will focus on the modern impacts of what humanity has evolved to consider 'beautiful', as well as the potential privileges that culminate from this transition. Beauty is often, if not always, considered an advantage in spheres both personal and professional, hence the term, 'pretty privilege'. As such, this beauty is an asset that is highly valued and has been unfortunately commodified by the

beauty industry. The following papers will also scrutinize the inevitable impact of attraction, and how it has altered the self perception of generations both past and present.

Beauty's transition from a concept to a commodity can be blamed entirely on the Cosmetic Industry. The use of beauty products to enhance or even modify one's beauty can be traced as far back as 4000 BCE, with the Egyptian use of kohl as a product to enhance their eyes and shield from the sun (Anonymous, 2014). Exponentially, the production of cosmetics has evolved to become an industry goliath, predicted to be valued at \$425 billion dollars (Anonymous, 2014). To expedite the purchase of beauty products, the Cosmetic Industry is prone to changes, or 'trends', that force their target market, women, to change their appearances in hopes of conforming to the current standard and attaining the status of 'beautiful'. "From White to Very White to Kinda Brown: Analysis of Racist Practices in the Cosmetic Industry", is a student-written article that notes on this capitalistic exchange of beauty, and how it encourages those who naturally fit in with the eurocentric beauty standard by ostracizing those that do not; inevitably this creates an industry that appeals to both markets, but is nevertheless truly available to one demographic. This invisible barrier is established through White representation alone---through an overwhelming presentation of European women in media--- that only started to pander to women of color in the mid 20th century. Even then, the repositioning of the industry was done so only to market skin lightening cream, with advertisements depicting men who saw 'lightened' women as more attractive than their former selves (Morgan, 2018). What is most strange, however, is the cyclical nature of this industry, as Morgan notes that modern-day cosmetic products market themselves as 'exotic' and unique through their use of Western nomenclature used to describe foreign traits. For instance, in 2016 MAC Cosmetics fashioned a lineup of products they distributed as the "Vibe Tribe Collection", utilizing the Native American style to change the distinctly American style of the United States public (Morgan, 2018). Fascinatingly, the introduction of remote aesthetics is done not out of a hope for diversity, but rather a continuation of the adverse desire for wealth that drives the current beauty industry and the US economy as a whole. To change the status quo of the Western population is to create greater production levels, and thus greater revenue, with the Cosmetic Industry retaining their ultimately eurocentric views that now hide behind a facade of 'representation'.

Though the discussion of the Cosmetic Industry's avidity helps the collective further grasp how beauty's standards are both consistently induced and constantly changing, the question of why men and women seek to attain the standard is one that remains unanswered. It is commonly considered that to seek beauty is to seek attention, and further status. Those with beauty are thought to be placed on a pedestal and the ideal of humanity. However, it is never discussed if these perceptions are rooted in reality or fantasy, with real-life examples of beauty acting in one's favor being difficult to measure and even determining beauty as a suspect of goodwill is considered improbable. In spite of this, an associate professor at Rice University named Comila Shahani-Denning claims to have a potential answer to this question in her analysis of past experiments that attempted to identify beauty as a culprit for societal privilege. The most prominent of the experiments Professor Shanhani-Denning examined was an

application research done by Musumeci and Shahani conducted in 1996. This study utilized 207 volunteers, 96 of whom were marketing professionals and 111 being secondary school teachers. The volunteers were told to examine the credit of a job applicant for an entry-level marketing position. Job applicants were inspected through resumes rather than interviews, all of which were uniform. There was one clear distinction between each of the resumes, which was a prominent difference in attractiveness for candidates' photos. With uniformity across all resumes, attraction would be the only factor changing the suitability of an applicant, and it was found that those who were more attractive were deemed considerably more suitable for the job. This assumption of credibility at the hands of beauty is one that perfectly displays the effectiveness of beauty and acts as one of the many reasons why humanity as a collective seeks it. To choose a subject for a job merely for their curated looks is indicative of the innate draw towards the beautiful, and is the conclusive evidence needed to support why all of the above transgressions have occurred and continue to transpire.

Literary Conclusion

Through an analysis of relevant scholarly literature, society as a whole can benefit from the analysis of prevalence, malleability, and the innate evolution that prefaces the amorphous concept of beauty. Though there are a myriad of essays detailing their interpretations of beauty's current impacts, the information analyzed above is structured to create a linear progression of the history of attraction, its continual inculcation, its evolutionary past, and the current and long-term effects it will have on future generations. Humans are ultimately fallible and it stands to reason that only through critical auditing of attraction accounts may one understand the bigger picture of beauty's influence on both familial and media outputs, rather than through a microscopic examination of personal accounts alone. The extensive research conducted has made it apparent the origins of beauty are incredibly difficult to capture properly, however it can now be concluded that evolution, family, and social influence are crucial aspects of this concept, with all three as drivers for the pattern that remains in eurocentrism.

Methodology

Introduction

In order to create a proper consensus for this question, beauty must be not only prefaced but tested, to ultimately understand if hereditary trauma usurps that of social media or even the inborn characteristics to which most are drawn. It is only through hypotheses and experiments that the collective can reach an agreement, thus this section of the research paper will detail the methodology for understanding what drives beauty, whether it be social or familial. To achieve what has been stated, this research paper will detail three key processes that seek to quantify data through a randomized questionnaire, a set of interview questions, and data collection.

Survey

A custom survey made through Google Forms was chosen as the first method of choice due in part to the convenience of the Google platform itself, and also for the qualitative data it would provide. The digital form was divided into two key sections, the first being a background survey that would allow for proper analysis of all demographics, and the second displaying groups of people with similar aesthetic beauty levels, with each member in each group representing a different ethnicity.

During the creation of the form it became increasingly clear that distinction would prove impossible, as asking surveyors questions on attraction without proper segmentation of demographics would make the question of parental relations, specifically, that of people of color, that much more difficult to define. Thus, a preliminary questionnaire was drafted to solve this issue and categorize respondents' results for ethnicity and age group. Scaled questions (Appendix 1A and Appendix 1B) were also lumped into the first section, creating a clear divide between the literary data and qualitative, or pictured, data. The beginning questionnaire was made to act as the floor plan for the survey's latter section, achieved by crafting only four questions, only two of which connected to the theme of the survey. This would ensure a greater lack of bias, as volunteers would most likely lack a deep understanding of the form's contents. The concise nature of the survey would also lend itself to one of the survey's initial purposes, which was to capture attention and gather information with brevity.

The second section of this survey was a pivotal point in the form's results and a key aspect in the conclusive results of the paper. This section utilized five respective groups that were titled simply in the order they were given (Group 1, Group 2, etc.), decreasing bias and making the survey one based purely on personal attraction and unaffected by external factors. Each group would have a series of black and white headshots of models falling into the same sex but in different ethnicities and would ultimately ask surveyors which of the portraits they deemed most attractive. Models chosen for their respective groups were selected to match each other in beauty levels and age ranges. This would also decrease external factors in the survey's results and hone answers to be based on ethnicity and social/familial influences. To achieve standardization across group headshots, peers and mentors were asked if the models were similar in attractiveness. Those asked to monitor similarity were specifically noted and did not participate in the surveys themselves. In addition this group was made to be quite large and consisted of ten members that examined each group and headshot to ensure decisions were based on the sentiments of the surveyor, rather than a distinct disparity in facial beauty. In addition, the images would lack color, removing potential bias in saturation, and headshots would feature lighting and poses akin to others in their groups. Though the author is aware this system of standardization is quite flawed, the goal of achieving similarity in attraction without the employment of attraction itself is one that is nigh impossible. Nevertheless, traits prone to surveyor aversion and factors easily tweaked were removed and the survey was distributed to three groups of women and two groups of men.

When the basis of this survey was first drafted, there had been hope that conclusions gathered from this particular methodology would be large enough, and thus broad enough, to allow for a safe generation to the US population, as the equal spread in participants of different age groups should fairly represent most demographics. However, during the surveying process, it was found that there was a lack of participants within older age groups and very young age groups, thus causing a disparity in sample sizes between the opinions of younger generations and older. This was likely due entirely to the distribution of the survey, which was primarily sent to a high school population. The lack of responses is a severe limitation that will be taken into account when examining the results of this survey, though this is largely due to the absence of distribution of the survey's contents, with much of the survey process being done in person rather than being transmitted online. As the overall population of this survey totals to roughly thirty five participants, with a moderately even spread of racial demographics represented, hypotheses can be drawn with caution.

The questionnaire would be examined through the Responses section of Google Forms. As many of the questions are to deal with demographics in ethnicity and age group, they will not be placed in the Appendix, however the prevalence of certain races and generations will be considered in the Analysis. Questions pertaining to the model headshots will also not be displayed in the Appendix in an effort to keep model anonymity and will be written about with understanding that some models may have simply been seen as more attractive than others not due to ethnicity, but rather symmetry and structure of their features, essentially theorizing that some models presented could be more facially pleasing than others.

Interviews

While the broad consensus of a distributed survey provides a summation of current world sentiments on beauty, it does not allow for a close interpretation of beauty's effects and the personal issues it may instill. To circumvent this limitation, a set of interviews were conducted to establish potential factors that may go into a relationship; further cementing the conclusion on whether social or familial relationships affect one's standard of beauty more. Interviews would supply both a deeper understanding of the topic and also allow for a greater curation of collected data; as with the survey's results being a largely uninvolved endeavor, interviews would present an opportunity to delve deeper into the world of romance and the extent to which attraction plays a role.

To establish juxtaposition between those potentially affected by parenthood and those who were not, it was decided that two types of subjects would be interviewed: a married couple of the same race, and a married couple of different ethnicities. This would allow for the hopeful verdict that parental relations are crucial in affecting the ultimate romantic decision of a person of color, with those in same-race relationships being likely pushed into a marriage with their ethnicity, or purely conditioned to only be attracted to their respective race. In addition, the couples would have to illustrate a disparity in age groups when compared, showing the transitional growth of possible eurocentrism and hereditary pressure through a generational gap.

Though it was largely unimportant which of the two groups was younger or older, there was an aim to discuss marriage with a younger couple of the same ethnicity and an older couple of different races, with hopes that the older couple would demonstrate a possible societal advancement and the same ethnicity couple indicating a loyalty to heredity teachings.

In order to enact these interviews, emails were sent to various married couples that fit the target traits of the survey initially drafted. However, there was a prominent lack of responses, with those who answered the emails only doing so to turn down the interview. There are a multitude of reasons as to why this could be the case, however it is likely that the couples did not wish to disclose information they considered private, and furthermore, act as representatives for the specified study of a marginalized group they may have had no say in. Regardless, this hurdle was one that was significant, and with a lack of response for both types of marriages, it was proposed that relatives might be willing to discuss this personal topic (Appendix 3A). Fortunately, there was an interest in the interview's contents, thus the author's distant relatives became the focal points for the interviews performed. Relatives interviewed would be distant enough as to lessen discomfort in sharing personal familial matters with family, as much of the information shared did not pertain to this author. To circumvent a possible bias in responses and uncomfortability with sharing information, the anonymity of the interviewers was assured.

To protect the anonymity of the interviewers, the relatives interviewed will henceforth be referred to as Group A for the same-race relationship and Group B for the different-race relationship. Both Group A and B agreed to voice recordings of their interviews, however this was prefaced with the clear intention that the author alone would listen to the recordings and note their main ideas on paper, ensuring the identification of those interviewed. Discussions with both groups were administered seamlessly, with little discomfort displayed during the process. During the interview process, data was collected through key points written down and supported by voice recordings through a phone. With the questions themselves being thoroughly answered and providing different perspectives on both sides, it is safe to assume that deductions drawn are truthful, albeit microscopic in their affinity to generalization.

Each of the interviewee's responses were dissected through a lens of cultural significance and took into account outside factors that may have influenced their marriage rather than assuming all answers given were due to parental influence. As such, the analysis of the data would be conducted with awareness of bias and emotional enhancement. With this in mind, many of the interview responses lacked distinction across both groups, and though this will be noted, answers that were not as notable were omitted from further analysis.

Data Collection

To act as both the grid and ground for the data captured from the survey and interviews, additional research data was conducted, which acted as another avenue for data through a collection of statistics and an analysis of said statistics. This methodology is the shortest of the three, as it is mainly one that acts as a backdrop to be incorporated throughout the research paper, rather than a standalone source of data. Data utilized was discovered through researching

statistical evidence supporting the negative ethnic impacts of the cosmetic industry and familial connections to romantic racial relationships.

With the intention of creating figures that would be easily digestible and still retain the core ideas of the project's thesis, there was an effort to select only a few articles that each had either many bits of information, each of moderate importance, or articles with one or two crucial pieces of data that stayed consistent with the ideas of the essay. After extensive research, there were four articles chosen, each of which came from a different place on the spectrum of beauty's conceptual being. Strictly following the two types of articles listed in the opening of this paragraph, two of the four articles chosen had a vital piece of information, while the other two articles were a list of percentages and numbers following a line of reasoning that could lead to the conceptual identity of beauty.

The articles chosen that depict data were curated to display only their data and short analyses, with most elaboration on the statistics' ramifications being done through this paper. Each of the articles were checked to be scholarly reliable, and though some were dubious in the nature of their data presentation, such as the romantic advice site "2Date4Love", they all ultimately cited from proper sources, with each of the sites cited also being checked for credibility. Data collected from sources will be dispersed throughout the Analysis of this methodology and Conclusion of this paper, as it will support the data collected from surveys and interviews, as well as supporting claims made in the Literature Review.

Each of the articles analyzed were done so through taking the numerical data from their respective articles and examined both without the context of the article and with it. If the article's written information did not pertain to the substance of the research paper, it was discarded and the hard evidence they carried was utilized instead. However, in instances where the author's opinion was seen as pertinent and an enhancement of the data, context would be given and prefaced before further analyzation of the data's consequences on the essay as a whole.

Analysis and Conclusion

When this research paper was first written, there had been a clear objective in finding the root cause of Western beauty standards today and discovering the primary reasons as to why they were still so prevalent. Specifically, thorough investigations of beauty were conducted in the pursuit of potential hereditary influence, examining if a deep familial connection facilitated a specific perspective on attraction, even to the point of pressuring marriage of a specific ethnicity. Within many communities of color, there is a pressing oxymoron presented that asks these groups to conform to both their cultural origins and Western surroundings. Often when asked to follow one's culture, the individual is encouraged to date, and eventually marry, a person of the same race. Taking into account the familial push towards a learned attraction of one's ethnicity, and the desire to be synonymous with the eurocentric standard of beauty, this essay has examined the primary aspects of beauty most pertinent to this question, ultimately reaching the conclusion that family, though impactful, is altogether a lesser facet of beauty standards than societal demands.

Examined first through the Literature Review, the connection of family values on beauty standards seems to shift from an issue of cultural loyalty to a further indoctrination of eurocentrism. Evident within the Generational Trauma section of the archival analysis, there are few cases in which family pressures are noted to be placed due to culture, rather than conformity. In rare instances such as the analysis of occidentalisation in Asia, induced through conflicting magazines that display both Western garments and Indian traditional clothing (QUOTE), there are scenarios of family and generational influence affecting what is seen as 'beautiful'. Most common, however, is the familial effect on eurocentrism, where people of color are forced to change their appearances in favor of more Western traits, such as lightened skin, straightened hair, and pointed noses.

Data that resulted from the distributed poll also indicated a major lack in family impression for beauty, with more than 40% of survey participants answering that they felt their parents impressed a certain beauty standard with a score of 1 to 2, with the overall scale being valued at 5. This hard data serves ultimately as the antithesis to this essay's proposed hypothesis, stating that most of the current generation is influenced by the prevalence of social media, rather than the pressure of hereditary traditions. There was also a severe lack of correlation between one's ethnicity and preferred model, as all headshots ended with similar results in preference, where participants of the same ethnicity as the model were just as likely to choose the other headshots. Thus, the data for the survey acted as more of a support towards the social media hypothesis on beauty, rather than a specific family or racial connection.

From the interviews conducted, it was concluded that familial relationships were in fact important to the respondents, where Group A and B answered with different experiences what they believed to be most influential in their final decision to marry. Group A stated that they both began dating because they found each other attractive, both in physicality and personality, however they began thinking of a serious future when their parents mentioned that they were compatible as they "were both Vietnamese". In a continuation of generational traditions, Group A followed in the steps of their ancestors and married a person of their own ethnicity. In contrast, Group B stated that their parents did not affect their standards of beauty very much, if at all, with a greater emphasis on relationship improvement rather than relationship choosing. In general, it was observed that Group B did not have a specific standard for beauty, even within that of eurocentrism, and rather married for personality and attractiveness rather than racial preference. When comparing the information collected from the interviews with the survey, it is evident that both figures largely clash. This disparity can be possibly attributed to the generational gap between interviewees and survey participants, which may be large enough to create a disconnect in how relationships with parents affect matters of romance.

Finally, the analysis of data collection found a rather large emphasis on the beauty industry as a unit, and its predatory practices involving ethnic erasure. For instance, within the \$200 billion industry of cosmetic enhancement products, skin whitening creams stick out as blatant ploys for the White standard, where the creams are valued at \$8.6 billion as of 2020 (Hall, 2021). Furthermore, this massive market has been predicted to increase to nearly \$12

billion by 2026, with women accounting for 80% of all skin-whitening sales (CNN). As researched in the Literature Review, the indication that the beauty industry will continue its growth of revenue within the skin-whitening market is a sign that marketing methods utilized for eurocentric indoctrination are effective, albeit detrimental to people of color. Additionally, it was found that interracial marriages are quite uncommon throughout the world, with only 10% of the US population being married to an individual of different race (Drah). Strangely, this sentiment is also reflected across their offspring with only 22% of Americans believing that children of mixed heritage are good for society; though it must be noted that this particular piece of data was not further elaborated upon in terms of scope and methods of questioning. All in all, though 10% of a nation's population may sound like a large amount, it is strange to consider that within a randomly selected group of ten Americans, typically only one of the ten would marry another individual of a different ethnicity. What makes this collection of data most frustrating, however, is that it shows a clear discrepancy between the proposed standards of the current generations, which present themselves as impartial to racial attraction, and the actual standards of the generations, which are seemingly determined by one's ethnicity. Though this paper does not answer why this trend occurs, it circumvents a potential factor of this question by gathering that the influence of parents is not to blame.

In the end, the terminating conclusion of this paper has dictated that while familial relations can play a hand in one's beauty standards and romantic relationships, it is dwarfed by the sheer prevalence of social media alongside the vast reach of the beauty industry. Guardian impression is found to be a key factor in the inculcation of European standards, however they are not found to be very important and rather only seen as a single factor of influence for one's standards of beauty rather than a significant facet. Though this conclusion is deductive of the numerous works cited and analyzed throughout this written work, it must be noted that there may be a fair amount of bias throughout the paper's writing process, as the author themselves is very passionate about this topic. In future writings it would be beneficial to note a proper structure of literary review and experiments to ensure that both sections of the paper would intertwine to answer one essential question. Even without a concrete determination of beauty's origins, the very advancement of such an ancient concept remains a fascinating endeavor nonetheless. The process of delving into further explorations of commodity---where the capitalism of the US has been placed on psychology and in fields that go past even beauty---would be an incredible successor to this paper and show the ways indoctrination can toy with one's innate psyche.

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**Ethnic Elements in Fashion:
Commercialization Strategies, Cultural Impact, and Market Success
By Menghan Yue**

Abstract

This research delves into the recent emergence of ethnic elements in fashion, and it seeks to understand the methods fashion brands employ to commercialize these elements, and the motives and impacts behind them. It explores the impacts that these elements bring to a brand's reputation and the broader role of ethnic elements in promoting cultural dissemination and fusion. By citing examples from fashion runway shows, this research illustrates how these instances deepen people's impression of a culture, whether by upholding tradition or embracing innovation, leaving a profound impact. Picking the right markets, offering culturally relevant products, and conducting effective marketing are highlighted as crucial factors recommended for brands' success in incorporating ethnic elements. Designing with inclusive cultural understanding is also key. Drawing insights from past examples, this research seeks to theorize the impact, and cultural communications generated by fashion brands incorporating ethnic elements on the runway.

Keywords Ethnic Elements in Fashion, Commercialization, Cultural Impact, Cultural Dissemination, Cross Cultural Communication

Introduction

Diversity and inclusion are increasingly recognized on a global scale, influencing various aspects of lives. Organizations cherish diversity with DEI initiatives, and research also suggests companies with DEI policies outperform peers, with companies in the top quartile for ethnic diversity 36% more likely to achieve financial returns above national industry medians (McKinsey & Company). Education is becoming more inclusive, contributing to better societal integration and reduced inequality across diverse populations (UNESCO). In fashion, similar steps towards change mirror this wider societal progression. While most might think about diversity as variations in gender, race and other personal differences, diversity as a phenomenon fundamentally encompass cultural variations. This means spotlighting people whose diverse perspectives and actions stem from their unique environments and experiences. Fashion showcases this uniqueness prominently through cultural expressions.

In recent years, there has been rising popularity in fashion designs' incorporation of diverse cultural elements, making a shift towards inclusivity and cultural appreciation. This is particularly evident in the Haute Couture world, where the Fall Fashion Month in 2022 (The Fashion Spot) saw a notable rise in diversity, and where brands pushed boundaries by blending cultural references with modern design techniques. Fashion is becoming a powerful medium for cultural expression and communication. This research delves into the recent surge of ethnic and cultural elements in fashion, and it aims to theorize the methods and motives fashion brands

employ to commercialize ethnic elements, seeking to understand the impacts and cultural communications that arise from these actions. Drawing insights from past examples, it illustrates how these instances deepen impressions of cultures, either by upholding tradition or embracing innovation to leave a lasting impact. Strategic market selection, culturally relevant product offerings, and effective selling mechanisms emerge as crucial factors contributing significantly to a company's revenue and market success, underscoring the importance of selecting the right designer for ethnic attire.

Literature Review

This research focuses on analyzing the use of ethnic and cultural elements in fashion. Fashion elements, by definition, are the defining characteristics that govern good design – shape and form, line, color, and texture (FITNYC). Elements highlight the objects or pieces that express the designer's idea and allude to a central message and purpose that is going to be presented in a series of collections. Many of these elements are presented by showcases such as fashion runways as a sales promotion mechanism (Skov et al.). Fashion elements contain a wide range of choices of material, color, the way models walk and present, and environment, to contribute to conveying the designer's vision and aesthetic. Elements are powerful ways to express design principles that incorporate proportion and scale, balance, harmony, rhythm, and emphasis (FITNYC). All these elements come together to evoke a particular emotion, tell a story, and ultimately, leave a lasting impression on spectators, making the fashion runway a powerful platform for creative expression and communication in the world of fashion.

In contemporary fashion, there is increased attention towards embracing cultural elements in design, particularly those of ethnic nature, within the context of a culturally diverse population (Triandafyllidou). Individuals from diverse ethnic backgrounds have commenced the active promotion of their respective cultural heritages, resulting in a reciprocal exchange of ethnic customs that has evolved into a more popular phenomenon. This burgeoning cultural exchange has witnessed merging of different cultures with contemporary elements – traditional patterns, styles, shapes, craftsmanship, and other constituent components have been subject to innovative re-interpretation to capture the attention of a broad spectrum of consumers on the fashion stage (Kaya et al.).

In recent years, diverse fashion designs are seen more and more embodied in a global lens, reflecting different international cultures, and daily lifestyles on the runway. International fashion weeks such as Mercedes Benz STYLO Asia Fashion Week serve as a platform to showcase local fashion designers but also draw the attention of international buyers and journalists, since influential people, including celebrities, sponsors, buyers, stylists, journalists, and more often attend these occasions in getting a first look of the newest designs (Fraser). Similarly, in 2014, Kazakhstan started their first ever fashion week, which also received attention internationally (Koopmans). This global presence significantly contributes to advancing the globalization of the fashion industry (Nagle). The fashion weeks showcase not only the fashion

but also the music, art, and traditions of various countries, fostering a deeper understanding and appreciation of different cultures.

Building on the relationship between fashion and cultural expression, this research seeks to analyze the underlying motives and strategies used by fashion brands in the commercialization of ethnic elements. Fashion serves as a powerful medium for cultural dissemination and identity, and many dynamic elements shape the trends of fashion design. To analyze these trends, visuals of design and analyses of change through fashion activities such as runway shows are employed (Furukawa), and these methods will be used in this research. The integration of ethnic elements into fashion design also probes further analyses on authenticity, cultural appropriation, and brand positioning. By looking at how brands select, adopt, and market ethnic elements, this study aims to identify some driving factors behind decisions and their implications for both the fashion industry and the cultures represented. Overall, this research aims to provide insights into how fashion brands balance between cultural representation and commercial success with the use of ethnic elements in design.

Methods and Analyses

The integration of ethnic components into contemporary fashion designs signifies the blending of heritage and innovation, driving important changes that hold cultural and social importance. With increasing global traveling today, and the resulting exchanges of cultures, more diversity of cultures are being recognized and one important form of representation is through the various fashion element designs. This research analyzes several recent fashion events where ethnic elements were incorporated (with visuals) to theorize how fashion brands incorporate and commercialize ethnic design in fashion and aims to understand the impacts (positive and negative) of these new trends in fashion design.

Fashion brands use ethnic elements to shape their diverse designs, and one important way to use these elements is to highlight the stories and traditions behind where the elements originate from. One example of this is the Christian Dior Cruise 2020 show, which was a fashion and culture fusion that honored North African cultural artistry. Held in the El Badi Palace, this show celebrated Morocco's aesthetics and paid homage to its ancient dynasties while highlighting the preservation of local artist skills (Diderich). Dior stated that Morocco is at the crossroads of the Mediterranean, Europe, and Africa, hence the fabric designers opted for materials that represent a cultural convergence for this lineup. Similarly, Maria Grazia Chiuri, the collection's designer, worked together with the Uniwax studio located in Ivory Coast to merge designs and incorporate local culture as a multicultural design team. This collaboration gave birth to a series utilizing wax print fabrics refreshed with tarot designs that honor African traditional patterns and fashion. While honoring and representing the unique culture of Morocco, this show also celebrates Dior as a brand with continued customer attraction and industry impact. This collection appeals to customers who are interested in learning about the African region and culture, and the lineup, despite its haute couture nature, contributes to Dior's identity as a forward-thinking, culturally aware, and inclusive luxury fashion brand (Grosfilley).



Figure 1. Christian Dior Cruise 2020 Show, Photo credit - Morgan O'Donovan

Brand Reputation and Identity

The Dior story is a success of incorporating ethnic elements in fashion. Fundamentally, when luxury brands successfully incorporate attributes such as those highlighted earlier, they are able to establish lasting "labels" and iconic stories that greatly enhance a firm's standing. Brands host runway shows to express their identities. For example, Chanel's annual Métiers d'Art show, which serves as a testament to its rich history and unique traditional craftsmanship, positions the brand as a guardian of timeless skills. This becomes a label that transcends time, contributing to the brand's enduring legacy. Such initiatives not only elevate a brand's reputation but also open new perspectives, attracting a broader audience and potential buyers. Research indicates that maintaining a high brand credibility positively influences customer satisfaction, purchase intention, and perceived value (Cuong). For a fashion brand, capturing customers and industry attention with iconic aesthetics and creating a label-like effect can be a powerful means of brand promotion, fostering lasting impressions and ensuring sustained success in the world of luxury fashion. The increasing use of ethnic elements in design can be seen as brands' efforts to instill the image of diversity into their labels.

Besides the runway shows, brands use other platforms such as exhibitions and regular lineups to incorporate ethnic elements as well. In the "Across the Style" exhibition of YSL (National Art Center Tokyo), Saint Laurent designed haute couture items using elements across the globe, from Africa (use of embroidery but with western cuts,) Spain (inspirations from the history of Gypsy,) to China (showing the history of imperial times elements of opium and perfume,) Russia (showcasing the lavishness,) and Morocco (the theme of a "wearable garden.") These elements certainly promote culture in the haute couture fashion. However, they also focus on showcasing the unique design languages of the brand. The use of ethnic elements in fashion design sometimes shows more of the identity of the designer/brand, in addition to the promotion of the culture. These utilizations are always judged by haute couture standards, and will usually

be critiqued based on such lenses, which tend to focus on the uniqueness of designers' own identities.

Targeting Specific Groups of Audiences for Market Expansion

Brands strategically market to evoke a sense of national identity, friendliness, and pride among a specific group of customers. To achieve this, they choose to offer products that align with the culture of that region. For example, China has a longstanding cultural symbol of the twelve zodiac signs to celebrate a cycle of twelve years, and many luxury brands endeavor to cater to this demographic of Chinese consumers. For the Year of the Tiger, Burberry, Fendi, and Versace integrated their respective monograms, the color red, and tiger motifs into their capsule collections (WWD). Louis Vuitton's special Chinese New Year collection is also a showcase of designs that feature a tiger motif, with the tiger depicted gracefully stop their iconic trunks (Figure 2). These designs are incorporated into scarves, plates, and even a puzzle set. Meanwhile, Ferragamo's collection includes a silk foulard and handbag adorned with a captivating tiger pattern created by contemporary artists Sun Yuan and Peng Yu (Zhang). By adopting cultural customization that celebrates Chinese festivals and mores, collaborating with Chinese artists and designers, along with the brands' existing local marketing channels and retail stores in prime locations, these cultural products allow for more reach into the Chinese consumer market.



Figure 2. Louis Vuitton Chinese New Year scarf with tiger motif
WWD

In the aforementioned Christian Dior 2020 Cruise collection, besides presenting the authentic African style, an intersection of the culture of Europe and the African continent was also displayed as a major theme. This theme reflects the design of the series and the attitude of the designer, as it signifies respect to the Moroccan ethnic culture. The theme of intersection also

shows that Dior targets consumers with intersection of cultural backgrounds, which is appropriate for many fashion markets. With intricate craftsmanship and a genuine respect for cultural history, presenting the "true" African style allows the brand to showcase its understanding of culture. This understanding is at the core of ethnic presentation, as it earns respect from the targeted market of consumers. Simultaneously, it promotes the diversity of cultures by depicting the transformation of this craftsmanship. With direct focus on target audience or an extension and fusion from brands' core consumer bases, fashion brands use ethnic elements to expand and further solidify their customer bases.

Increase Cultural Representation through Celebrities

Celebrities have shown up at events wearing outfits that were initially showcased on fashion runways and exhibitions during prominent annual fashion events (Guapologa). In the dynamic world of fashion, the strategic use of celebrities has become a powerful tool for brands to not only enhance their visibility but also shape their reputation. Celebrities serve as a live model on the fashion stage, possessing an inherent and fervent fan base. Their presence alone within a particular sphere has the profound capacity to sway, and even prompt emulation among countless admirers. Take, for instance, the case of Michael Jordan's partnership with Nike that resulted in the iconic Air Jordan line of basketball shoes. Fans of the NBA legend have been avidly collecting and wearing Air Jordans for decades, not only for their performance but also for style. The partnership between fashion brands and celebrities extends beyond endorsement deals, as it is a fusion of style, personality, and most importantly, a culture that resonates with a global audience. In many cases, these deals are presented in a cross-cultural manner.

In the 2015 Met Gala, Rihanna showed up wearing a stunning yellow fur-trimmed gown by Chinese designer Guo Pei, shown in figure 3 below (Legend). The canary-yellow gown is one of the hallmark pieces of Guo Pei's dress collections, incorporating Chinese color scheme and authentic embroidery, and this particular piece took thousands of hours to complete. During the interview of the Met Gala show, Guo Pei expressed her gratitude to Rihanna for bringing the name of Chinese culture and her brand out to the world. Guo Pei, in addition to showcasing her haute couture designs, was able to elevate her brand and clothing's reputation to new heights through this means. Prior to this 2015 Met Gala with its theme "China: Through the Looking Glass," there were not many instances where Chinese culture and design was focused on such high levels in the western world. Through celebrity publicity, Guo Pei successfully prompted the curiosity of the western world and promoted cultural heritage and exchange by showcasing her collection with celebrity endorsement.



Figure 3. Guo Pei's Yellow Dress worn by Rihanna, Legend

Danger of Cultural Appropriation

In 2012, model Karlie Kloss wore a Native feathered headdress and turquoise jewelry on the Victoria's Secret runway show as a celebration of Thanksgiving (Los Angeles Times). This high stakes appearance was widely criticized for being “mockery” to the tribal identity, and being “mean-spirited” and “disrespectful”. Traditional attire, especially items like feathered headdresses, holds sacred and ceremonial significance for many Native American tribes. Using these traditional elements in a fashion show have been seen as disrespectful and trivializing of their culture, with respect to American history. Both Victoria's Secret and Kloss apologized for this appearance. This goes to show the negative publicity ethnic elements could potentially bring to a brand if not done correctly.



Figure 4. Karlie Kloss in the 2012 Victoria's Secret Fashion Show

In a similar case, Dolce & Gabbana, an Italian luxury fashion brand released a commercial titled “Eating with Chopsticks”, which was supposed to serve as a promotion for their upcoming Shanghai runway show. The video features an Asian women model attempting to eat traditional Italian food using chopsticks. In the conversation of the video, the ad contains mispronunciation on purpose to mimic Chinese speech, and sentences such as “Let’s use these small stick-like things to eat our great pizza margherita” (NPR), where it shows informal – almost racist pronunciations of chopsticks right before presenting what’s called “great” Italian food. The advertisement was heavily criticized by many Chinese users immediately, with claims that the ad is “disrespectful, racist and sexist”. (NPR). This incident had huge repercussions for Dolce and Gabbana and was handled poorly by the brand. The Chinese consumers were infuriated with the company’s appropriation and negative light it shed on Chinese ethnic culture. This attempt of using ethnic elements in fashion from D&G not only did not expand its customer base in China, it lost D&G significant market share and risked the brand getting canceled in China (CNN).

It is important for companies to verify the sensitivity and cultural alignments of their designs when using ethnic and cultural elements to ensure that their designs are respectful and reflective of diverse cultures. Careful research and deliberation need to be conducted to avoid negative impacts on brands and risk cultural appropriation.

Discussions and Limitations

This study on integrating ethnic elements into the fashion sector provides guidance for strategic planning and decision making for fashion brands when they consider using such elements. Recognizing the importance of ethnic patterns enables companies to select textiles, hues, and representations more carefully, and these are essential factors in sharing a designer’s unique aesthetic. This understanding is important for effective fashion shows and brand impact, where designs can resonate on an artistic level and connect authentically with the audience. Combining historical and contemporary styles is an impactful way of using cultural motifs, safeguarding traditions while promoting intercultural dialogue. These methods resonate with today's society's openness to multiculturalism, appealing to a larger range of consumers and shaping a brand identity that is aware of cultural nuances. Research into branding, particularly via celebrity endorsements, highlights the tactical impact these high-profile individuals have on brand’s perception and the success of using ethnic elements in fashion design. Mindfully chosen celebrities can amplify local fashion to worldwide stature, such as Guo Pei’s dress debut with Rihanna. Collaborations at high-profile events between brands and local artists and academics, and between artists and celebrities, are some of the ways that brands effectively used ethnic elements in their designs.

There are some limitations in this research that could be improved on through further analysis and more data. The preference for the fashion industry is highly individualized, and it depends highly on personal tastes, making data analyses less directly applicable due to its inherent subjectivity. However, incorporating more data-driven information and gathering more

qualitative and quantitative data to support these conclusions can be helpful, some potential ideas include interviews with fashion designers, brand executives, and collecting quantitative customer feedback for existing ethnic elements in fashion design. Additionally, cases that have been investigated in this research are mostly from top tier fashion brands and haute couture events. Further research can explore ethnic element use in more areas of fashion, diving deeper into not just the top tier brands, but also how everyday fashion can benefit from this cross-cultural initiative. Future research could utilize more data and examples across the globe from more ethnic cultures, with a more comprehensive index of cultures to validate the commercial mechanisms discovered in this research.

Fashion brands and businesses can now leverage the knowledge in this research for informed decisions on design, cultural sensitivity, global strategies, audience targeting, and brand positioning. Remaining aware of cultural shifts and embracing diversity, fashion companies can navigate the use of ethnic elements in design with inclusivity and impact, with expansions into more customer bases.

Direct Evaluations of the Growth of the Universe By Alexis Babb

Abstract

The universe continuously expands at an ever increasing rate. The Hubble constant is related to the rate of expansion of the Universe, as discovered by Edwin Hubble. The rate of expansion is directly proportional to the distance between two objects, and is noted as recessional velocity being equal to the Hubble constant (H_0) multiplied by distance between two objects. The main measurement of the Hubble constant used is the cosmic distance ladder, which uses parallax to find the distance of cepheid variable stars and then calculates the relationship between distance and luminosity of these stars. Measurements are applied to stars in further galaxies that are also home to type 1a supernovae. The distance-luminosity relation of supernovae is calculated similarly to that of the cepheid variable, and after finding further supernovae, the redshift is calculated to ascertain the rate of expansion. Another example is the tip of the red giant branch (TRGB), which calculates the Hubble constant using the apparent brightness of helium flashes in red giant stars in order to evaluate their distance, then finding a value of H_0 using redshift, similarly to the type 1a supernovae distance ladder. Finally, gravitational lensing is used, which is the deflection of photons in some gravitational potential. The cosmic distance ladder finds expansion rates of $H_0 = 72.53 \pm 0.99 \text{ km s}^{-1} \text{ Mpc}^{-1}$, while the TRGB find an expansion rate of $H_0 = 69.8 \pm 0.8 (\pm 1.1\% \text{ stat}) \pm 1.7 (\pm 2.4\% \text{ sys}) \text{ km s}^{-1} \text{ Mpc}^{-1}$, and gravitational lensing finds rates of $64.8 \text{ km s}^{-1} \text{ Mpc}^{-1}$ or $66.6 \text{ km s}^{-1} \text{ Mpc}^{-1}$, depending on the model of mass distribution used. This paper further explores these astrophysical methods of determining the Hubble constant.

Introduction

A 5σ tension (Keating) between estimations of the Hubble constant has baffled scientists for nearly a century. Simply put, even the error bars of approximations (σ , the standard deviation), even enlarged to five times their size, do not overlap. This tension is mainly caused by differences in the results of astrophysical and cosmological calculations. This paper focuses on varying astrophysical sources, such as type 1a supernovae, gravitational lensing, and the tip of the red giant branch (TRGB), and how they provide information about the expansion of the universe.

In 1929, accomplished astronomer Edwin Hubble made the groundbreaking discovery that faraway galaxies seemed to be moving away from Earth. The further from us these galaxies were, the faster they were retreating (“Discovering the Runaway Universe”). The question of the exact value of the Hubble constant has sparked debate in the fields of astrophysics and cosmology alike. The astrophysical side of the argument is rooted primarily in direct observations, like the cosmic distance ladder, tip of the red giant branch, and gravitational lensing. These measurements provide a value of the Hubble constant of about $73 \text{ km s}^{-1} \text{ Mpc}^{-1}$ (Freedman, Madore), with the tip of the red giant branch method being an outlier. Cosmological estimates use the Lambda Cold Dark Matter (Λ CDM) model, the current standard model of

cosmology, to simulate the expansion of the universe all the way from the Big Bang to the present day, in turn predicting the Hubble constant. These estimates typically hover around $67 \text{ km s}^{-1} \text{ Mpc}^{-1}$ (Aubourg et al.) The large difference between direct and indirect calculations is known as the “Hubble tension”. The large size of this tension implies that there is either an issue with our technology or calculations on the astrophysical side, problems with the Λ CDM model, systematic errors in our cosmological analyses, or even new and undiscovered factors at play that could lead to a profound reformation of the field of physics.

Type 1a Supernovae

The type 1a supernovae cosmic distance ladder uses benchmarks of increasing distance to find the Hubble constant. The first “step” on this distance ladder is called parallax. Parallax measures how far stars appear to move in comparison to seemingly stationary background stars (Pattison).

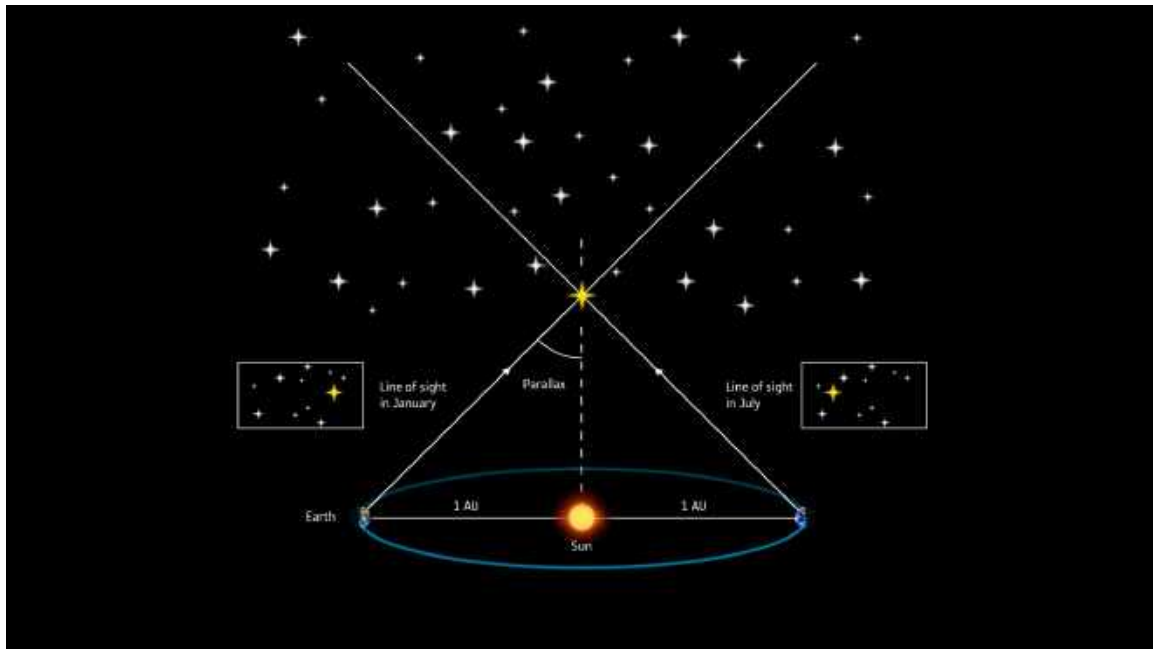


Figure 1: Parallax using angle related to line of sight, to find distance of faraway stars. (Lucas, Pultarova)

Using this information, one is able to find the distance of the nearby star using trigonometry. Scientists choose stars that are near cepheid variables (Pattison). Cepheid variable stars mark the next rung on the cosmic distance ladder. They pulsate, and the period, or length of these pulsations are directly proportional to the apparent luminosity of the star (Keating). The distance of these cepheid variables is already known due to parallax, allowing scientists to understand the period-luminosity relationships of cepheid variables. By applying these relations further from us, we are able to calculate the distance of faraway galaxies (Pattison).

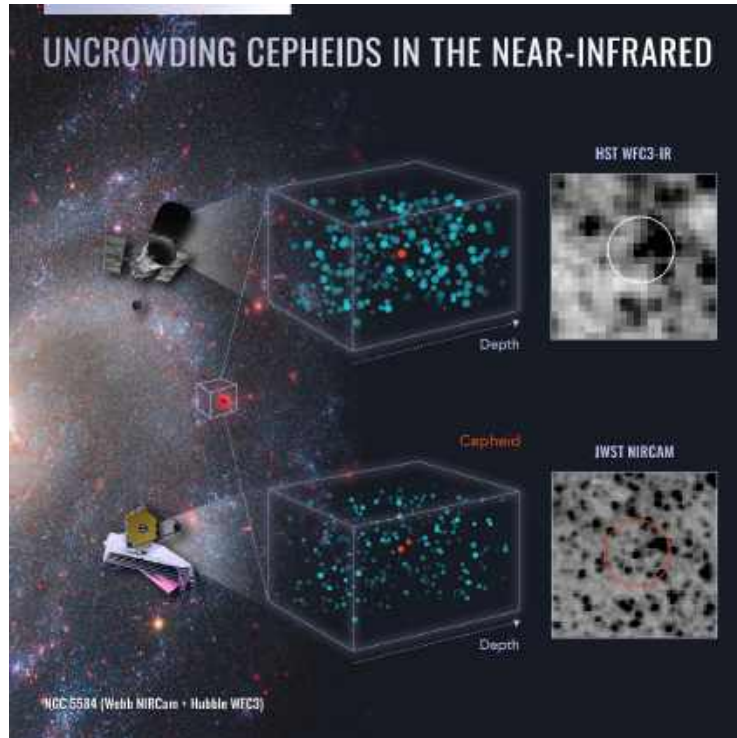


Figure 2: Images of cepheid variable captured by Hubble Space Telescope compared to images captured by JWST (James Webb Space Telescope). (“Webb Confirms Accuracy”)

The final step of the cosmic distance ladder is where it got its namesake: type 1a supernovae. These supernovae are white dwarf stars that explode when they reach a mass of 1.44 solar masses (“Type Ia Supernovae”), meaning they all have the same intrinsic brightness. Supernovae in the same galaxies as cepheid variables are used to calibrate this new cosmic ruler. This method is applied to further galaxies to find their distance. Once the distance of these galaxies are found, scientists use a spectrograph of them to find their redshift. A spectrograph is a piece of machinery that separates light into individual waves, allowing scientists to measure its wavelengths. Redshift is the result of these wavelengths expanding due to motion away from some reference point (“Webb Confirms Accuracy”), and therefore provides information about how fast a galaxy is receding. By comparing the distance of a galaxy with the speed at which it is moving away from earth, scientists are able to estimate an expansion rate.

The Riess et al. 2011 study put this method into practice, using the Hubble space telescope to overlook more than 600 cepheid variable stars. This experiment yielded an estimation of $H_0 = 73.8 \pm 2.4 \text{ km s}^{-1} \text{ Mpc}^{-1}$ (“A 3% Solution”). Ten years later, Riess et al. 2021 (commonly known as SHoES) utilized a larger scale experiment doubling the sample size of data, and using the more precise JWST (James Webb Space Telescope), resulting in a more refined estimate of $H_0 = 72.53 \pm 0.99 \text{ km s}^{-1} \text{ Mpc}^{-1}$ (“A Comprehensive Measurement”).

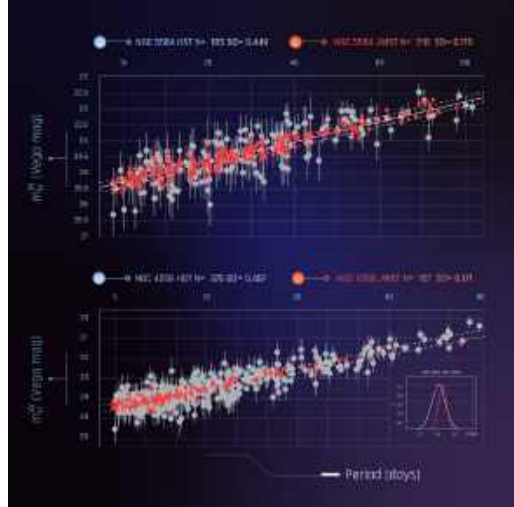


Figure 3: HST cepheid period luminosity relationship estimates (gray) in comparison to JWST cepheid period luminosity relationship estimates (red). (“Webb Confirms Accuracy”)

The Freedman et al. 2001 measurement was far less precise than its successors, yielding a result of $H_0=72 \pm 8 \text{ km s}^{-1} \text{ Mpc}^{-1}$ (“Final Results from the Hubble Space”). This was before there was much dispute over the Hubble Tension. In fact, in the early 2000s, it was not much of a tension at all because of the large margin of error on experiments.

Potential problems with the cosmic distance ladder method include faulty machinery or imprecise measurements; however the chance of this being an issue has somewhat decreased since data from the JWST has come to light. These new measurements not only agreed with the previous measurements from the Hubble telescope but significantly shrunk the error bars. This is because of the JWST’s heightened sensitivity to infrared light. It has extremely sharp blue-light vision, leading to clearer imagery of cepheids (“Webb Confirms Accuracy”).

Gravitational Lensing

Another way in which the Hubble constant can be measured is through gravitational lensing, which occurs when light is bent or reflected by large objects in or around their path (“Gravitational Lensing”). The amount of time these light rays take to reach the observer is affected by their diverted path. The light of lensed galaxies typically appears distorted and may seem magnified, or ring shaped (“Gravitational Lensing”), or as multiple points of light (Cooper).

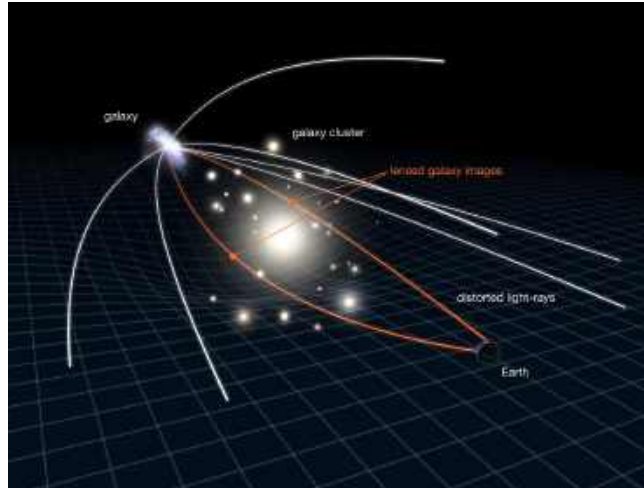


Figure 4: Model of gravitational lensing occurring. (ESA/Hubble)

Scientists measure the redshift of multiple points of light originating from the same source that take different paths and thus reach the observer at different times, because of the gravitational pull of non-uniform star clusters. By comparing the redshifts of these points of light and taking into account the difference in times they took to arrive, scientists are able to estimate the expansion rate of the universe. To accurately assess gravitational lensing, researchers must know how matter is distributed along the path of light. This is an issue because it is near impossible to determine, and models of potential matter distribution significantly vary from one to another.

This method was utilized when a cluster of matter with lumpy mass distribution diverted the path light from an exploded supernova (from around 9 billion years ago), causing it to be seen as four separate points of light. Around 376 days later, after the original points had dimmed, a new, fifth point became visible. It had been pulled through the cluster of matter differently than the previous four points, causing the light to take a longer path and therefore appear later. The extended path means the fifth light redshifted further than the other four as a result of the expansion of the universe. By calculating the additional redshift of this light and comparing to the time gap between the points of light arriving, researchers estimated the value of the Hubble constant to be $64.8 \text{ km s}^{-1} \text{ Mpc}^{-1}$ (Cooper).

Tip of the Red Giant Branch

TRGB is a distance ladder independent of the cepheid scale. It takes advantage of the Helium flash that occurs when a star burns up all the hydrogen in its core, and starts burning the hydrogen in the surrounding shell, resulting in a rapid increase of luminosity in a red giant, a star of low-intermediate mass. Helium flashes are a standard candle (all have similar luminosity) because they dim when the temperature of the core reaches critical temperature (Li, Beaton), which is 100 Million K (Thompson), and begin burning helium. All helium flashes are around the same luminosity, of about 3.6×10^{39} lumens (“Stellar Evolution”) per second, or a hundred billion times the luminosity of the sun (“The Sun's Energy”). The stage leading up to this helium

flash is the Red Giant Branch (RGB), with the flash itself making up the actual “tip” of TRGB, which is really just the brightest red giants.

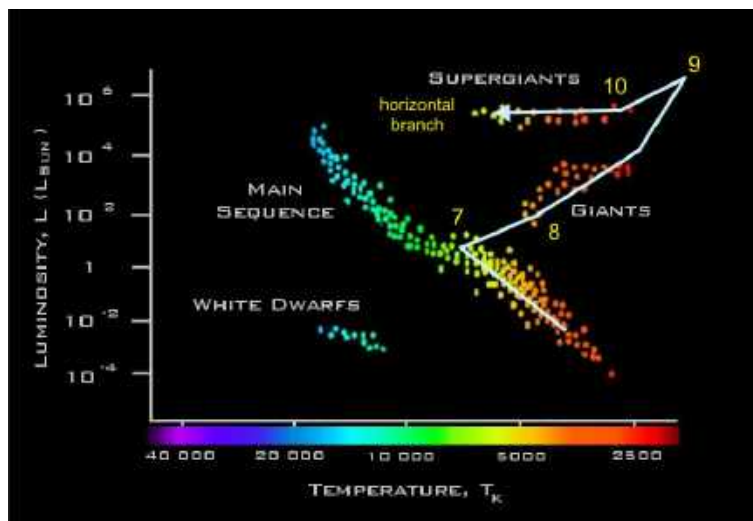


Figure 5: Graph shows different types of stars on ranges of luminosity and temperature. The tip of the red giant branch is marked by the number “9”. (Mould)

Because of the consistent luminosity, scientists are able to use them similarly to how they would use cepheids or type 1a supernovae in a distance ladder, calculating the relationship between distance and apparent brightness and using that to find the distance, then find the redshift of the light to calculate expansion. TRGB is generally measured in old galaxy halos (the predominantly dust and debris free space, with very few stars, surrounding a galaxy), in order to reduce the cross contamination of light from other stars (Li, Beaton).

Freedman et al. 2019 uses TRGB as well as type 1a supernovae in its distance ladder, forgoing the use of cepheids. This study uses the Hubble space telescope, specifically employing its deep HST Advanced Camera to obtain data relating to galaxy halos . It yields a value of $H_0 = 69.8 \pm 0.8 (\pm 1.1\% \text{ stat}) \pm 1.7 (\pm 2.4\% \text{ sys}) \text{ km s}^{-1} \text{ Mpc}^{-1}$ (“The Carnegie-Chicago Hubble Program”). It is important to note that this value is in between CMB estimates ($\sim 67 \text{ km s}^{-1} \text{ Mpc}^{-1}$) and direct measurements ($\sim 73 \text{ km s}^{-1} \text{ Mpc}^{-1}$), agreeing with the Planck Collaboration et al. and SHoES at the 1.2σ and 1.7σ (“The Carnegie-Chicago Hubble Program”) levels, respectively.

Conclusion

Astrophysical probes of the Hubble constant have vastly affected our understanding of the universe. Methods such as the type 1a supernovae distance ladder, gravitational lensing, and TRGB explore a wide range of experiments used to estimate the rate of expansion of the universe. Not only do these methods aid in informing about the universe's expansion, but their differences from cosmological estimates could have interesting implications for both fields. Errors on the astrophysical side could be the result of something small, like inaccuracies with instruments or calculation errors, or it could be due to something much more impactful, such as

implicating the existence of exotic dark matter or energy, or even new kinds of particles (“Webb Confirms Accuracy”). On the other hand, if the errors are mainly on the cosmological side, then that could mean that the Λ CDM model is inaccurate, or alternatively, suggesting deep systematic errors in the foundation that cosmology is built on. The Hubble tension is an extremely active area of research, with ongoing experiments taking a deeper look into TRGB, as well as CMB survey sites being built, such as Simons Observatory (SO). SO is planned to be located in Chile, and employs small and large aperture telescopes in order to calculate cosmological constants such as H_0 with increasing accuracy (Galitzki et al.). Also proposed to be in the Chilean desert is CMB-S4, although this experiment also has proposed telescopes located in the South Pole. This experiment makes use of both large and small aperture telescopes, and is to become the longest CMB observation experiment to date (“CMB-S4”). These upcoming experiments will be of increasing accuracy and precision, leading to our tightest constraints on cosmological parameters to date.

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Jane Eyre: The Infancy Narrative of Victorian Reformism By Ava DiGiuseppe

Introduction

The preface of Charlotte Brontë's *Jane Eyre* presents a proposal that is diametrically opposed to Victorian fundamentalism and gender-oriented hegemony: "Conventionality is not morality. Self-righteousness is not religion. To attack the first is not to assail the last. To pluck the mask from the face of the Pharisee is not to lift an impious hand to the Crown of Thorns" (Brontë 6). Correspondingly, the application of feminist literary criticism to *Jane Eyre* promotes the examination of sociological hindrances faced by representations of period-centered feminine archetypes, as well as author Brontë. The study of literature through critical lenses sanctions a methodical approach to textual analysis; critical lenses provide the foundation of ideological principles that aid in a structured study of a text. Additionally, a feminist critical analysis of *Jane Eyre* argues for the study of the rights and responsibilities of women during the Victorian Era. Though Victorian women were expected to maintain subservience under the scrutiny of social obligation and puritanical religion, literature such as *Jane Eyre* argues that Victorian women may find independence through excellence in their field despite aforementioned circumstances. This argument is perceptible with the progression of *Jane Eyre* from childhood through adolescence and adulthood since her academic pursuits in childhood, undeterred by hardships faced at Gateshead Manor and the Lowood School, culminate in maturity and intellectual prosperity at Thornfield Hall. The characters with whom *Jane* shares relations are representative of sociological auxiliaries and hindrances to her development; *Jane* prohibits characters who impeded upon her childhood development from deterring her ambitions in adulthood. Furthermore, feminist critical analysis argues for the study of Brontë in congruence with semi-autobiographical *Jane* as their parallel nature provides analytical insight. With its propositions in opposition to nineteenth-century fundamentalism and persecution of womanhood, *Jane Eyre* supports the employment and principles of feminist literary criticism. While maintaining the paradigmatic sociological positions expected of her Victorian contemporaries and simultaneously outlining an anachronistic argument for social progression, Brontë contributed *Jane Eyre* as doctrine within the feminist literary canon.

Literary Theory

Literary theory describes the analytical relationship between a text and an interpretive evaluation of its parts; the subjective element of literary theory culminates in the study of literature through critical lenses. With the periodical development of philosophical schools, branches of literary theory have expanded into varying sectors of study, which provide additional background for purposes of research and study through critical lenses in the form of dogmatic literary works. Critical lenses seek to develop a series of principles or tenets that are attributed to ideologies of their founders. Critical lenses are pioneered by authors, scholars, and theorists whose contributions to literary criticism are composed of literary works and theses. Furthermore, critical lenses study a syllabus of works that are considered doctrine within their schools of

thought (e.g. *Silent Spring* by Rachel Carlson, an environmentalist, is a canonical piece of literature within the study of ecocriticism) (Brewton). The literary contributions of critical lens founders provide literary material for analysis in addition to the necessary tools for researchers and students to develop critical skills. In addition to literary doctrine and the ideological teachings of lens founders, critical lenses may be applied to various pieces of literature, including works that are not within the canonical repertoire of a selected critical lens. The philosophical foundations of a critical lens require periodical additions, including works of literature and arguments presented by critical lens scholars, as the school of thought risks eradication without modern theorists to continue the practice. The practice of studying contemporary literature through critical lens analysis allows for the inclusion of additional literature in the ideological canon. With the principles of critical analysis having been applied to a text such as *Jane Eyre*, the literary canon of a selected critical lens will have been expanded upon in a manner that promotes the inclusion of contemporary literature and ideology.

The study of literary theory in congruence with the tenets and principles of contemporary feminism allows for the organized study of womanhood through literature. Feminist literary criticism proposes that works of literature are produced within the confines of a male-dominated society; therefore, it is essential to contextualize the social positions of women within these literary works for the purpose of comprehensive understanding (Spivak). The principles of feminist literary criticism promote the study of literary works with concentration on the roles of women in literature. Additionally, feminist literary criticism studies the hierarchical differences between the opposing sexes with the aid of historical resources for the purpose of sociological contextualization (Evans 285). Feminist literary criticism may study both works of literature and their authors as the position of authorship provides context that promotes concentrated textual analysis. In alignment with its predecessors, feminist literary theory studies works that are treated as doctrine within the philosophical scope of the lens. These dogmatic works of literature are credited to the founders of feminist literary criticism such as *The Second Sex* by Simone de Beauvoir and *A Vindication of the Rights of Women* by Mary Wollstonecraft (Goulimari). The academic value of these works parallels itself to the growth of the feminist movement from the eighteenth and twentieth centuries to the present day. Furthermore, the historical value of feminist literary doctrine allows for the addition of contemporary feminist literature to be included within the ideological canon (Goulimari). The application of feminist literary criticism to *Jane Eyre* promotes the analysis of nineteenth-century womanhood and advances the argument that periodical literature acts as an auxiliary to the study of Victorian sociology.

Contextual Summary

The metamorphic experiences of Jane occur in accordance with her age, societal expectations, and relationships. With her orphaned position, Jane resides at the persecutionary Gateshead Hall from childhood until early adolescence with tyrannical figures such as Mrs. Reed and her pugnacious children. As a form of punishment, the ReedJane is subjected to treatment such as confinement to the fearsome red-room and physical abuse delivered by the Reed

children. With contempt for Jane, the matriarch, Mrs. Reed condemns her to study at the fundamentalist Lowood School as a conclusive form of punishment that marks a cessation to her residence at Gateshead Hall. At the Lowood School, Jane is subjected to a disciplined and evangelical academic study that facilitates her excellence in the fields of music, visual art, language and composition, and literature. It is within the confines of the Lowood School that Jane develops relationships and socratic mentorships with her peers and instructors that counteract the autocratic rule of figures such as the sanctimonious headmaster, Mr. Brocklehurst. Despite Jane's valiance, she is burdened with the reign of consumption that strikes her dearest friend, Helen Burns, and stalemates her into a defenseless position of adolescence. Succeeding her tenure at the Lowood School, Jane accepts a position as a governess at the Gothic Thornfield Hall. In accordance with Victorian social conventions, Jane applies her education to the instruction of her pupil, Adèle Varens, in her fields of excellence and develops relationships with Mrs. Fairfax, the housekeeper, and Edward Rochester, the guardian of Adèle. With the passage of time at Thornfield Hall, Jane learns of the enigmatic secrets that plague Thornfield Hall, such as the psychologically impaired first wife of Edward Rochester who is confined to the attic, Bertha Mason. Bertha acts both as a hindrance to the developing romantic relationship between Jane and Edward and as the antithesis of Jane. In spite of Bertha's incendiary act that causes the disfiguration of Edward, however, Jane and Edward joyously wed one another as the culmination of the text.

Literary Analysis

The role of women in nineteenth-century works of literature requires a historical and theological analysis of fundamentalist doctrine in the Victorian era. With the application of a theological analysis, orthodox Victorian works equate the role of women to religious, and by extension, domestic subservience; religious subordinates act in accordance with auxiliary partnerships. Marriage and motherhood were vocational pursuits in which the woman served her dependents as a religious obligation. Victorian works, such as the poem "Women's Rights," reflected the belief that the political role of women was a realization of fundamentalist social organization in accordance with theological doctrine:

Such are the noblest woman's rights,
The rights which God hath given,
The right to comfort a man on earth
And smooth his path to heaven. (M.C.M.R.)

With the precedent of traditionalist theological philosophies, the development of conservative etiquette and mannerisms arranged an equilibrium of nineteenth-century religion and state in which women were subjected to subserviency. The women acted as the governed party that was subjected to servitude of a male-dominated oligarchy. In marital servitude, the woman was required to be the learned, economical, and didactic partner who acted as an

auxiliary to the energetic counterpart (Young). Victorian professions such as teaching and private tutoring as a governess expanded the traditionalist role of women from the domestic plane to the professional. A profession as a governess allowed a woman to prosper in the pursuit of intellectual achievement with devolution to the latter generation. With relation to Victorian theology, the governess was expected to instill moral, deportmental, and academic integrity in the pupil. In literature, a position as a governess represented an extended state of orphanage in which the subject was a dependent to their employer (Hughes). Additionally, the governess inhabited a purgatorial state between hierarchical subservience and academic aspiration. Theological and sociological principles developed in nineteenth-century England are obligatory to the study of its traditional and reformist literature.

Therefore, the paradigmatic development of Jane in opposition with nineteenth-century traditionalism supports Brontë's argument for reformism. Jane's childhood disposition is conventional in accordance with Victorian fundamentalism: learned, principled, and religious. Contrarily, the Reed family acts as the superlative form of sanctimony through which Jane is rebuked without principle. Analogous to her righteous constitution, Jane dismisses their Pharisaic reign as an allegory for the rejection of unjust social conventions: "I know that, had I been a sanguine, brilliant, careless, exacting, handsome, romping child, though equally dependent and friendless, Mrs. Reed would have endured my presence more complacently; her children would have entertained for me more of the cordiality of fellow-feeling; the servants would have been less prone to make me the scape-goat of the nursery" (Brontë 19). With her passage to the Lowood School, Jane develops discipline and academic competencies required of her Victorian contemporaries in which she excels and experiences fulfillment. Nevertheless, the authoritative Mr. Brocklehurst, whose conservative practices correspond with the Reed family, unjustly persecutes Jane. Contrary to her vulnerable position at Gateshead Hall, the companions of Jane valiantly protect her against the duplicity of Mr. Brocklehurst. Jane and her companions act in accordance with immutable morale as opposed to the fleeting piety of Mr. Brocklehurst and the Reed family. The fortitude and academic discipline of Jane culminates in her wish to serve a pupil as a governess, to prosper in the sharing of intellect as opposed to the pursuit of cavalier accomplishments: "My world had for some years been in Lowood; my experience had been of its rules and systems; now I remembered that the real world was wide, and that a varied field of hopes and fears, of sensations and excitements, awaited those who had courage to go forth into its expanse to seek real knowledge of life amid its perils" (Brontë 100). With Jane's position as a governess, she is permitted to maintain the symbolic status of an orphan as she becomes the tenant of Mr. Rochester in a foreign environment. Contrary to her position as a student, Jane must act as the primary caregiver to her pupil while burdened with the obstacle of adolescent naïvety (Bowen). Contrary to the Victorian convention of the pursuit of a governess position as a means to extend dependency, Jane develops cerebral independence through her passage of academic and developmental competencies to her pupil: "And when she [Adèle] left school, I found in her a pleasing and obliging companion; docile, good-tempered, and well-principled. By her grateful attention to me and mine, she has long since well repaid any

little kindness I ever had in my power to offer her” (Brontë 518). The professional, academic, and moral positions held by Jane act as an auxiliary for her sovereignty against fundamentalism and principled authoritarianism.

Correspondingly, Brontë’s principled education and upbringing served as precedent for that of Jane; their sociological positions provide plausibility with regard to Brontë’s reformist tenets. In childhood, Brontë and her sisters studied at the Clergy Daughters’ School at Cowan Bridge in Lancashire; Brontë’s circumstances were plagued by the dominion of Reverend William Carus Wilson, the transmission of typhoid fever, and consequential deaths in relation to the epidemic (Tompkins). Brontë’s tenure at the Clergy Daughters’ School acts as the constitutional reference for the Lowood School. Consequently, Brontë’s dissension against the feudal structure of the Clergy Daughters’ School is perceptible with her interpretation of the Lowood School. Succeeding her residence at the Lowood School, Brontë attended Margaret Wooler’s School at Roe Head, the establishment in which she developed academic independence with her studies of literature, music, art, and language (Tompkins). Regardless of Jane’s continued education at the turpitudinous Lowood School, her pursuit of excellence in academia shares a parallel with Brontë as her reformist principals are substantiated by means of scholastic achievement without regard to the corruption of the establishment. With the intention of extending academic residency, Brontë pursued a position as a governess in Brussels, Belgium while enrolled in the esteemed Pensionnat Heger (Alexander). Brontë’s pedagogical vocation shared a parallel to the pursuit of monasticism; Brontë’s scholarship was enriched by means of academic discipline as a pupil and instructor in accordance with Victorian asceticism. The scholastic disciplines and vocational aspirations pursued by Brontë and Jane share an equilibrium with periodical masculine professions, contradicting orthodoxy and advocating for social amendments. With the equivocating forces of academic exuberance and psychological dependence, Brontë developed a compulsive admiration for her intellectual counterpart and instructor, Constantin Heger; Their unrequited relationship served as precedent for the romantic partnership of Jane and Edward Rochester (Alexander). Brontë’s development of private relationships on the foundation of academia acts as unorthodox with relation to the principles of religious fundamentalism. Correspondingly, the development of the relationship between academic partners, Jane and Edward, shared a progressivist equivalent to that of Brontë and Heger. In accordance with the composition of *Jane Eyre* and the permissive proposals of Brontë, the text endured periodical criticism with regard to the iniquity of its exposition (Alexander 274). With dissension to the ideals of religious fundamentalism, Brontë, by means of her work, *Jane Eyre*, acts as a foundational theoretician of nineteenth-century reformism.

In conclusion, contemporary literature such as *Jane Eyre* that subsumes a social movement or theoretical field must be incorporated within its respective canon to develop the principles of the philosophy. The study of *Jane Eyre* by means of the feminist critical lens establishes the tenets and principles of feminist literary theory with relation to nineteenth-century literature and its successors. Additionally, the study of literature according to critical lens analysis provides historical and sociological insight with regard to a corresponding period.

Accordingly, texts such as *Jane Eyre* convict nineteenth-century authoritative systems of civil, sociological, and religious maladministration. By means of satirization and the employment of periodical archetypes, *Jane Eyre* opposes the Victorian tenets and principles of womanhood. The positions of Jane and her contemporaries act as paradigms of Victorian womanhood, developing a sociologically infallible platform to express notions of reform. Correspondingly, Brontë's esteemed vocational position within nineteenth-century society and masculine publishing pseudonym constituted her works as doctrinal. With the scholastic adoption of Brontë's tenets and principles, succeeding works have promoted the delegation of theological and sociological sovereignty to the governed bodies. The progressive proposals presented in *Jane Eyre* act as the paragon of nineteenth-century political reformism and gender-related egalitarianism.

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Influences of Gender Socialization Through Parent-Adolescent Relationship

By Zoey Hipwood

Abstract

This study explores the impact of sibling gender composition on adolescents' responses to gender-related questions. The literature review highlights the influence of parent to adolescent relationship, including parental gender socialization as long as relationship between siblings. All influencing adolescents' understanding of gender stereotypes.

The following research question guiding this study is whether individuals with same-gender siblings exhibit more similar responses to gender-related questions compared to those with opposing gender siblings.

I hypothesized that adolescents with same-gender siblings would respond with higher agreement in their responses to gender-related questions, compared to those with different-gender siblings who would have more diverse responses.

To explore this hypothesis, I designed a survey-based research method and distributed it to students aged 13-17, collecting a total of 13 responses. The sample consisted of adolescents from various family arrangements, gender, and relationships with their siblings.

My findings result that adolescents with same-gender siblings tend to share more similar responses to gender-related questions, guiding support to my hypothesis. This suggests that sibling gender composition may play a significant role in shaping individuals' thoughts and beliefs about gender.

The outcomes of this study are essential for understanding the role of sibling relationships in shaping adolescents' attitudes towards gender. By recognizing the influence of sibling gender composition, we can better address gender stereotypes and promote more inclusive societies focused on equality.

In summary, this study shines light on the importance of sibling gender composition in the development of gender-related beliefs, offering valuable insights for future research and practical applications in addressing gender stereotypes.

Introduction

Gender stereotypes apply to both men and women and can influence various aspects of their lives, including their career choices, emotional expression, and opportunities. The impact of gender stereotypes in adolescents can derive from the basis of the parent to child relationship. While children develop in their homes as they form their identities and beliefs, parents can really stress gender stereotypes throughout their parenting styles. Along with parents, the relationship between siblings often goes unnoticed when talking about the spread of gender stereotypes and multiplying the effect. However, through studying and looking even at the surface of these sibling relationships, it will become evident in so many different situations and "normalized" gendered prejudices both good and bad exist differently depending on different sibling set ups, but all lead to the same idea supported by gender stereotypes. Understanding how prescriptive

and descriptive gender stereotypes affect adolescents is essential for fostering more inclusive and equal societies.

Literature Review

Prescriptive Gender Stereotypes

Prescriptive gender stereotypes, distinct from descriptive stereotypes, impose societal expectations on how each gender should act or behave. These societal expectations perpetuate norms that define specific roles and behaviors based on gender. Prescriptive gender stereotypes are gender norms driven by societal beliefs that dictate how each gender should behave. Prescriptive stereotypes focus on the positive and negative characteristics and behaviors that each gender should maintain (Anne M. Koenig 2018). Prescriptive gender stereotypes are different from descriptive gender stereotypes as it creates the expectation for each gender to achieve, whereas descriptive gender stereotypes are created through observations of how each gender actually acts. An example of a negative prescriptive stereotype is “women are more nurturing so they should focus on care giving rather than pursuing a career.” In challenging prescriptive gender stereotypes, we single out deeply ingrained “norms” in society that limit individual potential and drive towards inequality. By recognizing and calling out these now called “norms” and “expectations”, individuals can work together to strive towards a more inclusive society that values individuals based on their unique abilities and aspirations rather than predetermined gender “norms”.

Negative prescriptive gender stereotypes, even simple “norms” that everyone follows, really impact our culture in every aspect. These stereotypes not only undermine emotional well-being but also hinder healthy relationship dynamics by imposing rigid expectations on gender roles. An example of a negative prescriptive gender stereotype for men is “men should suppress emotions and avoid showing vulnerability, as it is a sign of weakness”. Both of these examples are negative examples of prescriptive gender stereotypes of each gender. Negative prescriptive stereotypes are not helpful, instead they are harmful. Negative prescriptive gender stereotypes are harmful to each gender emotionally, in relationships, promoting inequality, and more. They cause mental health issues for people that feel like they have to compete with the pressure of societal expectations leading to stress and anxiety and eventually depression in men (Anne M. Koenig 2018). In women, it can lead them to have self doubt about what they are capable of and feel pressured to obey the societal expectations of being a caregiver and not pursue careers they have interests in. Negative prescriptive gender stereotypes are harmful to relationships because when both genders are trying to conform to societal expectations when expressing opinions and emotion it is hard to also listen and comprehend the other person's point of view.

While negative prescriptive gender stereotypes impose harmful expectations on individuals, positive prescriptive stereotypes also reinforce the pressure to live up to societal norms. Nevertheless, positive prescriptive stereotypes can be helpful in so many ways. Some

potential benefits to positive prescriptive gender stereotypes is creating a sense of self-worth for each gender. When people are told that they obtain certain gender characteristics it can give them confidence to achieve more things. People study prescriptive gender stereotypes for countless reasons. In order to understand social change, it is important to study the stereotypes that create the social norms that separate and highlight the differences between the genders (Anne M. Koenig 2018). By understanding the stereotypes behind this, researchers can spread their knowledge and help break down the negative stereotypes causing inequality. In studying prescriptive gender stereotypes, researchers aim to untangle the complex web of societal norms that reinforce inequality and hinder social change. By understanding and spreading knowledge of these stereotypes, collectively, people can work towards breaking social barriers and inviting a new flow of inequality.

Descriptive Gender Stereotypes

Unlike prescriptive gender stereotypes, descriptive gender stereotypes are generalizations based on observations of behaviors, traits, and roles generally associated with each gender. Descriptive gender stereotypes are created by how people view each gender and their actions (Anne M. Koenig 2018). These stereotypes can be both positive and negative towards their stereotypical views on each gender. An example of a positive descriptive gender stereotype for women is “women are often viewed as more empathetic and grow strong interpersonal relationships.”

An example of a positive descriptive gender stereotype for men is “Men are known for their assertiveness and leadership skills, taking charge in various situations”. These examples of positive descriptive stereotypes are both helpful and harmful. When each gender is associated with their own positive traits, it can help drive them to achieve those traits, which would be helpful. The tough part is when these positive traits and characteristics are not achieved, it can bring people to lack confidence and compare themselves as lesser to others of the same gender. For men, the stereotype that they are assertive and take leadership or that they are strong and able to excel can lead them to feel limited when expressing other emotions (Anne M. Koenig 2018). For instance they could start to feel weak when expressing sadness. Women on the other hand, are pressured to stay calm and not assert leadership. Therefore, limiting their opportunities to excel with leadership roles. Also putting a lot of pressure on them to pursue a caregiving role, rather than a career in a workplace especially one involving STEM.

As well as negative prescriptive stereotypes being harmful, negative descriptive stereotypes are harmful as well. A commonly used negative descriptive stereotype about women is “Women are not as competent in leadership roles as men and are too emotional to make rational decisions.” In any case, negative descriptive stereotypes are not helpful, and can instead be very harmful for both genders (Anne M. Koenig 2018). These stereotypes can harm people anywhere from limiting opportunities to reinforcing gender inequality. Limited opportunities may result from assumptions made about women in these negative stereotypes. If the observations were made that women should be only primary caregivers, going all the way

back centuries ago, this can lead to the descriptive stereotype today of the same kind. It starts by the observation that women are caregivers, then people start to make leading assumptions such as women don't have the skills to have a work career, therefore, they are caregivers. This has a really big impact for women in their education and working careers. The negative stereotypes about men and women such as lacking skills, breaks down their confidence and leads to self-doubt. With any negative descriptive gender stereotypes, also comes thoughts of gender inequality. The more differences, especially negative qualities about one another, pointed out, the greater the divide between the genders.

People study descriptive gender stereotypes to understand the impacts of negative and positive societal stereotypes on people's actions and beliefs. A lot of the research is also done to promote more gender equality that may be harmed by descriptive gender stereotypes. By understanding the impacts and life cycle of descriptive gender stereotypes, researchers can start to teach others about the positives, negatives, and effects. By spreading the information, people can then learn and hopefully promote change for a better and more equal future.

Gender role understanding for children and teens is influenced by several important factors, each playing significant roles in shaping this understanding. In broad terms, family, friends, peers, media, school, and religion all play a role in influencing children's understanding of gender. The evident influence of descriptive gender stereotypes extends beyond perceptions, limitation, confidence, and societal equality. Through recognizing and challenging these stereotypes, we can work towards a more inclusive society where individuality is encouraged and individuals are empowered to set goals that surpass their own limits. By spreading awareness, research, and education, we can promote change for greater equality in our near future.

Influences of Families on the Upbringing of Gender Stereotypes

Gender stereotypes play a significant role in the upbringing of adolescents and how they prepare for their futures. Families commonly guide each other and teach each other, especially those who are younger. No matter the culture, parents are some of the first introducers of gender socialization to their children, along with siblings. Parents can be the ones buying certain gender oriented toys for their children, using gender oriented sayings around them or to them such as “toughen up and act like a man,” and using other general teachings that can negatively act as gender socialization.

Other commonly parent influenced gender socialization that can occur in everyday life is what clothes they buy for their children. Parents may buy “boy” clothes and “girl” clothes and keep those separate, therefore enforcing the idea what gender their child is based on how they dress. Parents can also give their children gender based chores, mimicking gender stereotyped adult careers (Marina Epstein & L. Monique Ward, 2011). For instance, having the girls do indoor house work like folding clothes and cooking, while giving their sons outdoor jobs of mowing the lawn or grilling. Another very common way parents can influence gender on their children is pushing them towards gender based activities. Very commonly, parents may place their daughters in art and dance classes and their sons in sports and other physical activities. Parents may also

limit emotional expression, most commonly letting boys get more angry than girls and discouraging signs of weakness, like crying. Along with gender based clothes and activities, parents may buy gender based toys for their children as well. Toys such as trucks and cars may more commonly be bought for their sons, while dolls and princess costumes may be bought for their daughters. An overlooked aspect of gender socialization promoted by parents is the language used around their children. A common nickname that parents call their daughter is “princess”, while a common nickname for a son is “sport”. All these examples of gender socialization can lead to harmful stereotypes later in life (Marina Epstein & L. Monique Ward, 2011).

In Summary, the widespread influence of gender stereotypes within family dynamics underscores the importance of making conscious efforts to promote equality and try to wean away from traditional harmful biases. By challenging traditional gender roles and creating a new environment of open-ended equality, parents can play a big role in empowering their children and all the next generations to embrace their differences and rewrite “normal”.

Research on Family Dynamics and Gender Development

As many studies demonstrate, the family’s role in gender development circles around a complex web of individual relationships within the household that are prompt to promote greater societal influences beyond the household. The article “The Family Contexts of Gender Development” answers the research questions of “How does the family's role in gender development during childhood and adolescence, as traditionally understood through social learning and psychoanalytic perspectives, underestimate the complexities of gender socialization in the family?”. Their research shows that children's experiences in their one on one relationships are important factors of gender development (Susan M. McHale et al., 2003). Also that children's gender development is altered by how they witness their parents marital relationships and their parents relationships with others around them, including other siblings (Susan M. McHale et al., 2003). Influences from larger social settings and the immediate settings also contribute to how gender socialization dynamics are influenced (Susan M. McHale et al., 2003).

The article “Exploring Parent-Adolescent Communication About Gender” answers the research question of “How does the family's role in gender development during childhood and adolescence, as traditionally understood through social learning and psychoanalytic perspectives, underestimate the complexities of gender socialization in the family?”. Through research the data shows that

The findings suggest that children internalize parental communication of gendered messages, but there may be other influences on their gender beliefs as well (Marina Epstein & L. Monique Ward, 2011). These other influences include siblings, media, grandparents, other members of the family, schools, friends, television, books, celebrities, and much more. All these people and aspects of life influence children's gender beliefs because children are a blank slate when they are born. As they grow older, they learn new things through looking up to those around them and the things around them. Once they see something or hear something, you can

no longer erase that from their beliefs, and each little experience or conversation nudges their beliefs towards the path they will be on when they are older. By then, they can return the favor to the new youth. This is the endless cycle, where stereotypes can get dangerous. Once spread, it can travel a long way. That is why it is important to make the corrections now, so youth of the future will hear the right information to help make the future more equal.

With this in mind, recognizing and challenging ingrained gender stereotypes within family relations and interactions is crucial for fostering more equality in our environment. Furthermore, these gender norms that are continuously getting passed down from generation to generation, only further adding to the mess, research can spread awareness of this subconscious stereotyping, and help weaken the problem at its root: family dynamics.

How Societal Paternal Roles Influence Gender Stereotypes in Adolescents

Also that both traditional and egalitarian gender norms are communicated by parents (Marina Epstein & L. Monique Ward, 2011), so it's a whole loop of gender based parenting styles. Some very traditional gender norm examples include men as breadwinners, and women as caregivers. In other words, traditionally men are responsible for financial support as well as career advancement. Women on the other hand are often responsible for the role of primary caregiver of the home and the family, by nurturing the children and managing the household chores. Some more egalitarian, meaning equal or in this case shared responsibility, gender norm examples include shared caregiver responsibilities along with shared responsibility for providing money to the house through career and labor, and often the hardest, equal emotional expression. Since parents are the first ones to communicate gender norms to their children, it is important as to which ones they are communicating. In a perfect world, it would be all egalitarian gender norms and everyone would be treated and feel like equals. In this world today, there is a mix, if not more traditional gender norms communicated causing the divide between the genders.

How Sibling Relations Factor into Adolescent Stereotypes

The dynamics of sibling relationships play a crucial, yet under researched role in fostering the foundation for a children's understanding of gender within the family context. Although it may be limited, the review also found that relationships with parents and siblings are important, as well as how kids compare themselves to others in their family (Susan M. McHale et al., 2003). Understanding both the direct and indirect influences of siblings on each other's gender socialization is highly important for unraveling the web of complexities of familial gender dynamics. As said in the article, the relationships between siblings has often been looked over in the research of family gender socialization. Both the direct and indirect relationships between siblings is important to consider. The important factors to note is how each sibling is looked up to as a role model or interferes in another way with the development of gender socialization in children. Another important aspect is the direct relationship between sibling pairs, meaning how siblings talk to one another, and directly teach and give advice or relay life skills to their sibling. Just by recognizing the significance of sibling relationships in family

gender socialization, research has underpinned the importance of considering both direct interactions and subtle influences between siblings. Unfortunately, this factor of gender socialization development in children is under researched and often overlooked, so there remains limited information on the impacts siblings have on each other. Other Environmental Factors that Play into Gender Stereotypes in Adolescents

It is also largely important for researchers to consider the environment kids grow up in, like their culture and economic opportunities, because it affects how families teach about gender (Susan M. McHale et al., 2003). Researchers emphasize the importance of considering various environmental factors such as culture and socioeconomic status, which significantly shape parental beliefs and behaviors regarding gender roles. Parents have different beliefs based on different end goals they culture normalized for each gender. Different backgrounds and environments also change how parents interact with their kids, which also changes how they influence gender socialization in the children.

They also showed that the immediate environment and the broader social context have an impact on how children learn about gender roles and expectations within their family (Susan M. McHale et al., 2003). The research underpins the interconnectedness between the immediate family environment, broader societal influences, and children's perceptions of gender-role based expectations. Through recognition of the impact of cultural and socioeconomic contexts on family dynamics, researchers can gain deeper insights into the complexities of the path of gender socialization and work towards paving the way for a more inclusive and equal society, starting with children.

Surveys and Results Found in Research

Through the method of surveying college undergrads, mostly Caucasian, from Midwestern University asked gender biased questions (Susan M. McHale et al., 2003). Gender biased questions being questions that may purposely or accidentally favor or discriminate against a particular gender, reinforcing stereotypes. As an example for a female, a gender biased question you could ask is "Do you think women are naturally better at nurturing and caregiving?". All the questions were directed around opinions about gender, sexuality, and experiences of dating. The survey encompassed demographic variables, two assessments of gender ideology, and five discourses on gender socialization. The second sample of the survey was from public high schools in the same Midwestern state. These participants were asked to partake in a study about messages about women and men, experience with friends, and dating relationships. The results came to show that children's experiences in their dyadic relationships with parents and siblings are important factors in gender development (Susan M. McHale et al., 2003). The study also explored how parents' messages about gender influence people's beliefs. Traditional messages led to more traditional beliefs, while equal messages led to less traditional beliefs. Messages about toughness and appearance had stronger traditional effects on boys.

The article "Sexism In Schools" discusses different aspects of sexism in schools. This includes stereotypes, attitudes, prejudice, discrimination, and their crossover with ethnicity and

race. How biases can affect student's achievements and well-being, as well as how different ethnic/racial groups may experience and perceive sexism differently are all explained in the article. The impact on achievement through gender bias, are influenced by cultural contexts and ethnic/racial identities (Campbell Leaper, Christia Spears Brown, 2014).

Sexism in Schools

Despite efforts towards gender equality in education, persistent biases affect both girls' and boys' educational experiences on a daily basis. Fundamental skills that children build through their time in school are one of the biggest "make or break" factors for confidence, achievement, and social development. One major perpetuation of sexism in schools mentioned in the article, are teachers. Some teachers hold biased attitudes about students' abilities and treat girls and boys differently in the classroom (Campbell Leaper, Christia Spears Brown, 2014). Although today, more teachers aim to teach with equality, once you know of an inequality, it is hard to forget it. Teachers may now still have implicit biases affecting their teaching of students. As an example, some teachers were more likely to view boys rather than girls as liking math and independence in math. This leads teachers to be more likely to relate boys' success in math to ability, whereas girls' success in math to effort (Campbell Leaper, Christia Spears Brown, 2014). Research also revealed that teachers may favor calling on boys more in the classroom in science and math classes. The article also shares how when girls receive attention for their work, it is more likely to be related to criticism for the content of work complete, while complimenting for organization of the work. Recent research has shown that many teachers are trying to teach equally, and this is showing in the students' test results. Now, some teachers grade girls more competitive than boys in math classes when they are aware of the gender.. Some teachers view boys are more likely to make trouble in the classroom and put in less effort, strongly for African American students.

In the subject of school achievement, sexism has taken its effects on both boys and girls in schools. Girls are stereotypically assumed to have less athletic ability than boys and less ability to excel in STEM subjects. Because achievement in STEM subjects is related towards economic success, policymakers have been worried about the gender gap in certain STEM fields. Recently, 57% of bachelor's degrees have gone to women in the U.S. This is compared to women receiving only 43% of mathematics degrees, 20% of physics degrees, 16% of computer and information sciences, and 18% of engineering degrees (National Center for Education Statistics [NCES], 2013). There is no difference in test scores in middle and elementary schools between the genders, but as students get to high school and college, there is a slight favor towards boys. This research shows that girls start to lose interest in STEM subjects between middle and high school. This drop off has been found related to gender biases in schools, and girls' lack of confidence in STEM subjects has been a leading factor (Campbell Leaper, Christia Spears Brown, 2014).

On the contrary, boys have shown more likely to get lower grades or drop out of most industrialized countries high schools, over girls. In subjects such as reading, writing, and arts,

there is a big gender gap where girls have gotten better grades than boys. This gender gap led to on 43% of all bachelor degrees recently going to men. In the U.S. the gender gap in academic achievement is noticeably larger for African Americans and Latino children rather than White European Americans and Asian Americans (Campbell Leaper, Christia Spears Brown, 2014). Along with in the classroom, sexism is also apparent in male sports. Research has found that boys are likely to get made fun of if they lack toughness or athletic ability. Boys are also stereotyped and give assumptions to teachers that they are more troublesome in the classroom.

Along with teachers and parents, peers play a crucial role in adolescents' gender beliefs. Commonly, peers at school can contribute to sexism by enforcing gender norms, condoning the act of teasing classmates who don't relay these norms, and engaging in sexual harassment. Since sexual harassment at school occurs in a public place like a classroom, peers not only bystand, but reinforce the negative behavior (Campbell Leaper, Christia Spears Brown, 2014). Along with the behavior of reinforcement, peers may also tease others for not doing the same. Research also mentions that adolescents that may not fit the stereotypical norm of their gender can be bullied by group members.

Boys are more likely to get teased for not enforcing their own gender norms or bullying others for the same action, than girls. Although, the article does mention that girls also may receive negative comments for engaging in stereotypical male activities, such as mathematics or athletics. This does not compare to the worse repercussions that boys may face from their peers for appearing feminine or having poor athletic ability.

In a survey of students in grades 7-11, 56% of girls and 40% of boys reported having experienced sexual harassment. On the otherhand the survey of 12th grades, 62% of girls and 32% of boys reported having experienced sexual harassment (Campbell Leaper, Christia Spears Brown, 2014). Research showed that girls were twice as likely to receive negative sexual comments/jokes in schools than boys. The apparent consequences of sexual harassment have shown that girls are more negatively affected than boys. This includes not wanting to go to school, difficulty studying, and absence of activity or sports. The effects of sexism in education is a complex multifaceted web that influences achievement, confidence, and social dynamics in all genders. Through awareness, schools can learn to use their role for the better and make sure every student is set in the right direction with the idea that anything is possible no matter who you are.

Method

To collect data, I distributed a survey via email to students at my school, ages 13-17. I collected 13 responses. Participants range from 13 to 17 years old, one 13 year old and one 14 year old, six 15 year olds, three 16 year olds, and two 17 year olds. 8 self identified as girls, 5 self identified boys, 0 self identified nonbinary. 5 participants had 1 sibling, 5 participants had 2 siblings, 4 participants had 3 siblings, and 1 participant had 4 siblings. 9 participants had siblings that were older, 3 had siblings that were younger, 1 had siblings that were the same age.

I asked participants questions regarding their siblings. Participants were asked to think of the sibling that is closest in age to them and then were asked questions such as “Did you share toys when you were younger” and asked to reply with yes or no. Other questions asked “Do you feel you are treated the same (receive the same punishments/emotional encouragement)?” and the participants were asked to reply with yes, no or maybe. Please see appendix for complete set of survey questions.

Results

I analyzed my survey data using quantitative and qualitative methods. Overall, 46.2% of participants said that their siblings did use their clothes and the same amount, 46.2%, said they used their siblings clothing as well. 76.9% said they shared toys. 46.2% said they have shared a room with their sibling. 61.5% said they watch most of the same shows as their sibling. 69.2% said they are interested in most of the same subjects in school as their sibling. 69.2% also said they play most of the same sports as their sibling. 46.2% said they read most of the same books as their sibling. 84.6% said they have most of the same household chores and responsibilities as their sibling. 0% said their parents call them or their sibling a gender related nickname. 69.2% said they feel they are treated the same (receive the same punishments/emotional encouragement) as their sibling.

Three participants were girls who responded about their girl siblings. All of these participants range from 14-16 and their girl sibling who is closest in age to them is older. They responded saying mostly yes to each question. They share all the same toys, clothes, bedrooms, watch the same shows, read the same books, are interested in the same school subjects and sports, and have the same household chores. Two of the 3 girl + girl sibling responses were they feel they are treated the same by their parents. In their responses, one girl said “I love all my sisters and they are so nice to me. We are all treated similarly by our parents!” and another girl said “I am closest with her because my other 2 siblings are brothers and they are closest in age to each other. We do fight the most though.” The third girl said she doesn't feel she is treated equally by her parents. She responded saying “I am the baby of the family and my mom definitely babies [me] more for that!” meaning that she feels unequally treated based on her age and not her gender.

Three participants were boys who responded about their boy siblings. These responses were similar to the girls who had girl siblings. All of these participants range from 15-16. Two of them responded saying their brother was younger, while one of the participants responded saying his brother was older. They responded saying mostly yes to each question. They share all the same toys, clothes, bedrooms, watch the same shows, read the same books, are interested in the same school subjects and sports, and have the same household chores. All 3 participants responded saying they feel they are treated equally. Their following responses for elaborating on how they feel their parents treat them similarly or differently include: “they treat us the same”, “we are treated like our ages are the only difference” and “we are the closest in age to each other out of all my siblings so most people think we are twins and my parents treat us like that.” None

of the participants related differences to gender , instead, they only pointed out differences due to age.

Five participants were girls who responded about their boy siblings. These participants range from 15 and 17. Four of the 5 said their boy sibling was older than them, while 1 responded that their boy sibling was younger than them. All 5 participants said they do not share clothes with their boy sibling. 3 out of 5 participants responded that they do/did share toys with their sibling. All said they have never shared a room with their siblings. One out of the 5 participants said they watch the same shows as their sibling. 2 out of 5 participants said they are interested in the same school subjects as their sibling. 3 out of 5 participants said they play most of the same sports as their sibling. 1 out of the 5 participant said they read most of the same book as their sibling. 1 out of 5 participants said they have most of the same household chores as their sibling. That 1 participant also responded that they don't feel that having different household chores is based on gender. When asked “Do you feel you are treated the same (receive the same punishments/emotional encouragement)?” 2 out of 5 participants responded “No.” Their elaborated written responses include: “My brother is treated with favoritism for his academics and sports because he places better in both those than me. My parents feel he should only focus on those and he gets out of a lot of punishments and stuff like that” and “my parents are harder on me because I am older.” One of these response relating to gender, 1 out of the 5 participants responded “Maybe.” Her response was “Differently but also the same” The final 2 out of 5 participants responded “Yes.” They elaborated written responses include: “me and my brother are pretty different and my parents treat us differently because he likes sports and I don't so he gets more attention for that” and “my parents are separated so their parenting styles differ a little bit.” The first of these 2 responses seem to lead a bit more into feeling like their parents do not treat them equally.

Two participants were boys who responded about their girl siblings. These participants are 16 and 13. Both responses include that their girl sibling is older than them. Both participants said they do not use their siblings' clothes and vice versa. One of the participants said they have shared toys with their sibling, while the other said they didn't. Neither of the participants have shared a room with their siblings. One of the participants says they watch the same shows as their sibling, while the other participant doesn't . Both participants are interested in the same school subjects as their siblings. One of the participants said they play the same sport as their sibling, while the other doesn't. Neither of the participants read mostly the same books as their siblings. One of the participants said he does not have the same household chores and responsibilities as their girl sibling, while the other responded saying that they do. The participant that doesn't have the same household chore as their sibling thinks it is due to their differing genders. However, both participants responded saying that they feel they are treated equally. They were asked to elaborate their answer and these are the responses they shared: “my sister is in college so it is different since it is just me at home” and “my parents treat us pretty similarly because we have the same rules.”

Discussion

In my study, I aimed to investigate the impact of sibling gender composition on individuals' responses to gender related questions. My research question focused on the understanding whether individuals with same-gender siblings exhibited more similar responses, while those with different gender siblings had fewer shared responses. In my findings, it revealed that individuals who had same-gender siblings tended to have more similar responses to gender-related questions compared to those with different-gender siblings, suggesting that sibling gender composition may influence individuals' perceptions and beliefs about gender. My research helps underpin the societal impacts of something that originally appeared so small and meaningless. All these different factors that play into as adolescents perception on stereotypes, can easily evolve to benefit society in the long run. For example, if enough awareness is spread about family dynamics influence on gender stereotypes, then parents will hopefully become more self aware of their actions, and promote more inclusivity and equality throughout their household. If enough research reaches the right audience, society can work together to tackle inequality at the root; children. Eventually, if our target audience is adults and children influencing equality on children, the next generation should be at least a little bit more equal, as we can only go up from here.

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Do We Have Any Good Reasons to Trust Our Moral Intuition? By Elin Yuan

Abstract

Moral intuition is the instinctive, immediate understanding which self-evident basic moral propositions are based upon, arising from an inner sense of right and wrong that operates without the need for conscious reasoning—in other words, intuition (Stratton-Lake Intuitionism in ethics). These judgments often occur spontaneously and with a sense of certainty, and help us navigate social interactions by providing quick assessments of ethical issues. However, there is no convincing reason to trust moral intuitionism by itself because the way that morality develops from innate sources and manifests itself as a result of socialization is inconsistent and thus unreliable. This paper will prove this by assessing the origin of moral intuition and how that affects the reliability of moral intuition in daily life.

Where Does Moral Intuition Originate?

Arguments about the origin of moral intuition can be divided into three categories: social sources, innate sources, and a combination of social and innate sources.

Monistic Theories of Moral Intuition

Arguments that moral intuition comes from social sources suggest that moral intuition is a direct product of our social surroundings, reflecting a variety of factors such as social norms and education.

This argument is exemplified by the sociologist Emile Durkheim, who argues that moral beliefs are not inherent or purely rational but are products of socialization and collective life. According to Durkheim, individuals internalize the moral values of their society through social institutions such as family, education, and religion (Durkheim Moral education: A study in the theory and application of the Sociology of Education). One example would be the development of moral intuition surrounding the concept of justice. In traditional societies, justice often means retributive justice, where punishment matches the crime to maintain order. In modern societies, justice shifts towards distributive justice, focusing on a fair distribution of resources and opportunities. This shift reflects the evolving structure and needs of society, showing how moral intuitions about justice change with social organization.

However, Durkheim's argument is flawed. He ignores the existence of the innate sources that are biological factors, and how many moral actions are rooted in biological and evolutionary traits that have become innate in the human psyche. Moral behaviours and emotions like empathy, justice, and the aversion to harming others are shaped by evolutionary processes that favour social cooperation. Neurological evidence, including functional MRI studies, points to specific brain regions (such as the ventromedial prefrontal cortex and the amygdala) as central to moral judgment (Marazziti et al. The neurobiology of moral sense: Facts or hypotheses?). In a study conducted on the topic, the findings indicate that specific brain regions—such as the ventromedial prefrontal cortex (VMPFC), the amygdala, and the orbitofrontal cortex—play

crucial roles in shaping morality. The Ventromedial Prefrontal Cortex (VMPFC), for example, has been observed to integrate emotional and cognitive inputs to evaluate moral situations: damage to this area can result in impaired moral judgment and decision-making. This body of evidence suggests that moral sense is underpinned by a network of brain regions that integrate emotional and cognitive information, influencing moral judgments and behaviours.

The Suitability of Dual-Source Theories

Despite arguments for both the purely social and purely innate origin of moral intuition, neither is convincing by itself. Moral intuition develops from both sources.

If one were to make an argument for the purely biological origin of moral intuition, it would be equally difficult to validate. It's unreasonable to completely separate moral judgments from natural facts about human nature and the world, as human beings are part of the natural world, and evolutionary processes have shaped our moral intuitions and behaviours. The biological argument overlooks multiple connections between innate moral beliefs and our social behaviours. The belief that facts and norms are entirely disconnected is flawed because facts inevitably influence the mental processes that lead to the adoption of norms.

Attachment theory explains how attachment behaviours, such as seeking proximity to a caregiver, are rooted in evolutionary biology to ensure survival. Secure attachment in early childhood fosters empathy, trust, and social cooperation, which are foundational to moral norms (Bowlby Attachment and loss). Conversely, neglect or inconsistency can lead to insecure attachment styles (avoidant, ambivalent, or disorganized). This phenomenon can affect future attachment styles within people, permanently shaping their innate judgement. Despite the consistent biological impulse to seek parental attachment, the developed attachment styles prove that biological facts (innate attachment behaviours) and social experiences (caregiver interactions) are deeply interconnected, shaping moral intuitions. Larger norms are not developed in isolation from external socialization; instead, they are deeply intertwined.

Moral intuition is difficult to define concisely when considering its intricate role in our daily lives. Morality involves complex cognitive processes, including reasoning, empathy, and abstract thinking. While neural and evolutionary biology can explain basic instincts, they do not fully account for higher-order moral reasoning and the development of sophisticated ethical systems. On the other hand, moral development is heavily influenced by social interactions and learning. Instances such as cultural variability, where different cultures exhibit diverse moral values, or historical changes of moral intuitions and norms through time, indicate that moral intuitions are influenced by cultural context and social learning rather than being purely innate. From childhood, individuals learn moral values and norms through family, education, and peer interactions, which a purely biological perspective cannot fully explain. The complex interplay of moral intuition involves the interaction between innate biological factors and the social influences that shape and refine our moral judgments.

Thus, an integrated approach that considers both natural and social factors provides a more comprehensive and accurate understanding of moral intuition. This approach

accommodates the complexities of human morality, acknowledging both its universality and variability.

Is It Trustworthy?

It is the position of this paper that there is no good reason to trust moral intuitionism, as there is no guarantee that it will lead us to morally good decisions.

Variability of intuition is inevitable, as it's highly variable on a person-to-person basis. Intuitions play a crucial role in ethical decisions by providing the instinctual basis that guides the actions and thoughts that follow them. Despite further rational thought refining the initial impression of intuition, the core of the thought process remains grounded in intuition, leaving its mark on the ideology behind one's moral judgment. The non-rational nature of intuition leads to action based mainly on the result of socialization rather than the also present consistent innate source. Even if saving human life is innately seen as morally correct—whether that is due to our predisposed nature to value life, or biological and evolutionary reasons—that does not mean that actions and beliefs following this value are definitively correct. If two people believe that a certain ethnic group of humans has a population-level statistical hereditary predisposition, one person could conclude that the persecution of this ethnic group is an excusable "necessary evil" for the sake of future human life, while another might conclude that it is an unjustifiable evil to persecute living humans. Both of these perspectives value human lives from fundamentally different stances, showing the difference in manifestation.

The variability of the manifestations of ethical intuition is significantly influenced by social factors such as upbringing, culture, and personal experiences. For example, collectivist cultures emphasize group harmony, while individualist cultures prioritize autonomy (SANTIAGO Individualism and collectivism: Cultural orientation in locus of control and moral attribution under conditions of Social Change). These cultural norms shape moral intuitions, showing that they are not solely innate but are deeply influenced by the social environment. Collectivist cultures might view filial piety as a core moral duty, while individualist cultures might prioritize personal achievements and rights, with moral intuition developed from this cultural norm varying based on priority. Humans are naturally social creatures who learn by observing and imitating others. Moral intuitions can be influenced by the behaviour of peers, authority figures, and cultural role models, leading to the internalization of socially accepted moral standards. Continuous socialization profoundly shapes moral intuitions, more so than innate tendencies do.

In many cases of socialization in intuitive morality, biases or prejudices can be reflected in actions that result from an intuitive moral belief, leading to moral intuition being thoroughly unreliable due to the prejudice that exists in one's viewpoint. Societal norms and values provide frameworks for interpreting and expressing innate moral responses. These frameworks can emphasize or suppress certain moral intuitions, making social influences more dominant in shaping overall moral outlooks. Because moral intuition is present in all judgments that are made—with the initial impression it provides remaining even after further rational

thought—when these decisions are made in high-impact environments, they can strongly affect both the decision-maker and others within the same society. An example of this is racial prejudice in intuition.

When one is socialized in a group that inherently accepts the narrative that a particular race is inferior, moral intuitions can be shaped by unconscious biases learned from a racially biased society (Alcoff Critical philosophy of race). It often goes unquestioned that certain species of animals are deemed inferior to the human race, and a similar effect is created in racist narratives, which often depict white supremacy as an unquestioned standard. These prejudiced supposed certainties influence judgments and behaviours without conscious awareness. Especially in a society such as our own, where a degree of racism is ingrained within social, legal, and legislative systems, historical and structural racism can shape perceptions and intuitions about justice and fairness. Racially segregated housing, enforced through systematic disparities, exemplifies systemic discrimination (Banaji et al. Systemic racism: Individuals and interactions, institutions and Society). Economic, political, and social inequalities lead many Black individuals to live in impoverished areas, creating racial isolation. This segregation not only increases disproportionate costs in terms of network opportunities and education for these communities but also normalizes the disparity as there are no clear recent discriminatory actions, creating a positive feedback loop that perpetuates systematic bias against Black individuals. People may intuitively accept norms and behaviours that perpetuate racial inequalities without recognizing their inherent bias. A manifestation of this sort of moral intuition is the gut feeling you get when someone feels untrustworthy to you, but more often than not that gut feeling is visually determined (Equality and Human Rights Commission et al. Processes of prejudice: Theory, evidence and Intervention). Through systematic and cultural racism, people often draw up the image of a “dangerous person” as dark-skinned, leading to more people distrusting darker-skinned individuals on instinct. Bias affects so many of the principle-based arguments that are in conflict, with discriminatory biases, often stemming from social factors such as religion and culture, being alarmingly prevalent in discussions regarding basic human rights. To allow for a force that is certainly biased, context-dependent, and irrational to be seen as a trustworthy force of action is illogical and irresponsible, considering both its omnipresent nature and its inconsistent manifestation.

One could argue as a refutation that despite variations in moral intuitions across cultures, these differences are often minor compared to the broad areas of agreement. Furthermore, there is likely a shared ethical intuition aimed at understanding others, which facilitates overcoming regional differences and fosters mutual comprehension. However, while in certain situations a mutual agreement can be found within differing moral intuitions, there is no basis upon which one can ensure the compatibility of moral intuitions overall, even agreement of morality is difficult to guarantee. Socialization is not entirely a matter of consent, and how people are affected by their surroundings is equally dependent on the individual, leading to large enough variations in moral intuitions that it is difficult to guarantee a common manifestation.

Conclusion

There is significant evidence supporting the role of social factors in shaping our moral beliefs, but there is also considerable evidence pointing to biological and evolutionary influences. Therefore, it is reasonable to conclude that both social and natural elements contribute to the development of moral intuition. Because moral intuition originates from both innate and social sources and thus isn't trustworthy—largely because of the variability of social surroundings—there is no good reason to trust moral institutions as possessing legitimate decision-making power.

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Hoover's Blame Game: Analyzing the Role of Behavioral Economics and Speculation in the Great Depression By Elliot Kaner

Abstract

This essay analyzed the impact of behavioral economics and speculation on the onset and severity of the Great Depression, with a focus on President Herbert Hoover's 1930 address to Congress. It explored Hoover's emphasis on external global factors over internal psychological influences, such as margin trading and market speculation, as primary causes of the economic downturn. The analysis suggested that behavioral psychology, including phenomena like overconfidence, moral and quantitative anchoring, and magical thinking, played a critical role in exacerbating the financial crisis. While Hoover attributed the depression largely to global events, this essay argues that his rhetoric overlooked the significant internal factors driven by human psychology that contributed to the market crash and the subsequent economic collapse. The findings highlight the importance of understanding psychological influences in financial markets, both historically and in contemporary contexts.

Introduction

Following the first full year of the Great Depression, Hoover delivered a message to Congress on December 2, 1930, regarding America's economy. While various factors contributed to the downturn, President Herbert Hoover overlooked the influential role of behavioral economics and speculation in his report. In his attempt to explain the economic collapse, Hoover primarily emphasized external forces and global events, downplaying the significant role of human psychology, particularly manifested in speculative behaviors. This oversight becomes apparent when examining the period preceding the stock market crash, which had large market fluctuations and mass speculation. During the 1920s, a significant market boom occurred, characterized by a constant upward trend driven by strong performance in production and the overall economy. Various other factors and events in the 1920s contributed to an optimistic economic outlook, leading to a rapid surge in speculation. Investors eagerly rushed to engage in margin trading to capitalize on the perceived opportunities. Psychological behaviors such as magical thinking, overconfidence, and psychological anchors guided the actions taken during the market booms and crashes, which ultimately resulted in disaster. While numerous consequential events contributed to the stock market crash, adverse behavioral psychology ultimately played the primary role in exacerbating the extreme downturn. This disproves President Hoover's assertion that the severity of the depression was primarily attributable to the economic actions of other nations.

Hoover's Oversight: The Dismissal of American Speculation in the Face of Global Factors

President Hoover downplayed American speculation and the stock market crash, primarily emphasizing the impact of other nations on the severity of the depression. His dismissal of the role of internal factors is evident in his statement that the primary influences

behind the depression originated outside the United States, suggesting that America's recovery was hindered by the fear generated by these external factors. Hoover's rhetoric aims to absolve both his administration and the American people of blame for the Great Depression and its slow recovery. It also serves as an example of his attempt to portray himself as a capable and proactive leader throughout his speech. In his message, Hoover further provides extensive detail on how other countries contributed to the downturn. He explains that the global overproduction of basic commodities such as wheat, rubber, coffee, sugar, copper, silver, zinc, cotton, and other raw materials led to a constant decline in prices for these goods. This oversupply caused a financial crisis and reduced the purchasing power of many countries, leading to widespread unemployment in industrial countries and affecting the overall global economy. Hoover additionally adds other global factors that contributed to the economic downturn, such as political unrest in Asia and parts of Europe, revolutions in South America, and Russia's agricultural export methods, which flooded European markets and potentially impacted global trade dynamics. Despite the role these external factors had in contributing to the Great Depression, Hoover only dedicated two sentences in his entire speech to internal issues and American speculation, which is strikingly insufficient given their immense impact on the economy.⁸

The Illusion of Stability and Its Role in 1920s Speculation

The sequence of events that sparked speculation began during the early to mid-1920s, fueled by a false sense of security that emerged in an era of affluence. During this period, the American economy experienced immense reliable growth, instilling a sense of optimism and trust regarding the market among the public. One reason for this boom in the stock market before the eventual crash of 1929 was that production and the economy in the 1920s were at a high, which contributed to the uptrend of the market. For example, the number of manufacturing establishments in the USA increased from 183,900 to 206,700 between 1925 and 1929, with the value of output rising from an initial \$60.8 billion to \$68 billion. The Federal Reserve index of industrial production also almost doubled in that time period.⁹ Since corporate earnings were stable and increasing, the prices of stocks rose. Furthermore, stock prices were also at a low in the early 1920s, attracting investors with promising returns and fueling the upward trend. By 1927, stock prices went up daily and while the increases were not relatively large, the gains were reliable. Major events during this period, such as Henry Ford's Model T transition in the summer of 1927, had the potential to dampen the market. This transition could have created uncertainty among investors about the future of Ford's business and the automobile industry as a whole, potentially leading to a decrease in industrial production, as indicated by the Fed's index of industrial production receding. Additionally, there was also a temporary industrial production

⁸Herbert Hoover, "Annual Message to Congress 1930," online.infobase.com, 1930, online.infobase.com/Auth/Index?aid=&itemid=&primarySourceId=5747.

⁹ John, Galbraith, *The Great Crash 1929*. (Boston: Houghton Mifflin, 1955), 16.

decline during early 1926. Despite these events, both had little impact on the market, which continued its upward trend, displaying its reliability.¹⁰

The Fed's Misguided Policies

The Fed's policies in 1928 fueled more speculation despite signs of decline, marking a crucial turning point in the stock market's trajectory and setting the stage for the subsequent crash. These actions, which included lowering interest rates, purchasing government securities, and flooding the market with funds, also led to a surge of activity in the stock market. This intervention, considered the catalyst for the crash, caused the market to spiral out of control, resulting in a period of large fluctuations and increased unpredictability.¹¹ For example, until the beginning of 1928, the stock market experienced a stable uptrend. However, after 1928, when the Fed intervened, there was a shift, and people began believing in false narratives created by high authority figures about the stock market's stability and the economy's resilience, ignoring the signs of instability. There was also a constant need for reassurance that the market would continue to perform well, as it had in the years before. The shift in 1928 is evident in the market behavior during that period. After a stable trend in the market during the winter of 1928, the market experienced a significant rise, followed by a sharp decline, only to recover and rise even higher afterward. The market fluctuated so much that some people were able to make 20 points in a single day of trading.¹² This movement was highly unusual in the 1920s because of the era's less developed market infrastructure and lower trading volumes. In modern times, with advanced technology and higher trading volumes, such movements are more common. Then, In June 1928, the market experienced losses almost as large as the gains during the first half of the year. As a result of these losses, the volume of trading reached a high of 5,052,790 shares. The idea of 5 million shares being traded on the New York Stock Exchange was almost inconceivable, especially considering that it increased by more than a million in less than one month.¹³ The market showed signs of decline, and news of an impending drop spread rapidly.

The Psychology of Margin Trading

Psychology and the nature of human cognition heavily influenced the widespread practice of margin trading among individuals, companies, and professional investors, directly fueling speculation. When someone buys stocks on margin, they own the stock fully, but they do not need to pay the full price upfront. Instead, they leave the stocks with their broker as collateral for a loan. If the stock prices increase, they profit, but the loan amount remains unchanged. Although the speculator earns from the stocks, these earnings were typically lower than the interest on the loan, and in some cases significantly lower. Despite this, speculators were willing to accept the risk because they were primarily focused on the anticipated rise in stock prices,

¹⁰ Galbraith, 20.

¹¹ Galbraith, 21-22.

¹² Galbraith, 23.

¹³ Galbraith, 26.

signaled both by the market and the Fed.¹⁴ This type of speculation experienced rapid growth over the whole year of 1928 as speculation grew.¹⁵ For instance, In the early 1920s, the volume of broker loans varied between \$1 billion to \$500 million dollars. However, by the end of 1928, broker loans increased to \$6 billion.¹⁶ People from across the U.S. and even worldwide, including people from places like London and Shanghai found the activity very appealing. Consequently, a lot of money started flowing into Wall Street which facilitated the increased demand among Americans to buy stock on margin. Even large companies found the rates appealing and believed that investing in Wall Street could yield greater profits than increasing production. Consequently, companies channeled their excess funds into Wall Street.¹⁷ The primary factor driving speculative price movements, such as the ones during this time period, is psychology.¹⁸ While investors, like the margin traders, are often described as following "the herd" during market crashes and booms due to fear or optimism, the reality is more complex. During market fluctuations, trades are not solely driven by emotion, and most individuals tend to act more rationally during these financial periods. As a result, it is hard to believe that the market purely reflects emotions as described in traditional theories.¹⁹ However, solid psychological research actually indicates that there are patterns in human behavior influencing the market in ways that would not be expected if markets operated entirely rationally. These behaviors stem from inherent aspects of human intelligence rather than ignorance. While investors aim to make the right decision, their actions are often shaped by natural behavioral tendencies, particularly in situations where there is no clear guidance on the appropriate course of action, such as the strategy of margin trading. These tendencies include quantitative anchors, moral anchors, overconfidence, and magic thinking.²⁰

Quantitative Anchors and Their Role in Market Psychology

Quantitative anchors shape people's psychological evaluation of stocks and can lead to heightened reactions to economic changes during market booms and crashes. This phenomenon is highlighted by the intensified reactions during the market peak in the late 1920s, particularly evidenced by increased margin trading. The concept of quantitative anchors suggests that people tend to rely on certain values or numbers as mental benchmarks, and these anchors significantly impact their judgments. In the context of stocks, the most recently remembered stock price serves as a benchmark for individuals when assessing a stock price. During market fluctuations, investors anchored onto the recent high prices and could have reacted strongly to bad news or economic changes, causing a rapid drop in stock prices.²¹ Investors also rely on past events as reference points which influences market behavior. For example, the percent drop in the 1987

¹⁴Galbraith, 31.

¹⁵Galbraith, 29.

¹⁶Galbraith, 32.

¹⁷Galbraith, 33.

¹⁸Robert, Shiller. *Irrational Exuberance* (Princeton, New Jersey: Princeton University Press, 2000), 135.

¹⁹Shiller, 135-136.

²⁰Shiller, 136.

²¹Shiller, 138.

market crash was similar to the 1929 crash, which was widely discussed during the 1987 crash.²² Quantitative anchors likely contributed to the 1929 stock market crash because as stock prices rapidly rose, investors may have anchored their expectations to these gains, leading them to continue buying stock and trade on margin despite signs of an impending crash and overvaluation.

Moral Anchors and Their Role in Market Psychology

Moral anchors affect individuals' psychology in stock market decisions by influencing the emotional appeal of investing based on personal values, narratives, and desired wealth. This is exemplified in the 1920s by the narratives of market stability investors relied on and their tendency to pursue risky investments. Moral anchoring influences an individual's decision to buy or sell stocks based on their personal values and beliefs. With moral anchors, individuals consider the emotional appeal of investing in the market in relation to their current wealth and financial needs, rather than adhering to an objective "right" or "too high" market level. Ultimately, the decision is influenced by an individual's perceived needs versus their current investment holdings. Consequently, if the market becomes excessively high, it is likely to crash because eventually investors will feel that they have made enough money. For example, if the market rises dramatically, investors only look wealthy on paper but cannot enjoy the money. As a result, the desire to improve current living conditions could lead to selling stocks. Furthermore, a large portion of human actions involves creating narratives and justifications, extending beyond quantitative considerations.²³ This is exemplified by the fact that employees have a tendency to invest in their company's stock. This inclination aligns with the notion that narratives sway investors. They are more familiar with the stories and news surrounding their own companies, leading them to invest in their stock.²⁴ Moral anchors influenced investors in the late 1920s as traders opted to trust narratives propagated by high authority figures, despite signs of an impending crash. Additionally, the fact that investors chose a risky form of investing rather than a safer approach highlights the role of greed during this period. Driven by the desire for significant profits, investors ultimately turned to margin buying.

The Role of Overconfidence and Magical Thinking in Stock Market Psychology

Overconfidence shapes individuals' psychology in stock market decisions during booms and crashes as people commonly overestimate their beliefs and engage in "magical thinking," ultimately contributing to speculative behavior. This trend was prevalent in the late 1920s because of the preceding market stability and growth. All humans have a pervasive inclination towards overestimating their beliefs. This tendency often results in individuals acting confidently in situations where they might lack sufficient evidence or knowledge.²⁵ One explanation for why people exhibit overconfidence is that they tend to focus only on the final step of their reasoning

²²Shiller, 137-138.

²³Shiller, 138-139.

²⁴Shiller, 140.

²⁵Shiller, 142.

process, neglecting to consider potential errors in their earlier assumptions and logic. Another theory suggests that overconfidence stems from “hindsight bias,” meaning individuals mistakenly believe that they would have predicted actual events if they paid closer attention beforehand. This idea relates to how individuals felt like they should have foreseen the crash of 1929.²⁶ Overconfidence can also stem from the fact that individuals often rely on familiar patterns to make judgments in challenging situations, assuming that future patterns will mirror past ones without adequately justifying this assumption. This connects to the overconfidence instilled in investors during the late 1920s, as the period leading up to the crash was marked by prolonged bullish trends and stability. Accordingly, this pattern reinforced the belief that the growth would continue and past stability would persist. This concept also reinforces the unexpectedness of the market experiencing such a significant downturn.²⁷ Overconfidence and speculative markets can also stem from “magical thinking.” This is the belief that certain actions can bring luck, even if it defies logical reasoning. This occurs when people rely on gut feeling and their intuition, which they feel no obligation to justify to others.²⁸ Research on “magical thinking” suggests that investors intuitively believe that buying a stock will likely cause its value to increase afterward, or if they purchase a stock, others will automatically mimic their trade. Additionally, individuals may perceive a recent streak of success as evidence that their luck will persist, influencing their belief in continued prosperity.²⁹ These intuitive beliefs subtly contribute to overconfidence, fueling the spread of speculative behaviors.

Psychological Impact and Societal Shifts Following the 1929 Crash

Following the 1929 crash, psychology significantly shaped the post-crash events as individuals grappled with profound psychological impacts. After the crash, there was a shift in collective mood and societal attitudes. This change is highlighted in a quote by Frederick Lewis Allen, who emphasized that prosperity is not just an economic situation, but is also a mentality. He noted that the bull market symbolized more than just the end of a business cycle; it represented a peak in American mass psychology and sentiment. With the decline of the bull market and the fading prosperity, Americans found themselves navigating a new reality, prompting the need for new habits of thought, ideas, order of values, and adjustments. According to Allen, the stark reality of lost prosperity profoundly influenced individuals’ perceptions and behaviors, resulting in a loss of trust in the financial system and increased caution. This cautious approach could lead to reduced spending and investment.³⁰ Additionally, feelings of panic, fear, and depression spread throughout America. This is illustrated by the tragic reality that some individuals were unable to bear the financial losses of the stock market crash and resorted to

²⁶Shiller, 143.

²⁷Shiller, 144.

²⁸Shiller, 142.

²⁹Shiller, 144.

³⁰ Maury Klein, “The Stock Market Crash of 1929: A Review Article,” *Business History Review* 75, no. 2 (2001): 341.

taking their own lives. Numerous reports indicated that investors and stock brokers ended their lives by jumping from the tops of buildings in response to the market downturn.³¹

Conclusion

The human psychology of speculation significantly influenced the Great Depression. While various factors contributed to the economic downturn, President Herbert Hoover's deliberate exclusion of the role of behavioral economics and speculation concealed the true causes of the crises. By primarily attributing the depression to external factors and global events and not internal speculation, Hoover aimed to maintain public confidence in both his leadership and the market. Hoover's biases and motivations in his message reflect a self-serving mindset, prioritizing personal interests over addressing the underlying factors that led to the crash. Utilizing psychology to analyze complex occurrences and historical events is an effective method for gaining valuable insights and information. Moreover, the rise of meme stocks in contemporary markets further underscores how psychology plays an increasingly prominent role in shaping modern stock market dynamics. These stocks, often driven by online communities and social media trends, exemplify a shift from traditional fundamentals to a more narrative-driven approach to investing. With a growing number of investors basing their decisions on psychological factors, traders must now comprehend behavioral economics more than ever to navigate the progressively psychology-driven environment of the stock market.

³¹ James, Harold. "1929: The New York Stock Market Crash." *Representations* 110, no. 1 (2010): 137.

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Hydrological Dynamics of Greenland Lakes: Understanding The Process In Which Rapid Drainage Can Occur By Vrishank Malik

Introduction

The Greenland ice sheet (GrIS) is rapidly melting due to an increase in surface temperature and ocean warming. Since 1985, Greenland has lost about 1,140 billion tons of ice, correlating to 30-35% of the global sea level rise. Greenland's contribution is expected to increase to 50% over the next few decades, primarily due to the effect of global warming (Fiondella, 2024). As global temperatures continue to rise, the amount of Greenland's meltwater contributing to rising sea levels is exponentially increasing.

Paleoclimatic reconstructions—methods used to understand past climate conditions before instrumental records were available—have demonstrated that meltwater contributions can cause sea levels to rise several meters. Specifically, they claim that the maximum levels of meltwater released can exceed 1 meter/century (Overpeck et al., 2006). However, other studies suggest that Greenland's contribution to sea level rise will be approximately 22 cm by the end of the century (Bindschedler et al., 2013), with a potential increase rate of 0.7–0.8 mm/year (Fettweis et al., 2008). These claims contradict each other's predictions due to one pivotal unknown: what portion of the meltwater produced on the surface of the GrIS becomes runoff into the ocean (Rennermalm et al., 2013).

This proportion of runoff relies closely upon the drainage of Greenland's supraglacial lakes. However, the exact mechanisms and pathways of the lake's drainage are poorly understood. Supraglacial lakes are bodies of meltwater in the ablation zone of glaciers and ice sheets—the lower part of the glacier where snow loss exceeds accumulation. These lakes are typically found during the warmer months when surface melting occurs more extensively. While lakes may be present on the surface for months, they can mysteriously drain in seconds (Otto, 2022). In this paper, we will explore Greenland's major drainage systems to discuss how meltwater from the GrIS contributes to rising ocean levels.

Greenland Ice Sheet Hydrologic System

The GrIS has three main components: water across the surface (supraglacial), internally through (englacial), and beneath the bed of the ice sheet (subglacial) (Nienow, 2017). Efficient meltwater routing through ice sheets can significantly increase the ice flow velocity and thus ice discharge into the ocean, leading to greater contributions to sea level rise (Smith et al., 2017).

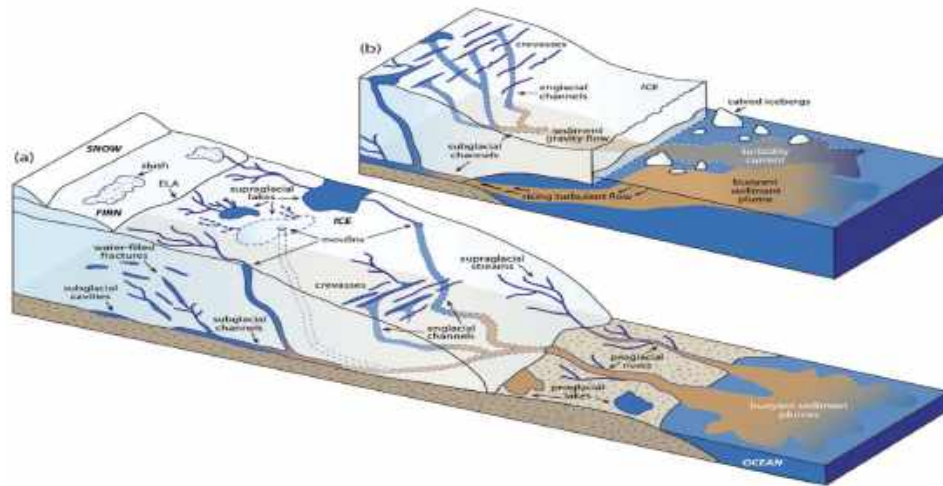


Figure 1. Elements of the Greenland ice sheet hydrologic system. (a) Above the equilibrium line altitude (ELA) in the accumulation zone, water moves through snow and firn, forming slush regions and supraglacial streams. Below the ELA in the ablation zone, meltwater gathers in supraglacial lakes and flows into crevasses and moulins, eventually reaching proglacial rivers and lakes. (b) For marine-terminating glaciers, the meltwater exits differently. Sediment-rich subglacial discharge, released underwater, can rise to form a plume or create a turbidity current beneath the surface.

Note. Modified from Cuffey and Paterson (2010).

Supraglacial Lakes

Before the twenty-first century, there had been little research on the hydrology of supraglacial lakes. However, in the past few years, there has been increased attention on the subject due to supraglacial lakes' importance in meltwater storage and drainage. Meltwater can accumulate in depressions over impermeable ice or dense firn, forming supraglacial lakes that often reappear in the same locations over multiple years (Chu, 2014). While some supraglacial lakes appear in the same area, numerous studies have shown that the lake's location is dependent on the time of season, elevation, and topography. Supraglacial lakes can release large amounts of meltwater into the ice sheet through rapid drainage events—a sudden and swift release of large volumes of meltwater from surface lakes or subsurface reservoirs within an ice sheet.

The creation and drainage of supraglacial lakes depend greatly on summer melt intensity—the GrIS has experienced the greatest summer melt intensity since 1990 (Otto, 2022). Some lakes store their water throughout the winter, however, they do not drain in the winter because the drainage network beneath a glacier becomes more efficient during melt seasons. As the glacier warms and more meltwater is introduced, subglacial channels (the conduits for water flow beneath the glacier) develop (Schoof, 2010). It is due to the development of subglacial channels that rapid drainage events happen in greater frequency during the summer season.

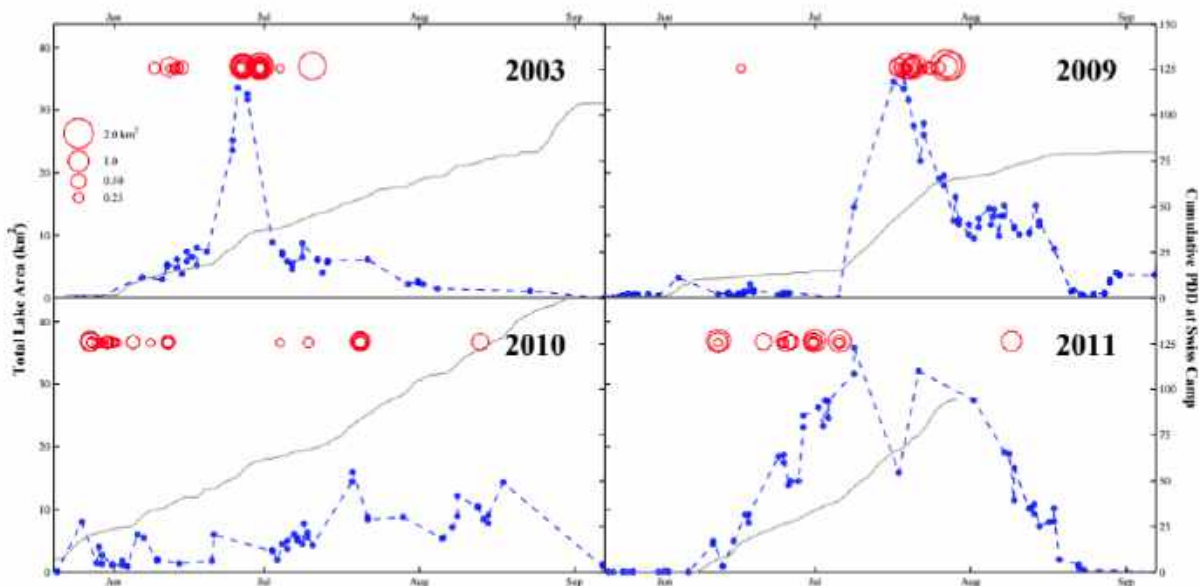


Figure 2. Total lake coverage (blue) and rapid drainage events (red circles, see inset scale) versus cumulative positive degree days (PDD, gray) from the GC-Net station at Swiss Camp for selected years. Rapid drainage events are plotted at an arbitrary vertical axis value to show temporal relationships. PDD, or Positive Degree Day, is a measure used in glaciology and meteorology to quantify the melting potential of snow and ice. It represents the cumulative sum of daily average temperatures that are above the freezing point (0°C or 32°F) over a specific period. Data from 29 July 2011 to 30 September 2011 is unavailable. Note. Adapted from “A ten-year record of supraglacial lake evolution and rapid drainage in West Greenland using an automated processing algorithm for multispectral imagery” by Morriss et al.

Figure 2 visualizes how the total lake area directly correlates to the number and intensity of rapid drainage events. However, such a correlation was not seen with PDD, suggesting that there can be a minimum lake area for rapid drainage to occur. Nevertheless, no such correlation has been established yet.

Hydrofracture of Supraglacial Lakes

Hydrofracturing is the process of water fracturing unconsolidated sediments and bedrock when high fluid pressure surpasses the material's cohesive strength (Ravier, 2024). This process occurs primarily during the melt season when increased surface melting generates substantial volumes of water inside sediments which creates high pressures. This causes the sediments to crack, lowering the pressure by letting the water escape to subglacial channels.

In Nienow's 2017 study they analyzed 2000 Greenland lakes over 5-years and estimated that 13% of the lakes in Greenland were ‘fast-draining’ (Nienow, 2017). Fast (rapid) lake drainage can result in large volumes of water entering the subglacial drainage system over a few

hours with rates of up to 8700 and 3300 m³/s (Das, 2008). Before meltwater reaches the ocean, it is first transported across the ice sheet surface in supraglacial stream networks. The meltwater then navigates through the ice along any permeable pathways. In temperate glaciers, these pathways allow rapid routing through localized macroporosity, such as moulins and crevasses, or slower drainage through microporosity within the ice's permeable vein structure (Nienow, 2017).



Figure 3. Crevasses found on the GrIS.
Note. Adapted from Jason Box.



Figure 4. Meltwater flowing through a moulin.
Note. Adapted from Jason Box.

Crevasses (Fig. 3) and moulins (Fig. 4) are responsible for connecting supraglacial and englacial environments. Crevasses are formed primarily due to surface tension and their pattern is determined by the direction of their principal stressors (Chu, 2014). Crevasse fields are common in the lower ablation zone—where ice melts more than it accumulates—and let meltwater drain into channels within the ice (Lampkin et al., 2013). The amount of drainage is closely linked to the size of the area covered by these crevasses. While crevasses are responsible for around 48% of the total meltwater output (Mc Grath et al., 2011), they discharge steadily over a short period.

Unlike crevasses, moulins provide rapid and near-vertical drainage. Moulins form when summer meltwater corrodes ice. Modeled drainage through crevasses shows reduced diurnal variations, slower transfer times (indicating sustained meltwater input), and lower meltwater drainage per crevasse (Chu, 2014). In contrast, moulins enable rapid pulses of meltwater to drain from large, well-developed catchments (Colgan et al., 2011). This makes moulins crucial for quickly transferring water into the ice sheet, potentially overwhelming the subglacial hydrologic system. This can lead to uplift and increased basal sliding—resulting in increased ice detachment from the ice bed.

Conclusion

The drainage of Greenland lakes plays a pivotal role in understanding the dynamics of the Greenland ice sheet and affecting global sea levels. As per current scientific knowledge, little is known about the reasons or requirements for rapid drainage systems. However, due to this topic being fairly new, Greenland's rapid lake drainage will continue to be explored and uncovered.

Rising surface air temperatures and increased availability of meltwater have caused the GrIS's supraglacial lakes to expand further inland to higher elevations in recent decades—a trend expected to persist. As supraglacial lakes migrate, there will be an exponential increase in the risk of rapid drainage via hydrofracture. This risk will have greater implications beyond the drainage of supraglacial lakes; rapid drainage of lakes can accelerate the movement of ice, possibly destroying more of the Greenland ice cap. This will not only serve as problematic to the species living in the continent itself but will also affect those residing in the world's coastal regions. For example, changes in ice melt can lead to rising sea levels and alterations in ocean salinity and temperature, disrupting marine ecosystems and impacting species dependent on stable conditions. Additionally, increased freshwater runoff will affect nutrient cycles and the health of coastal habitats. This makes it pivotal that action must be taken to prevent the melting of the GrIS by understanding the reasons for rapid drainage of meltwater in supraglacial lakes.

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The Extraliterary Impacts of Dyslexia on Student Athletes: A Review

By Chris Liu

Abstract

Dyslexia is a neurodevelopmental disorder that impairs the accuracy and fluency of word recognition, spelling, and decoding skills without affecting overall intelligence. Recent examinations of dyslexia have identified differences in several brain structures, correlating with impacts on the oculomotor, sensorimotor, and visuomotor systems. Dyslexia impairs an individual's ability to perform the kinds of highly coordinated tasks required by high level athletics. In this comprehensive review, I examine the impact of dyslexia on motor control and sensory coordination to understand the challenges faced by dyslexics during athletic performance. Furthermore, the interplay between dyslexia and concussion risk and recovery highlights the importance of understanding and accommodating the needs of dyslexic athletes.

Introduction

Over 100 years ago, German physician Adolf Kussmaul first described Dyslexia as word-blindness (Kirby and Snowling). In the modern era, dyslexia is defined as a specific learning disorder with impairment in reading without concomitant deficits in IQ (Diagnostic and Statistical Manual of Mental Disorders). Furthermore, dyslexia is now recognized as a complex sensory integration disorder with multiple clinical manifestations arising from complex and poorly understood mechanisms.

Dyslexia is often thought of as a disorder which primarily affects reading and writing skills; however, mounting evidence demonstrates that dyslexia also impairs broader sensory and motor functions. In fact, issues with reading in dyslexia may arise from primary deficits in auditory and visual sequencing (J. Stein; Vidyasagar and Pammer).

While the reading and writing deficits observed in dyslexia are well documented, much less is known about how dyslexia impairs performance in motor or other coordinated sensory tasks. Athletic performance places a high demand on both sensory and motor systems and requires rapid and accurate integration of information from multiple sensory modalities. Indeed, studies of proprioception and balance in dyslexics demonstrate greater discoordination and instability when compared to non-dyslexic children (Scheveig and Bucci).

Critically, individuals with dyslexia may require longer recovery times or special attention following sports-related injuries including concussion (Snowling et al.). These safety concerns are complicated by the multifaceted symptomatology and social stigma of dyslexia which impair diagnosis and discourage self-reporting of diagnostic status. Here, I review the recent literature examining the sensory/motor deficits associated with dyslexia and draw parallels between these laboratory tasks and athletic performance. I make recommendations for further research and examine the current safety protocols for student athletes with dyslexia.

Clinical definition of dyslexia

The fifth edition of the Diagnostic and Statistical Manual of Mental Disorders defines dyslexia as a pattern of learning difficulties characterized by problems with accurate or fluent word reading, poor decoding, and poor spelling that persists for at least six months, despite standard interventions. A key identifying characteristic of dyslexia is low academic achievement for a child's age or average achievement that is sustainable only by extraordinarily high levels of effort and support (Diagnostic and Statistical Manual of Mental Disorders).

Reading development is complex (for a recent review see Castles et al.). At the core of language learning is understanding the letters or combinations of letters which represent each speech sound. Dyslexics are unable to distinguish these as clearly as non-dyslexics (Snowling et al.). Impairment of this process, called phonology, is consistently associated with dyslexia (Griffiths and Snowling; Vellutino et al.).

Theories and mechanisms relating to dyslexia

Genetics play a significant role in the generation of oral language processing, phonological processing, and rapid automatized naming (Grigorenko; Petrill et al.; Snowling and Melby-Lervåg). In the late 20th century, genetic factors associated with dyslexia were identified in families with high rates of the disorder. This was the first suggestion that dyslexia was a developmental disorder that relates to the phonological components of language (Snowling and Hulme). Indeed, the rates of dyslexia diagnosis are higher in children with a family history of dyslexia, in fact, 45% of children with at least one dyslexic parent or sibling will also have dyslexia (Kearns et al.).

There is correlational evidence suggesting the association between dyslexia and reduced visual processing and perception. This correlation has been one of the oldest, most persistent myths regarding dyslexia. Dyslexia is not based on the inability to identify words or text normally since, with practice, these issues are often remedied. Moreover, vision therapy has been proven effective for improving reading skills in dyslexics (American Academy of Pediatrics, Section on Ophthalmology, Council on Children with Disabilities et al.). Furthermore, dyslexia-specific fonts do not improve reading skills. In fact, dyslexics usually prefer traditional fonts (Clemens and Vaughn).

Three theories on the origins of dyslexia

Despite an extensive literature on dyslexia, the exact cause has remained elusive. As such, multiple theories have been proposed to describe the origins of dyslexia including the sensory theory, phonological theory, and the cerebellar theory. These theories underscore the complexity of dyslexia and reinforces the need for more extensive research to understand the significance and dynamics of dyslexia.

1. Sensory theory and developmental dyslexia

Although once considered to be a purely cognitive disorder, mounting evidence demonstrates that dyslexia is associated with multiple sensory impairments. A key source of reading problems in dyslexia is difficulty with auditory and visual sequencing (J. Stein; Vidyasagar and Pammer). Impaired auditory and visual sequencing makes it challenging to locate the precise memory representation of the word. Indeed, auditory and visual deficiencies link closely to temporal processing, and dyslexics struggle to deploy attention accurately and in the correct sequence. An accurate, normal temporal processing sequence would include not only the visual and auditory systems but also in the somatosensory, motor, and proprioceptive system.

The proprioceptive system is a key component of sensorimotor control and sensorimotor impairments are present in Dyslexics (Pozzo et al.). For example, dyslexics tend to have greater balance instability. Postural parameters can even be used as an indicator to distinguish younger dyslexics from age-matched controls (Pozzo et al.). Although not all dyslexic children show a strong proprioceptive impairment, proprioceptive and reading skills appear to be correlated in dyslexic children (Laprevotte et al.). These results are generalizable to a number of key joints including the elbow and hip (Laprevotte et al.).

2. The phonological theory

The phonological theory of dyslexia posits that difficulties with reading arise from a failure to acquire the skill of separating word sounds into separate phonemes to match with the letters that represent them (Snowling; Szenkovits et al.; Vellutino et al.; Bradley and Bryant; Fischer et al.). The most utilized test of this skill is to ask participants to read invented pronounceable non-, or pseudo-, words, such as 'tegwop'. These require letter sound translation without any help from context or meaning; so it is easy for a competent reader to pronounce them but very difficult for poor decoders (Rack et al.). Those children who demonstrate reading difficulty with translating letters into sounds may struggle due to other possible causes such as poor teaching or lack of family support.

3. Cerebellar deficit theory

The cerebellar deficit theory states that the cerebellum is greatly impacted in dyslexia. Different parts of the cerebellum are involved with the control of different types of eye movements and dyslexics often exhibit abnormal eye movements (De Freitas et al.). Not only are eye movements affected for dyslexics but also walking instability, decrease in muscle tone and the inability to control and coordinate muscle movements accurately. Children with dyslexia often struggle to perform tasks which require coordinated cerebellar-vestibular function, such as standing up straight with their eyes closed (Scheveig and Bucci). Furthermore, the quality of eye fixation is significantly poorer with dyslexics with respect to normal readers. In one study of eye fixation 34% of children with dyslexia struggled to accurately perform fixation tasks (Scheveig and Bucci).

Taken together, the cerebellar deficit theory argues that dyslexic children are facing problems that are not only related to reading and spelling, but also motor and sensory integration

skills. There are impairments in the ability to perform automatic skills and coordinated body movements. Behavioral and neuroimaging tests also indicate that dyslexia is indeed associated with cerebellar impairment in about 80% of cases (Scheveig and Bucci).

Sensory deficits in dyslexia

Dyslexic children demonstrate poor performance on tasks requiring control of body posture (Barela et al.; Moe-Nilssen et al.; Viana et al.). Dyslexic children also have decreased performance in manual skill tests (Fawcett and Nicolson; Leslie et al.), possibly due to impaired sensory systems such as the visuomotor, sensorimotor and oculomotor abilities. Sensorimotor deficits may be present in 25-35% of the dyslexic population (Ramus; Scheveig and Bucci). These pervasive sensory impairments may be present in an even larger proportion of patients given the narrow scope of the documented experiments (Scheveig and Bucci). Difficulties with sensory integration are important in athletic performances. These sensory processing issues in dyslexia can hinder the ability to follow complex instructions, maintain balance, and coordinate movements, thereby impacting basic athletic performance.

Multiple sensory deficits are present in dyslexia such as impairments of the oculomotor, proprioceptive, and visuomotor systems. These deficits result in poorer performance on hand force coordination tasks, standing upright or other basic needs in athletics (ref)(Scheveig and Bucci; Eden and Zeffiro; Crawford and Higham; J. F. Stein; Brooks). The ability to perform those sensorimotor functions are crucial in sports performances, for example, a deficiency in the visuomotor ability will cause trouble for a baseball player to hit a baseball or a soccer player to kick the ball. As most sports require visuomotor, postural, or oculomotor abilities, therefore it is reasonable to think that dyslexics will not be performing better than non-dyslexics on the sports field.

Oculomotor and inhibitory control

Vision is one of the most important sensory systems for athletes. Visual impairments, or impairments in visual processing and coordination, greatly affect the ability of athletes to make and execute effective decisions during play (Millard et al.). For example, rugby players rely heavily on knowing their teammates' positions so that they can effectively handle the ball and react to events on the field. All of these skills rely heavily on hand-eye coordination skills (Millard et al.), hand-eye coordination skill highly requires the ability of the oculomotor system where timely and skillful movements such as reaching for the ball or grasping small objects all depend on acquiring high quality visual information (Rizzo et al.).

The oculomotor system is responsible for the movements of the eyes so that images are clearly seen, and are stable during body movements. People with dyslexia are unable to effectively filter distracting signals from information (Eden et al.). This could be the result of reduced eye movement stability during fixations and after saccades (Nyström et al.). Dyslexics have an oculomotor system that is relatively unstable and noisy compared to normal where they would produce interfering signals as a result of motor instability and visual perturbations.

Comprehensive study of oculomotor control and inhibitory interference demonstrates that dyslexics perform worse than control subjects on multiple tasks requiring volitional inhibitory control (Wilcockson et al.). It is important to note that this evidence does not link to the deficits in phonological processing also observed in dyslexia and that multiple impairments likely contribute to the overall dyslexia phenotype (Ramus).

Proprioceptive deficits in dyslexics

Proprioception is the body's ability to sense movement, action and location. This critical sensory modality is impaired in dyslexics. Proprioception and postural ability requires a high level of spinal stability, hands eye coordination and eye fixation towards objects (Scheveig and Bucci).

In a test of balance on an unstable platform, dyslexics were more unstable and had less precise motor control when compared to a control group. For example, 73% of the children tested with dyslexia showed instability on unstable platforms versus only 24% of children in the control group. Another test of head-eye coordination showed that only 21% normal children have discoordination compared to 79% in the dyslexic group. Taken together, these results are consistent with the cerebellar theory where it (Beckinghausen and Sillitoe) underscores the role of the cerebellum in maintaining posture, coordination and motor activities.

Visuomotor deficits

The visuomotor system has the ability to translate a visual image or plan into an accurate motor action for an individual to perform. The reading and writing deficits in dyslexia have been associated with the visuomotor system. Visuomotor impairments not only include reading and writing disabilities but also, difficulties in maintaining a stable, upright stance. For example, greater variability in visual cues induces a less coherent optical sway thereby impairing vestibular function (Barela et al.; Viana et al.). The visuomotor deficiencies resulted in a poorer performance in tasks involving isometric force productions and control guided by visual feedback (De Freitas et al.).

Visuomotor deficits have been demonstrated experimentally in dyslexic children. During an object manipulation task where participants needed to match their force exertion on an object to an on-screen prompt, dyslexic children exhibited a greater degree of variability in their performance. It is important to note that both control and dyslexic groups were able to complete the task successfully and that dyslexia is not accompanied by any discernible gross motor impairment (De Freitas et al.).

Overall sensorimotor deficits

Although dyslexia is primarily a phonological deficit disease, the sensorimotor deficits have a significant impact. Sensorimotor is the combined ability for an individual to perform motor tasks based on the information received through the sensory systems. Sensorimotor

impairments occur in more than 33% of dyslexics (Ramus) which may impact the ability to perform certain athletic moves.

Differences in brain structures in dyslexia

Dyslexia poses multiple sensorimotor deficits as mentioned above. The structural and functional alterations in the cerebellum and the posterior parietal cortex are the key to all these inability to function properly since both structures are activated during visually guided force control which many sports require (De Freitas et al.). The posterior parietal cortices are also significantly affected (Facoetti and Molteni; Galaburda and Livingstone; J. Stein) where visual and tactile sensations may be affected (Rosa) potentially causing the deficiencies in the visuomotor areas (Figure 1).

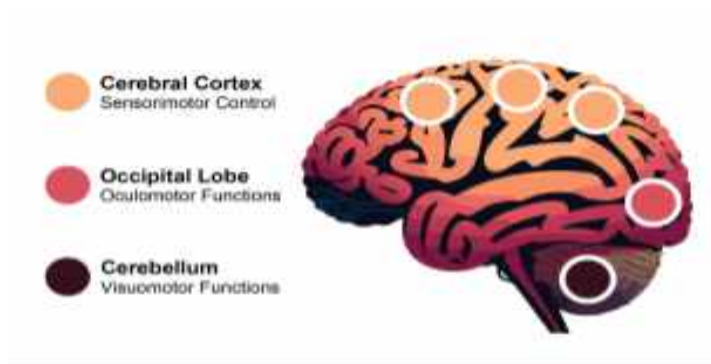


Figure 1. Brain regions involved in motor deficits in dyslexics

An alteration in the cerebral cortex, especially the visual cortex, is responsible for the Visuomotor deficits shown in dyslexics. The alteration of the occipital lobe is responsible for the visual perception & Oculomotor perception deficits shown in dyslexics. Finally, the alteration in the cerebellum causes movement, coordination, and postural disabilities.

Risks for dyslexic children and concussions.

Concussion is a common sports related injury with potentially devastating outcomes. While many sports have adopted enhanced safety protocols to prevent concussion, there are still an estimated 300,000 concussions each year in high school athletes in the United States alone (Gessel et al.). Globally, around 1.6-3.8 million athletes will experience concussion from sports and recreational activities each year (Langlois et al.). The long term effects of concussion can include cognitive and neurological dysfunction that can disrupt daily life. Concussion recovery protocols are often as short as 7-10 days with appropriate cognitive, and physical testing, for highschool students however, the recovery period for high school age students may go up to 15 days. A key variable in determining recovery time is age where children may take longer to recover compared to adults (Manzanero et al.). A 15 day recovery period includes the process of

return to play from light aerobic activities to full contact competitions with few limitations (Williams et al.).

Dyslexic athletes, however, may require modified return-to-play procedures. Student athletes with learning disabilities are more vulnerable to concussion (Wiseheart and Wellington, “Identifying Dyslexia Risk in Student-Athletes”) and sustain significantly more concussions over their lifespan than students without learning disabilities (Iverson et al.). A more gradual return to activity is necessary especially for dyslexic athletes (Giza and Hovda; Giza et al.; Henry et al.).

Concussion and return to play protocols

For a non dyslexic athlete, a typical return to play protocol ranges from 7-10 days or up to 15 days for highschoolers as mentioned above. Although dyslexics have similar return to play durations, it is strongly recommended to consider longer recovery times or additional tests in their return-to play process. This is especially critical when athletes have had a history of concussion (Covassin et al.). The international guidelines for sport concussion management indicate that athletes with outside factors such as dyslexia or other learning disabilities may need more careful planning and intervention (Wiseheart and Wellington, “Identifying Dyslexia Risk for Sport-Related Concussion Management”).

There are several key steps in concussion recovery and return to play procedures. The exact duration of each step should be determined in discussion with the athlete and their physician. Recovery times are known to vary by patient age (Manzanero et al.) and learning disability diagnostic status (Collins et al.).

United States Centers for Disease Control Return to Play Recommendations

Step 1 - Return to Regular Activities

Athletes will go back to regular activities, they should be attending school (with extra-time given on tests and homeworks) and managing other responsibilities.

Step 2 - Light aerobic activity

Start by doing activities only to increase an athlete’s heart rate. Simple light aerobic activities such as exercise bike, walking, or light jogging is recommended. However, heavy weight-lifting or other running are still not allowed.

Step 3 - Moderate activity

Continue with activities to increase an athlete’s heart rate with more body integrated or head movements such as moderate jogging, moderate-intensity exercise biking. Depending on the athlete’s recovery, moderate-intensity weight lifting could be added, at a lower intensity than their pre-concussion norm.

Step 4 - Heavy, non-contact activity

Could begin heavy non-contact physical activities such as sprinting or running. Could start a regular weightlifting routine again and integrate some non-contact sport-specific drills.

Step 5 - Practice & full contact

Return to full practice including full contacts, little to no restrictions are implemented, continue monitoring.

Step 6 - return to competition

If full contact practice goes well, athletes will be allowed back to full competition, thereby ending the concussion return to play protocol (Returning to Sports).

Specific guidelines for the duration of rest are based on the individual and broadly defined as limiting physical and cognitive activity (Wiseheart and Wellington, “Identifying Dyslexia Risk for Sport-Related Concussion Management”).

Conclusion

Here we have demonstrated the ways in which dyslexia extends beyond the canonical deficits in reading and writing to affect sensory processing, auditory, visual, and proprioceptive systems. We have also demonstrated how these impairments can hinder the ability to complete complex tasks, maintain balance, and coordinate movements, thus affecting athletic performance. Furthermore, dyslexics are more prone to concussions, experience longer recovery periods, and face worse outcomes from additional injuries. While non-dyslexic athletes typically follow a 7-15 day return-to-play protocol after a concussion, dyslexic athletes require more careful consideration.

Although there has been much work done on understanding the full phenotype of dyslexia, it is clear that there is a bias in our understanding towards how dyslexia impacts academic skills. Despite this, mounting evidence demonstrates that dyslexia is a multi-system disorder which affects both linguistic and sensory/motor functions. Further work could identify athletes with dyslexia and compare their visuomotor skills to non-dyslexics. Furthermore, the heightened risk of repeated concussion associated with dyslexia and other learning disorders gives clear reason to investigate these effects further.

This review highlights the need for tailored approaches in coaching and rehabilitation for dyslexic athletes, emphasizing the importance of further research into the unique sensory and motor challenges dyslexics face. These specialized accommodations may leverage the natural abilities of dyslexia while addressing the specific needs such as targeting specifically on the oculomotor areas etc. More importantly, further studies on dyslexia and athletic relationships may ensure dyslexics receive the support they need to excel in whatever athletic situations they may need.

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The Pathway to Amelioration of the Vietnamese Insanity Defense

By Kim Anh Ngo

I. Introduction

The insanity defense has been a topic of great debate among legal scholars, healthcare experts, and members of the public. Some believe that it is a loophole that allows criminals to evade punishment for heinous crimes, while others see it as a way to protect the vulnerable. The insanity defense is a legal concept that allows for the acquittal of defendants whose mental condition demands accommodation from the law. It is based on the premise that individuals who are unable to distinguish right from wrong or who lack the ability to control their actions should not be held criminally liable. The insanity defense is often used as a plea bargaining strategy in which the defendant pleads guilty with the hope of a reduced sentence. In such cases, defendants, with the help of their attorneys, justify their criminal acts as symptoms of mental illness. This, however, results in a legal loophole that allows criminals to get away with their crimes. Furthermore, the insanity defense can be abused as a means to avoid the death penalty or a lengthy prison sentence, and mental illness might be merely presented as an excuse to escape severe punishment. The insanity defense has, in fact, been exploited by criminals who fake or exaggerate their symptoms of mental illness. Mental health experts, tasked with diagnosing a defendant, can easily be misled or even deceived by an individual presenting false claims of mental illness. This leads to a dangerous situation where people with confirmed mental illnesses become agents of suspicion, and criminals get off with a light sentence. Moreover, the insanity defense can be manipulated to gain unjustified sympathy and legal acquittal. This manipulation of public opinion is particularly dangerous because it can lead to judicial and social upheaval alike. This could even have far-reaching impacts on victims and their families, leaving them with an inevitable feeling that the criminal justice system has failed them and the perpetrator avoided responsibility for their actions. Finally, the exploitation of the insanity defense can create a dangerous precedent. If the defense is seen as an easy way out of punishment, it can encourage individuals to commit crimes knowing they can avoid legal accountability.

The concept of the insanity defense dates back to 1800s England, where it was first introduced in 1843 as the M'Naghten Rule after a man named Daniel McNaughten was found not guilty by reason of insanity for the murder of a British politician. The defense quickly spread to other countries, including the United States, where it was formally recognized in 1834 in a case known as the Durham Rule. The insanity defense has been used in a number of high-profile cases throughout history, including the trial of John Hinckley Jr., who attempted to assassinate President Ronald Reagan in 1981. Hinckley was found not guilty by reason of insanity and spent over two decades in a psychiatric hospital before being released in 2016. Since then, the insanity defense has been used in numerous cases, albeit infrequently. One of the main reasons for the existence of the insanity defense is to protect individuals who are suffering from mental illness. Mental illness can impair a person's cognitive and emotional abilities, leading to irrational

behavior and decision making. In some cases, individuals may not be fully aware of the consequences of their actions or may be unable to control their impulses. It would be unjust to hold these individuals fully responsible for their actions and punish them accordingly. The insanity defense allows for a fair and just outcome in cases where it is clear that the defendant was not in control of their actions. Another reason why the insanity defense exists is to uphold the principles of justice and the rule of law. The criminal justice system is based on the principle that individuals are responsible for their actions and should be punished accordingly. However, this principle should not be applied when the defendant is not fully responsible for their actions due to mental illness. By recognizing the insanity defense, the justice system is able to ensure that individuals are not held accountable for actions that they were not capable of controlling. This upholds the principles of fairness and justice in the legal system. Furthermore, the existence of the insanity defense also serves as a deterrent against potential abuse of power by the state. Without the insanity defense, the state could potentially label anyone with a mental illness as a criminal and imprison them without justification. Before the insanity defense existed in Vietnam, there were a number of precedences that shaped how individuals with mental illness were treated in the criminal justice system. These precedences were often shaped by cultural beliefs and practices, and were influenced by factors such as colonial law, lack of resources, and stigma surrounding mental illness. While these precedences may have seemed reasonable at the time, they often resulted in harsh and unfair treatment of individuals with mental illness, and made it difficult for them to receive the care and support they needed to recover from their condition. The emergence of the insanity defense represented a significant shift in how mental illness was viewed in the legal system, and paved the way for more compassionate and effective treatment of individuals with mental illness in Vietnam and beyond.

This is a violation of civil liberties and would undermine the trust and legitimacy of the legal system. The insanity defense provides a safeguard against this type of abuse of power and ensures that individuals are not punished unjustly. Advocates may argue that it offers a humane and just approach to criminals with mental illness, but it is a deeply flawed system that does more harm than good. It is an outdated and harmful concept that provides no real service to society. It violates the ethics of justice and deprives victims of the closure they deserve while glamorizing mental illness. Instead, the insanity defense should be reformed. Authorities should allocate resources to improve physical and mental health services that can prevent mental illness from deriving into criminal acts.

Analyzing the insanity defense as a loophole allows for a better understanding of the legal system and its limitations. The insanity defense is based on the notion that a person who is not in a sound state of mind cannot be held fully accountable for their actions. However, this concept is often used to defend individuals who have committed heinous crimes, such as murder. This raises important questions about the legal system and what constitutes a fair and just punishment. Furthermore, analyzing the insanity defense as a loophole helps to highlight the issue of mental health and its impact on criminal behavior. It enables a better understanding of the factors that contribute to a person's actions and how their mental state can affect

decision-making. By recognizing that mental health plays a significant role in criminal behavior, the justice system may be able to take a more proactive approach to addressing mental health issues and providing appropriate treatment for individuals who need it. Not only that but, this can assist in identifying the weaknesses within the legal system that make it susceptible to exploitation. This can range from inadequate laws to poor implementation and enforcement of existing laws. By highlighting these issues, it can provide insight into the changes that may be necessary to close any loopholes and ensure that the justice system is more effective in dealing with criminal behavior. Finally, analyzing the insanity defense as a loophole can help to shift attention away from the individual and towards the broader social and economic factors that play a role in criminal behavior. By understanding the context in which crimes are committed, the justice system may be able to identify and address the underlying issues that contribute to criminal behavior. This may include poverty, unemployment, and lack of access to healthcare and education.

II. Methodology

To answer the objective of the research, I conducted research on articles published in “JSTOR”, Cornell Law School with a view to providing a definite explanation for terms such as insanity defense, M'Naghten rule, and *Insanity v. Diminished Capacity*. Further to be more inclusive, terms such as, not guilty by reason of insanity, guilty but insane/mentally ill and criminal responsibility were used as terminologies to search on government archives. The cross-references of major articles, and reviews, wherever relevant were further reviewed. In order to carry out searches related to legal issues, I utilized various databases from online searches such as PubMed, Ebsco Host, Science Direct, ProQuest, Manupatra, Hein Online, Lexis Nexis, Jstor, Springer Link, Cornell Law School, AIR online and SCC online. Additionally, a wide range of published articles and relevant case laws were also discussed in the review.

The use of the insanity defense remains controversial today. Critics argue that it is often abused, and that defendants are able to manipulate the system to avoid punishment. Others point to the stigma surrounding mental illness, and argue that the insanity defense can be an important tool for recognizing the issues faced by those with mental health conditions. Advocates of the insanity defense argue that it serves as a safety net for individuals who suffer from severe mental illnesses. This defense asserts that the defendant did not understand the nature and consequences of their crime or was unable to control their actions due to their mental state. Without this defense, individuals with severe mental illnesses could be punished for crimes they did not have control over, leading to injustices in the criminal justice system. Critics of the insanity defense counter that it is often used as an excuse for criminal behavior. The defense is so broad that it can be used by defendants who do not have a legitimate mental illness to escape punishment for their crimes. These critics say that the insanity defense may be overused, and some juries may be too lenient on those who claim that they are not responsible for their actions due to mental illness. The insanity defense also raises questions about the legal definition of mental illness. Lawmakers have struggled to create a definition of insanity that is broad enough to cover a wide range of

mental illnesses but specific enough to prevent the abuse of the defense. The line between sanity and insanity can be difficult to determine, and the criteria for the defense can vary between states, leading to disparities in the criminal justice system. Furthermore, the public perception of the insanity defense can also be skewed. Some individuals view the defense as a loophole for those who commit crimes to get off without taking responsibility for their actions. Others argue that the defense is necessary to ensure that individuals who suffer from severe mental illnesses receive the treatment they need, rather than being locked up in prison.

Vietnam's legislation regarding the insanity defense is complex and evolving. While Vietnamese law also recognizes the notion of diminished responsibility, the insanity defense is not recognized as a separate defense. This means that, while an accused individual's mental health may be considered during the court proceedings, insanity cannot be used as a standalone defense for exoneration. The Criminal Code of Vietnam recognizes diminished responsibility as a mitigating factor leading to a reduction in an accused's sentence. Clause 1, Article 13 of the Criminal Code states that an offender who committed a crime under the influence of mental disorders or other similar circumstances that lead to reduced ability to recognize, control, or determine a wrongful act is subject to a less severe punishment than the maximum prison term. This provision is aimed at ensuring that individuals who may be suffering from mental disorders or other circumstances are treated fairly by the judicial system. The Mental Health Law of Vietnam, which came into force in November 2020, provides more detailed provisions on the treatment of offenders with mental disorders. Specifically, it emphasizes the importance of rehabilitation and community-based treatment for offenders who are found to have mental disorders at the time of the offense. The law also ensures that mental health assessments must be carried out for all people accused of a crime, and that defendants with a history of mental illness or disorders are not discriminated against based on their conditions. Even with the new Mental Health Law in place, the recognition of mental health and the reduction of punishment for offenders with mental disorders have faced some criticism from criminal justice experts. Some have argued that the current provisions do not go far enough in preventing court cases from further stigmatizing people with mental health concerns. Others have pointed out that the court's decision to reduce sentences based on a psychiatrist's diagnosis may not be reliable due to the personal beliefs and opinions of each individual psychiatrist.

According to the provisions of the criminal law, if the person who caused the crime is mentally ill, they will not be held criminally responsible. In principle, when a person commits a crime with mental symptoms, the investigating agency must solicit and the assessment agency must examine and conclude whether that person is really crazy or not. However, unlike other types of assessment, psychiatric assessment is very special, sometimes it takes many times to get accurate results. Dr. Trinh Tat Thang, Director of the Psychiatric Hospital of Ho Chi Minh City, former Director of the City Center for Mental Health Services, once shared that he most often encounters the pseudo-psychotic form, and at that time, solid skills and professional conscience are two essential things in the examiner. Dr. Thang emphasized: "In many cases, the appraiser will create a very real crazy facade, even willing to negotiate with the examiner to fake the

results". Master Doan Hong Quang, Deputy Director of Hai Phong Psychiatric Hospital and Deputy Director of the City Center for Mental Health Care, also said: "The characteristics of mental illness are complex, long-term progression, difficult to diagnose because there is no psychological quantification. Unlike medical and surgical diseases, which have tests, scans, screenings for immediate diagnosis, mental illnesses are mainly determined through questioning, investigation, and objective investigation. Therefore, the work of each forensic psychiatric examiner is no different from an investigative officer of the police force".

Another difficulty in this profession is the limited time for assessment because it is related to the time limit for investigation and prosecution according to the provisions of the Criminal Procedure Code, while psychiatric assessment requires a lot of time to grasp the rules and monitor the living habits of the patient. Many assessors said that in many cases, especially complicated ones, they do not have enough time to draw firm conclusions, so there are cases that have to be re-examined many times. That is not to mention that some types of mental illness are difficult to recognize, when they are sick, when they are not, or when they are sick but in a hidden form, and how to make people who are crazy really not be unjustly wronged. It is such a heavy job, but according to many insiders, the work of mental health counseling still has a lot of mess: 18 localities, although there are mental hospitals, have not yet established a mental health center according to the provisions of the new law. but still maintain the organizational form according to regulations since 1988; there is still a serious shortage of forensic psychiatrists; Facilities and equipment for psychiatric assessment are still lacking and outdated.

III. Literature Review

Section 1: The history of the insanity defense

The historical roots of the insanity defense can be traced back to ancient civilizations such as Greece and Rome. The concept of mental capacity as a determinant in criminal responsibility emerged during this era. Scholars like Plato voiced ideas about the defense of insanity, suggesting that individuals unable to control their actions due to mental illness should be considered exempt from punishment.

One of the earliest instances of recognizing the influence of mental illness on criminal behavior can be found in ancient Mesopotamia. The Code of Hammurabi, dating back to 1750 BCE, exemplified the general belief that a distinction should be made between rational and irrational behavior when assigning punishment. This code acknowledged that individuals with mental disorders should not be held fully accountable for their actions.

Ancient Greece further contributed to the historical roots of the insanity defense. Greek physicians, such as Hippocrates, identified mental illness as an organic condition. Hippocrates emphasized that the mentally ill required care, not punishment. This perspective laid the groundwork for the recognition of mental illness as a mitigating factor in criminal cases.

The legal systems of the Roman Empire also recognized the impact of mental illness on criminal responsibility. The Twelve Tables, ancient Rome's first legal code, stated that an insane

person could not be held accountable for their actions. Additionally, the Roman philosopher Cicero argued that punishing the mentally ill was both unjust and unnecessary.

During the Middle Ages, religious beliefs heavily influenced the understanding of insanity. The influence of the church resulted in the treatment of the insane as possessed by evil spirits. However, gradual shifts towards a medical explanation of mental illness and its impact on an individual's criminal responsibility began to take hold during the Renaissance.

The Enlightenment era witnessed a renewed interest in human reason and the development of legal thought. Influential thinkers like Cesare Beccaria argued for the humane treatment of the mentally ill, emphasizing the need to distinguish between criminals of a sound mind and those suffering from mental health disorders. This shift in perspective laid the foundation for the modern understanding of the insanity defense.

As societies developed and legal systems became more sophisticated, various legal precedents emerged that cemented the insanity defense. In 1843, the British legal case of Daniel M'Naghten set a crucial precedent for the defense, establishing the "M'Naghten rule" which stated that an individual is not criminally responsible if they suffer from a defect of reason caused by a mental illness. In this case, Daniel M'Naghten attempted to assassinate the British Prime Minister, believing he was being persecuted. He was found not guilty due to insanity and was committed to a mental institution. Following this ruling, the British House of Lords created the McNaughton Rule, which held that an individual could not be held criminally responsible if they were incapable of understanding their actions. In the early 1900s, the use of the insanity defense became more common as mental health professionals gained a better understanding of psychiatric disorders. In 1954, the American Law Institute developed the Model Penal Code, which stated that a defendant could be found not guilty due to insanity if they could not appreciate the wrongfulness of their act at the time it was committed. This code has been adopted by a majority of US states, and remains the standard for the insanity defense. In the 1980s and 1990s, the use of the insanity defense came under increasing scrutiny, as high-profile cases led to concerns that it was being misused. In particular, the case of John Hinckley Jr., who attempted to assassinate President Reagan and used the insanity defense to avoid conviction, led to calls for reform. In 1984, Congress passed the Insanity Defense Reform Act, which raised the bar for defendants seeking to use the defense, and made it more difficult to establish that an individual was legally insane.

Regarding the historical roots of the insanity defense in Vietnam, the complex interplay between cultural, historical, and legal factors. Traditional Vietnamese law was deeply influenced by Confucianism, which emphasized moral principles rather than mental states. Consequently, mental illnesses were not considered a valid defense during this period, but are often associated with bad life habits, generating guilt and social stigma for both individuals and their families. The arrival of French colonizers in the late 19th century brought with it a new legal framework based on the Napoleonic Code. This legal system introduced concepts such as individual responsibility and the capacity to differentiate between right and wrong. However, it did not introduce specific provisions for the insanity defense. Following Vietnam's independence in

1945, efforts were made to modernize the legal system to align with international standards. This included the recognition of the insanity defense as a crucial aspect of criminal justice. The post-independence era saw significant changes in Vietnamese law, which began to consider mental illness as a potential mitigating factor in criminal trials. Efforts to integrate the insanity defense into Vietnamese law were influenced by the country's mental health landscape. Historically, mental illness was stigmatized and often handled at a community level. The development of psychiatric facilities and a deeper understanding of mental health issues prompted changes in attitudes towards the insanity defense. Throughout the 20th century, several landmark cases emerged in Vietnam that illuminated the importance of recognizing mental illness as a legitimate defense. These cases, along with shifting cultural attitudes and international legal trends, led to the implementation of legal reforms establishing the insanity defense as an essential safeguard for those suffering from mental disorders. As globalization continues to shape legal systems worldwide, Vietnam's approach to the insanity defense has become more closely aligned with international standards. The country's participation in international legal forums and its commitment to human rights have contributed to an evolving understanding and application of the insanity defense

Section 2: The legal basis of the insanity defense in Vietnam

a) The legal basis of the insanity defense in Vietnam

Although the insanity defense has been widely used in many countries, its legal basis in Vietnam is a topic of concern. The history of the insanity defense in Vietnam dates back to the country's traditional legal system. In the Nguyen dynasty, Vietnam's legal framework was based on Confucian principles, which had a specific provision for the defense of insanity. In the case where a person commits a crime due to a mental illness, the law stipulates that the perpetrator cannot be held criminally responsible. However, this traditional view of criminal responsibility has changed over time due to the country's modernization and the adoption of new laws. In order to handle criminal liability for someone who commits acts dangerous to society, the prosecution agency needs to determine the criminal liability capacity of that person. If at the time of committing an act dangerous to society, the person performing the act does not have the capacity for penal liability, he or she is not liable for penal liability: "If you are suffering from a mental illness or another disease that causes you to lose your ability to perceive or control your behavior, you will not be held criminally responsible". (Article 21 of the Penal Code 2015). The code does further acknowledge that certain conditions may mitigate or nullify criminal liability. For example, Clause 1 Article 51 of the 2015 Criminal Code states that "Criminal responsibility shall be mitigated or exempted in cases where a person commits a crime because of an irresistible force, coercion, deception, or other reasons that make the actor unable to control themselves." While this article does not mention mental illness directly, it leaves room for the application of the insanity defense, although it may be subject to interpretation by the courts.

Another relevant law in Vietnam for the insanity defense is the 2015 Law on Mental Health, which outlines the legal framework for the treatment and management of mental health. This law acknowledges the need to protect the rights, dignity, and safety of patients with mental illness. The law also stresses the importance of providing appropriate treatment and support to individuals with mental health conditions, which may be helpful in mitigating the defendant's criminal liability in cases where the mental disorder is a factor.

Vietnam has been exploring the possibility of adopting such a defense mechanism. In 2016, the Ministry of Justice of Vietnam proposed the introduction of an insanity defense provision in the country's criminal code. However, this proposal was met with opposition from some who feared that the insanity defense could be abused and lead to the release of dangerous individuals back into society. Moreover, the lack of trained mental health professionals and resources to diagnose and treat mental disorders remains an obstacle to the effective implementation of the insanity defense in Vietnam. There is also the concern that the use of the insanity defense could be subject to cultural biases and misunderstandings regarding mental health conditions.

Another factor to consider is the role of the judiciary and the court in the application of the insanity defense. The judge's perception and interpretation of the law may influence the outcome of such a defense. There is also the issue of the burden of proof, as the defendant has the burden of proving their insanity beyond a reasonable doubt, which may be difficult to achieve in cases where the mental disorder is not well-defined or documented. In addition to legal factors, social stigmatization and discrimination against mental illness may result in a defendant being hesitant to disclose their mental condition, or even being misdiagnosed due to cultural biases and lack of awareness. Social stigmatization can have a profound impact on those who use insanity defense. It can affect their mental health and well-being, as well as their ability to receive fair treatment in the legal system. Social stigmatization can also make it difficult for them to reintegrate into society after their legal proceedings are complete. It can lead to discrimination in the legal system, as well as make it difficult for individuals to reintegrate into society after their legal proceedings are complete. Individuals who use insanity defense often face social stigmatization due to the negative connotations surrounding mental health issues. Mental health issues are often misunderstood or considered taboo in society, which can lead to discrimination against those who suffer from them. They are often labeled as "crazy," "unstable," or "dangerous," which can lead to ostracism from their communities and loved ones. Several solutions exist to address social stigmatization discrimination with insanity defense. Media professionals could focus on the underlying mental health issues that may have contributed to crimes rather than sensationalizing the crimes themselves. The legal system could also be reformed to ensure that those who use insanity defense receive fair treatment and appropriate mental health treatment. However, it will take a concerted effort from the media and legal professionals to reduce social stigmatization and ensure that those who use insanity defense receive fair treatment.

There is also the issue of access to legal representation for defendants, particularly those who may not be able to afford legal services. Aside from the legal, practical and social factors that may affect the insanity defense in Vietnam, there are also ethical considerations that should be taken into account. One ethical concern raised by critics of the insanity defense is the issue of personal responsibility and accountability. Many argue that individuals should be held responsible for their actions, regardless of their mental health status. Another ethical consideration is the fairness of the insanity defense. Some have argued that the insanity defense is discriminatory against those who cannot afford access to mental health treatment, as only those with a diagnosed mental illness are eligible to use this defense. There is also the issue of the impact of the insanity defense on the victims and their families, who may feel that justice has not been served, or that the defendant has escaped punishment for their crime.

b) The low prevalence of the using the insanity defense in Vietnam

The use of the insanity defense has not been as prevalent in Vietnam as it is in many other parts of the world. There are several reasons why the insanity defense is not used as frequently in Vietnam, including a lack of proper legal infrastructure, limited access to mental health care, cultural differences, and a lack of understanding among both the legal and general public. One of the main reasons why the insanity defense is not more prevalent in Vietnam is due to limited access to mental health care. Despite government efforts to improve this situation, there is still a deficit of mental health resources throughout the country. This lack of resources means that many people who suffer from mental illness may go undiagnosed or untreated, leaving them without the necessary evidence to plead the insanity defense in a courtroom. Another reason why the insanity defense is uncommon in Vietnam is due to a lack of proper legal infrastructure that supports its use. Although Vietnam has a legal system based on the French civil law system, there has been limited development of legal provisions to support the insanity defense. Additionally, there is a lack of specialized courts, judges, and lawyers with expertise in handling cases involving mental illness, which discourages individuals from using this defense. Cultural differences can also be a reason why the insanity defense is not more prevalent in Vietnam.

There is a lack of public understanding surrounding mental illness in Vietnam. Many people still hold misinformed views about mental health issues and may not recognize the symptoms of mental illness, making it difficult for defendants to use the insanity defense. Additionally, mental health experts are often not consulted in legal cases, which can further exacerbate the misunderstanding of mental illness and hinder the use of the insanity defense. The judicial system in Vietnam also plays a role in the low usage of the insanity defense. Judges in Vietnam often heavily rely on witness testimony and physical evidence, leaving little room for the consideration of mental health issues. This approach can limit the usage of the insanity defense and discourage defendants from using it.

Additionally, the cultural perception of mental health being linked to criminal activity can impact the prevalence of the insanity defense in Vietnam. In some instances, individuals with mental health issues may be unfairly labeled as criminals, leading them to be punished rather

than treated. This problem is even more pronounced in the case of vulnerable populations, such as those who are homeless or dispossessed and lack family or legal support. Another factor contributing to the lack of prevalence of the insanity defense in Vietnam is the government's current political and economic situation. The government's emphasis on economic development has resulted in a legal system that prioritizes economic growth over civil rights, with few resources allocated for mental health initiatives. This can hinder the development of policies and programs that support the use of the insanity defense.

Finally, the lack of trained mental health professionals in Vietnam can be a factor that contributes to the low prevalence of the insanity defense. Due to limited resources, mental health professionals frequently work in understaffed facilities and may not have the necessary training to diagnose and treat complex mental health issues. As a result, expert testimony supporting the use of the insanity defense may not be available in many cases.

c) An exemplary case of which used the insanity defense

There were a series of serious murders caused by people with psychiatric disabilities in 2018. On October 22, a serious murder continued in Luong Son, Hoa Binh when the victim was murdered by her own adopted child. Regarding the incident, Hoa Binh Provincial Police informed that the suspect had signs of mental instability and had been taken to a psychiatric hospital for treatment.

With the case of a person with a mental illness committing a crime, Lawyer Duong Van Thu, Thien Duong Law Office (Hanoi Bar Association) analyzes:

Firstly, mentally ill people commit illegal acts that cause damage to property, health and life of others, which is a very dangerous phenomenon for society. Current law stipulates that the state of incapacity, criminal responsibility is a person who commits acts that are dangerous to society while suffering from a mental illness or another disease that causes loss of consciousness or the ability to control their own behavior is not criminally responsible.

In Clause 2, Article 49 of the Penal Code 2015 also stipulates that offenders, while having penal liability capacity but have fallen into the situation specified in Clause 1, are also subject to criminal law and take the measure of compulsory medical treatment and, after recovering from the disease, must bear penal liability. Based on the provisions of the law and established facts of the case, the procedural authorities need to carry out procedures for psychiatric assessment of the person who committed the murder. Based on the expert's conclusions, the procedural authorities will apply penalties or other measures to the person who commits the act of murder.

Secondly, according to the provisions of current law, for mentally ill people who commit crimes, they are likely to be prosecuted for penal liability in the case of conclusions of the medical assessment panel, which concludes that only limited capacity to act can still be prosecuted.

In case the competent medical council concludes that they have lost their act capacity, they will be exempt from criminal prosecution. However, in terms of civil liability, mentally ill

people (through their legal representatives) are still responsible for compensating for civil damages to the families of the victims.

“...Currently, there is no regulation on requesting compulsory medical treatment for people with mental illness in case they have not yet committed acts dangerous to society. Therefore, most patients with signs of mental illness are often still living independently, without a manager, except for their family. If the family does not detect or prevent timely mental illness and violates the law, it can easily lead to heartbreaking cases. This is also a potential problem causing great danger to society” – Lawyer Thu emphasized.

To overcome some of these inadequacies, Lawyer Thu proposed that families with people suffering from mental illness should actively take the patient to medical examination and treatment. We should also not rely too much on local agencies, organizations, and authorities but the main responsibility is still from the families of people with signs of mental illness to give supervision, devotion, and provide medical treatment for the mentally ill in time to prevent unfortunate consequences that may occur.

The fact that the current law prescribes the state of incapacity, criminal responsibility is the person who commits acts that are really dangerous to society while suffering from a mental illness or another disease that causes loss of cognitive ability or the ability to control their actions, they are not criminally responsible, this is considered a "loophole" for criminals to somehow create fake documents in order to legalize "fake psychos" to escape the cycle of labor.

Section 3: The flaws of the Insanity Defense

a) Feign insanity a means of escaping punishment

Legal cases that involve the defense of insanity have been happening for centuries. The definition of insanity itself has evolved over time, and has become a contentious topic in legal and medical circles. While legitimate cases of mental illness are associated with the insanity defense, there are instances where criminals feign insanity and use the defense as a means of escaping punishment. These fake crazy criminals present a challenge to jury members, judges, and medical experts who must assess the accused's mental state to determine if an insanity plea is merited.

During the Vietnam War, many people who were drafted into the army devised strategies to escape the war. One of the famous techniques was pretending to be insane. This was done for two main reasons. One, to avoid fighting in the war altogether. Two, to escape the punishment that comes with deserting the army during wartime. In addition to this, they also knew that they would receive treatment in mental hospitals rather than serve a prison sentence for avoiding the war. The success of the insanity defense was dependent on several factors such as the ability to convince a medical examiner of insanity and inconsistencies in the system.

One strategy employed by the draftees was to pretend to have schizophrenia, a mental illness that causes disruptions in thinking, feelings, and behavior. Most soldiers who feigned insanity did so by putting on an act of extreme behavior. Their objective was to portray themselves as being crazy enough not to identify their true motives. This helped them qualify for a diagnosis of mental illness, and it was also their ticket out of the army and free from their sentence. Although many people devised methods to fake insanity to avoid punishment, the government soon discovered that a lot of the people who claimed to be insane were not.

As a result, the government established several criteria to determine whether a person was truly insane or not. Psychologists were brought to the field to examine the soldiers and to decide on what constituted insanity. They studied behavioral patterns, interviewing techniques, and other aspects of a person's life in search of inconsistencies. In addition to this, the government's efforts to curtail fake insanity were evident but not effective when they enforced regulations that scrutinized the veracity of the draftee's claims. They made sure that psychiatrists were well trained to identify false claims; consequently, the success rate of fake insanity went down drastically. In addition, some soldiers were subjected to a polygraph test to determine their mental health status accurately. This test was helpful in distinguishing between the real inmates and those who were pretending to be insane.

It was evident that the failure of the fake insanity defense led to an increased number of prosecutions for desertion. Those who were found guilty faced severe consequences, including lengthy prison sentences. These consequences made it challenging for those who were considering pretending to be insane to escape their punishment. Leading to the act of faking insanity reduced over time, and soon the government could determine which cases were real and which were not. Furthermore, one of the negative impacts of the fake insanity defense during the Vietnam War was that it stigmatized mental illness. Many people equated mental illness with faking illness, and this made it difficult for people with genuine mental problems to get the help they needed. This also led to the notion that people who were truly insane should be suspected of faking it, and as such, the legal system became very skeptical of those who actually had mental health issues.

b) Ethnicities and Gender Disparities

Vietnam is a country with a diverse array of ethnic groups that are divided into two main categories: majority groups and minority groups. Minority groups, such as the Hmong people, often face discrimination and a lack of access to healthcare, including mental health services. This lack of access can lead to a higher prevalence of mental illnesses, which can be exacerbated by factors such as poverty, insufficient education, and limited social support. In addition to ethnic disparities, there are also significant gender disparities in Vietnam. Women are often discriminated against in the legal system and face a higher risk of being sentenced to prison. The intersection of gender and ethnicity only compounds these disparities. For example, ethnic minority women may be particularly susceptible to discrimination and criminalization due to their marginalized status in society.

The insanity defense in Vietnam is governed by a complicated web of laws, regulations, and judicial precedent. The insanity defense is only recognized in very specific circumstances, and even when it is recognized, the defendant may face a lengthy and arduous legal process. The legal system has strict standards for what constitutes insanity, and many defendants are unable to meet these standards due to lack of resources or medical records. In terms of mental healthcare, there is a significant shortage of mental health practitioners and facilities in Vietnam, particularly in rural areas. This means that many individuals with mental illnesses go untreated, which can exacerbate their symptoms and increase their likelihood of engaging in criminal behavior. Ethnic minority groups and women are likely to face an even greater lack of access to mental health services due to their intersectional status.

The complexity of the insanity defense in Vietnam is further compounded by the disparate ways in which it is applied in different regions and for different groups. For example, some legal jurisdictions may be more likely to recognize the insanity defense for ethnic minorities while denying it for majority groups. Similarly, some regions may be more sympathetic to women who plead insanity, while others may be more skeptical.

One possible solution to these disparities is to improve access to mental health care for all individuals, regardless of their ethnicity or gender. By increasing funding for mental health care and expanding services to underrepresented communities, individuals with mental illnesses may be able to receive the treatment they need to avoid engaging in criminal behavior. This would also make it easier for defendants to demonstrate a history of mental illness and to receive a proper evaluation for the insanity defense.

Additionally, legal and medical professionals could work to establish more standardized criteria for determining insanity, which would help to reduce variability in how different groups are treated. Such criteria could take into account the cultural differences that exist in Vietnam, perhaps by involving cultural experts or recognizing that certain symptoms of mental illness may be more prevalent in certain communities.

c) Rehabilitation vs Punishment

There is also a philosophical debate about whether the insanity defense is more aligned with the idea of rehabilitation or punishment. The insanity defense is often seen as a way to show leniency toward defendants who are not fully responsible for their actions. However, some argue that this approach to justice is fundamentally flawed, as it treats the defendant more as a patient in need of treatment than as a criminal who must be held responsible for their actions.

Proponents of the rehabilitation perspective assert that the insanity defense is more in line with rehabilitating offenders. According to these scholars, the defense is designed to ensure that individuals who suffer from mental disorders are placed in treatment programs rather than being incarcerated. This approach aims to help individuals address the root cause of their criminal behavior, thereby increasing their chances of rehabilitation. The idea is that if the offender can be successfully treated, they are less likely to commit further crimes in the future.

Moreover, the rehabilitation perspective argues that the insanity defense should be viewed as a medical issue rather than a legal one. This means that the goal should be to provide medical treatment to individuals suffering from mental disorders, rather than punishing them for their actions. From this perspective, it is believed that punishment would not be appropriate since the individual did not genuinely understand the gravity of their actions. This reasoning is consistent with the underlying principle of the criminal justice system, which is to reform rather than punish criminals.

On the other hand, proponents of a punishment perspective argue that the insanity defense is more in line with punishment. According to these scholars, individuals who are found not guilty by reason of insanity should be punished in the same way as sane individuals who commit similar crimes. This reasoning is based on two central principles. First, it is believed that offenders must be held accountable for their actions. Second, the punishment must be proportional to the severity of the crime committed.

Furthermore, this perspective asserts that the insanity defense is often abused by criminals who pretend to be insane in order to evade justice. This abuse has led to public outrage over the perceived leniency of the insanity defense. As a result, punishment advocates claim that the defense must be reformed to ensure that only individuals who genuinely suffer from mental disorders benefit from it. Advocates also argue that punishment is the most effective way to deter future criminal behavior.

Another argument that supports a punishment perspective is that the insanity defense does not reflect the public's desire for justice. The public often perceives the defense as a way for offenders to avoid punishment for their crimes. This perception is reinforced by the fact that individuals who are found not guilty by reason of insanity are often detained in psychiatric facilities rather than being sent to prison. This approach does not satisfy the public's desire for retribution, making it challenging to convince the public that the criminal justice system is just and fair.

In contrast, proponents of the rehabilitation perspective argue that punishment does not address the root cause of criminal behavior. It is believed that individuals who suffer from mental disorders require medical treatment rather than punishment to help them recover. This approach is consistent with the fundamental principle of the criminal justice system, which is to rehabilitate offenders, rather than punish them.

Furthermore, the rehabilitation perspective points out that individuals suffering from mental disorders have limited control over their actions. Thus, punishing them for their behavior would be unfair and unjust. Instead, treatment tailored to address the specific needs of the individual is more appropriate. Such an approach would also reduce recidivism rates, thereby reducing the overall crime rate.

However, one of the drawbacks of rehabilitation is that it is a costly and time-consuming process. Many treatment programs require long-term treatment, which can strain the resources of the justice system. This causes a dilemma between treating offenders and punishing them, with the latter being a more cost-effective option.

Another argument in favor of the punishment perspective is that the insanity defense undermines the deterrence effect of the criminal justice system. The deterrence effect holds that the criminal justice system can deter potential criminals from committing crimes by punishing those who commit offenses. However, the argument is that if insanity is accepted as a defense for criminal behavior, it fails to send a clear message to potential offenders that they will face severe punishment for their actions. Thus, the deterrence effect is weakened, and crime rates may rise.

In contrast, the rehabilitation perspective argues that the mental disorder defense increases the deterrence effect of the criminal justice system. By offering treatment and rehabilitation options to mentally ill offenders, potential criminal offenders can be

Section 4: The ethics and culture surrounding the Insanity Defense

a) The philosophy of the insanity defense

The insanity defense has been a topic of ongoing philosophical debate within the criminal justice system. The defense aims to prove that the individual who committed the crime lacked the necessary mental capacity to understand the nature of their actions and, thus, was not criminally responsible. This argument presents a philosophical dilemma as it forces us to consider the extent to which mental health should be taken into account when deciding legal responsibility for a crime.

The defense has been argued to be necessary as it provides justice for those who genuinely suffer from mental illness. Those who suffer from mental illness are often unable to control their behavior and may act impulsively without thinking of the consequences of their actions. If they are found guilty, they may end up being punished for something over which they had little control. Therefore, the insanity defense provides a way for such individuals to avoid punishment for something they could not prevent due to their mental illness. However, the use of the insanity defense has also been criticized as a loophole which allows criminals to evade punishment. Critics argue that some individuals may fake mental illness or exaggerate their condition in order to evade punishment. This can lead to a situation where individuals who have committed heinous crimes end up being released back into society without any punishment or rehabilitation. The philosophical dilemma of the insanity defense revolves around striking a balance between a fair and just legal system and the protection and treatment of individuals suffering from mental illnesses.

On the one hand, the legal system seeks to protect society from criminals and hold them accountable for their actions. On the other hand, the mental health system aims to treat individuals suffering from mental illnesses and help them recover. These two goals are often in conflict, and bringing them together requires a careful consideration of the philosophical and ethical dilemmas involved. The inconsistent application of the insanity defense is another aspect of the dilemma. The decision to use the insanity defense is often subjective and dependent on the interpretation of the mental state of the accused. This decision can be influenced by the age, gender, race, and social status of the individual. This raises questions about the fairness and

consistency of the justice system and whether mental illness should be a significant factor in determining guilt or innocence. The use of the insanity defense also raises questions about the rights of the victims of crimes.

While the defense aims to provide justice for the accused, it often overlooks the rights and needs of the victims of the crime. The focus on the mental state of the accused can lead to the dehumanization of the victim and a disregard for the emotional and psychological trauma they may have experienced. The philosophical dilemma of the insanity defense is further complicated by the fact that mental illness is a complex and multifaceted phenomenon. Mental illnesses vary in severity, duration, and type, and the treatment for them is highly individualized. Therefore, determining the extent to which an individual's mental illness influenced their behavior at the time of the crime is a complex and challenging task.

The use of the insanity defense also raises ethical questions about the role of society in protecting and rehabilitating individuals with mental illnesses. It is argued that the criminal justice system should not be the primary means of punishing or treating mentally ill individuals. Rather, society should provide more comprehensive mental health resources to help prevent crimes and support those who suffer from mental illnesses. By doing this, society can help prevent the need for the insanity defense in the first place. Moreover, the use of the insanity defense also highlights the dichotomy of the justice system's two primary goals: retribution and rehabilitation. While retribution aims to punish criminals for their actions, rehabilitation seeks to help individuals overcome the underlying factors that contributed to their criminal behavior. The insanity defense can be seen as undermining these two goals as it usually results in neither punishment nor rehabilitation.

b) The moral basis of the insanity defense in Vietnam

One of the primary ethical concerns with the insanity defense lies in its potential to be abused by individuals who are not genuinely mentally ill. This concern is often referred to as malingering. Malingering is the act of faking or exaggerating symptoms in order to receive a favorable outcome. In Vietnam, there are many cases where defendants have attempted to use this defense to escape punishment even though they are not genuinely insane. This presents a significant moral challenge since it is difficult to distinguish between genuine and fake mental health problems.

Another significant ethical concern is that the use of the insanity defense can undermine the public's confidence in the criminal justice system. When individuals who commit heinous crimes are found not guilty by reason of insanity, it can be challenging for the public to accept such a result. This can lead to a perception that the criminal justice system is inadequate, and it can cause public dissatisfaction with the overall system.

Despite the ethical challenges, the use of the insanity defense is still a necessary legal mechanism. It is essential to ensure that individuals who genuinely suffer from a mental illness are not unfairly punished for crimes they did not intend to commit. The morality of the insanity defense lies in its ability to promote compassion and understanding towards people who suffer

from mental health problems. It also creates a legal framework that preserves the principle of justice and fairness.

In most cases, defendants who successfully plead insanity often require treatment to address their mental health problems. As such, the use of the insanity defense promotes the rehabilitation of individuals as opposed to punishment. This is aligned with the principles of restorative justice. Restorative justice is rooted in a belief that justice should focus on healing the harm caused by the offense rather than punishing the offender.

Another significant moral justification for the insanity defense in Vietnam is to promote access to mental health services. When individuals who suffer from mental illness find themselves in the criminal justice system, they are often forced to get access to mental health services that they otherwise would not have received. This is because the court can mandate that they receive treatment to help them overcome their mental health problems. This promotes the provision of mental health services to vulnerable individuals.

The scope and application of the insanity defense are also influenced by cultural and social factors. In Vietnam, the use of the insanity defense is still relatively underutilized compared to western countries. This can be attributed to various factors such as cultural beliefs, stigma surrounding mental health, and low levels of education. However, as the country continues to develop, these factors are changing, and the use of the insanity defense is expected to increase.

It is vital to note that the insanity defense is a legal mechanism that should be used with caution. It should not be viewed as a loophole that allows criminals to avoid punishment. Instead, it should be used as a means to promote justice and fairness in the criminal justice system. The morality of the insanity defense lies in its ability to provide an opportunity for individuals with mental illness to get the treatment and support they need. It also ensures that justice is not only seen to be done but also done compassionately and fairly.

c) The Insanity Defense and religious influences in Vietnam

Vietnam is home to several religious beliefs, but Buddhism has had the greatest impact on the culture and society of the country. According to Buddhist beliefs, mental illness is caused by past actions and thoughts, and it is not considered a punishment or result of divine judgment. Mental illness is seen as a natural occurrence that can be resolved through meditation, mindfulness, and the cultivation of good thoughts and deeds. This belief system may have had an impact on the way some Vietnamese people view the insanity defense. In Buddhist culture, personal responsibility and good behavior are highly valued, and there may be a sense that individuals should be held accountable for their actions, regardless of their mental state.

Another religion that is prevalent in Vietnam is Christianity, particularly Catholicism. The Catholic Church has a strong tradition of valuing human life and human dignity, which could influence the way Catholics view the insanity defense. The Church places a high emphasis on morality, and mental illness may be seen as a moral failing or weakness. However, Catholic

social teaching stresses the importance of compassion, mercy, and forgiveness, which could lead to greater acceptance of the insanity defense in certain circumstances.

Despite the influence of Buddhism and Catholicism, many Vietnamese people adhere to traditional folk beliefs. These beliefs often involve a belief in spirits and supernatural forces that can cause mental illness, and traditional healers are commonly used to treat mental disorders. This belief system may be linked to a greater acceptance of the insanity defense, as it is believed that a person may not be responsible for their actions if they are under the influence of these forces.

The Vietnamese government has had a significant impact on the use of the insanity defense in the country. The Communist Party of Vietnam has historically taken a strong stance against mental illness, labeling it as a bourgeois affliction that is the result of capitalism. This attitude towards mental illness has led to a lack of resources and support for people with mental health issues, which could impact the use of the insanity defense in criminal cases.

Despite the government's stance on mental illness, Vietnam has made some progress in addressing the issue. The country has a national mental health plan, and there are increasing efforts to destigmatize mental illness and promote awareness. These developments could lead to a greater acceptance of the insanity defense as a valid legal strategy.

IV. Discussion

1. Why the insanity defense should be ameliorated

The insanity defense should be reformed. As a matter of equality, offenders with a mental illness should be treated the same as offenders without a mental illness. The insanity defense undermines the decision-making capacity and autonomy of such defendants. I am approaching the situation from a human rights perspective, in particular from the point of view of the UN Convention on the Rights of Persons with Disabilities (CRPD).

What I find most troubling is the discriminatory consequences of the insanity rather than the insanity defense. These consequences include indefinite detention, involuntary treatment and stigma. In the same vein, Christopher Slobogin of Vanderbilt Law School has said that “If the decisions they make violate a criminal law, they are to pay the consequences to the extent everyone else does.” Tina Minkowitz the founder of the Center for the Human Rights of Users and Survivors of Psychiatry has commented that “Capacity to be held accountable for harm... is a corollary of the capacity to exercise rights” and is a corollary of our “mutual obligations towards others”. These commentators have found great support in the UN Office of the High Commissioner on Human Rights who has found that the CRPD and the “recognition of the legal capacity of persons with disabilities requires abolishing a defense based on the negation of criminal responsibility.”

To further support my case, I will be stating some arguments. The basic reason why the insanity defense should be abolished in Vietnam is that it is seldom successful and may be used to manipulate the justice system. Defendants who plead insanity need to provide evidence to

convince the court that they lacked the mental capacity to understand the consequences of their actions. The burden of proof falls on the defendant, and the standard for establishing insanity is high. Consequently, many defendants who plead insanity are found guilty despite their claims of mental illness. Moreover, some defendants may fake or exaggerate their symptoms to avoid a conviction, or they may use the insanity defense as a bargaining tool to negotiate a plea deal with the prosecution. Furthermore, it undermines the principle of deterrence in criminal justice. Deterrence is a concept that suggests that the fear of punishment deters people from committing crimes. If insanity can be used as a legal defense, it weakens the signal of punishment that the justice system sends to would-be criminals. In other words, the insanity defense may encourage people to commit crimes, knowing that they can avoid punishment by pleading not guilty by reason of insanity.

The major argument against the insanity defense is that it is often at odds with the concept of justice as retribution. Retributive justice argues that people who commit crimes should be punished for their wrongdoing, regardless of their motive or mental state. The insanity defense can be seen as a way to minimize or excuse the harm caused by a criminal act, which goes against the principles of retribution. If someone commits a heinous crime, it may not be just to let them off the hook by claiming that they were not responsible for their actions.

The most disheartening of it all, it can delay justice for victims and their families. Criminal trials may take months or even years to complete, and the use of the insanity defense can prolong the legal process. Victims and their families may experience additional trauma during this time, waiting for justice to be served. Furthermore, the use of the insanity defense may lead to multiple appeals and retrials, which can be emotionally and financially draining for all parties involved.

Lastly, the insanity defense can fuel public outrage and vigilante justice, creating a systematic cycle of crime and violence. If the public perceives that someone who committed a crime is getting off the hook because of a mental illness defense, they may take matters into their own hands. This may lead to violence and mob mentality, which are antithetical to the rule of law. The insanity defense can also fuel resentment between communities, especially if the defendant belongs to a group that is already marginalized, such as people with mental illness or minorities.

With all the aforementioned reasons, I contend that the insanity defense should not be accepted; therefore, should be abolished for good.

2. An alternative path

With abolition comes reinvention. The overarching fact that surrounds my thesis is that the insanity defense has its share of problems. The biggest one being how easy it is for criminals to exploit the defense, turning it into a loophole that is undetectable by the flawed justice system. However, for the lawfully insane, there still must be a judicial system that ensures their rights, the mental illness only worsens in prison or treated improperly due to Vietnamese society's preconception of it. There especially must be a system where criminals cannot take advantage of

such targeted policy. Furthermore, we need to address the social stigma surrounding the mentally ill and provide enlightenment on the true nature of the law that protects them. It is not a means for people to shirk responsibility. Pleading insanity comes with its own consequences upheld in court, including conditional release. All aspects of the crime should be considered when deciding the sentencing for the individual, even the state of their mental health. We need to stop scapegoating the problem and address the issue's root. Only then can we truly move forward and make a better world for those around us. Some alternatives to the insanity defense can be suggested:

One of the alternatives put forward by the abolitionists of the insanity defense is known as the mens rea alternative. This approach has been undertaken in 5 U.S. states and by the jurisdiction of Sweden. Under such a model, evidence of a mental illness will only become admissible and relevant in a criminal trial in so far as it negates the mens rea element of the crime in question, such as intention for murder. There would be no special defense for those with a mental illness in this model, but also in the alternative model known as “integrationism” put forward by Slobogin. Under integrationism, a defendant with a mental illness will only be able to avail of the generic defenses available to all defendants, which are disability-neutral. However, if due to a mental illness, for example due to schizophrenic hallucinations a defendant subjectively feels they are under threat, they would be able to avail of the self-defense doctrine or the duress defense.

Vietnam is a country that possesses a rich and diverse legal system, which draws influences from a variety of sources. However, its legal framework lags behind in comparison to the legal systems of many developed nations. The main legal texts governing the country are the Criminal Code, which outlines the offenses, and the Code of Criminal Procedure, which governs the process of criminal prosecution. To understand how the mens rea alternatives would be applied in Vietnam, one needs to understand these codes and the concept of mens rea.

In the Vietnam legal system, mens rea is an essential element of criminal law. In criminal law, mens rea refers to the mental state or intention of a defendant when committing a crime. In most cases, an individual can only be found guilty of a crime if they had the requisite mens rea. However, there are situations where a defendant lacks the mens rea required for a crime but still behaves in a manner that is criminal. This gives rise to the concept of mens rea alternatives – situations where proof of mens rea is not required for a conviction.

The doctrine of mens rea requires prosecutors to prove that the defendant had the intent to commit a crime before they can be convicted. Unlike other legal doctrines, mens rea does not rely on the defendant’s actions alone but also their state of mind. Crimes are therefore classified into two categories: crimes of general intent and crimes of specific intent. In the case of crimes of general intent, it is sufficient to show that the defendant had the intent to perform the criminal act. In contrast, for crimes of specific intent, prosecutors must show that the defendant had the intent to commit the crime and had a specific purpose behind it. This can be a challenging burden, as it requires prosecutors to provide a high burden of proof.

The first alternative that Vietnam's legal system has in respect to establishing mens rea is the defense of mistake of fact. This defense is based on the concept that if the offender did not have knowledge of a critical fact that would have prevented him from committing the crime, he cannot be held accountable for the offense. However, there are specific criteria for applying this defense in Vietnam. The offender must not know about the facts of the crime, and these facts must be legitimate and justified, and the mistaken belief must have driven the offender to commit the crime.

The second alternative that Vietnam's legal system has for establishing mens rea is the defense of duress. The defense of duress is used when the accused has been threatened or coerced into committing the criminal act. The accused needs to prove that the threat or coercion was due to an immediate and direct danger that could not have been avoided by any other means. In Vietnam, this defense is established under specific criteria and only applies to situations where immediate danger exists that cannot be avoided through alternative means.

The third alternative available in Vietnam's legal system for establishing mens rea is the defense of entrapment. This defense applies when the offender was induced to commit the crime by the law enforcement authorities. The entrapped offender can establish his mens rea only by proving that the crime was initiated by the law enforcement authorities and that the offender would not have committed the offense without their involvement.

The fourth alternative to Vietnam's legal system for establishing mens rea is the defense of self-defense. This defense applies when the defendant had to commit a crime to protect himself or others from imminent danger. The critical criteria for this defense include an immediate and direct danger, the lack of any alternative means to avoid the threat, and proportional use of force to the threat faced.

The fifth alternative applicable in Vietnam's legal system for establishing mens rea is the defense of provocation. This defense applies when the offender is provoked by the victim to commit the crime. For this defense to gain traction, the defendant must have reacted immediately to the provocation, and the reaction should be reasonably proportional to the provocation.

The sixth alternative in Vietnam's legal system for establishing mens rea is the defense of voluntary intoxication. This defense is established when the offender has become intoxicated without any coercion and was acting under the influence of the substance upon committing the crime. This defense is available only when the intoxication was not self-induced and deprived the offender of his control over his actions.

The seventh alternative available for establishing mens rea in Vietnam's legal system is the defense of diminished responsibility. This defense is available when the offender's capability to discern or control his actions was impaired due to mental illness, medical condition, or psychological trauma. The offender must establish that the condition prevented him from discerning the nature and quality of his actions, or he did not know that the actions were wrong.

The eighth alternative available for establishing mens rea in Vietnam's legal system is the defense of necessity. This defense applies when the offender has no other alternative but to

commit the crime to avoid immediate and direct danger. The offender must prove that an emergency situation existed, and he had no other choice but to commit the crime.

The ninth alternative available for establishing mens rea in Vietnam's legal system is the defense of consent. This defense is established under specific criteria, and the offender can be acquitted if he can establish that the victim consented to the crime. The offender must prove that the victim was of an age to give consent and had the capability of giving consent.

Finally, the tenth alternative available for establishing mens rea in Vietnam's legal system is the defense of the mistake of law. This defense applies when the accused has committed the crime while believing the act was legally permissible. However, this defense is only available in exceptional circumstances where the accused receives incorrect legal advice from a credible source.

V. Conclusion

The insanity defense system in Vietnam needs reform. The current system is often used as a way for defendants to escape punishment and sends the wrong message to society. Reforms are needed to better understand mental illness, reduce the stigma attached to it, and ensure that defendants are fairly judged. Possible reforms include training for legal professionals, establishing mens rea system for assessments of defendants' mental states, and limiting the circumstances in which the insanity defense can be used. It is important that these reforms are considered and implemented to ensure that the legal system in Vietnam is fair and just.

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Investigation of the Interactions and Benefits of Music Therapy and TREM2 in the Reduction of Alzheimer's Disease by Sophie Nam

Abstract

Alzheimer's disease (AD) is a progressive neurodegenerative disorder characterized by cognitive decline and memory loss, driven by complex interactions between genetic factors and environmental influences. Despite advancement in the understanding of AD, therapeutic approaches are limited. Among the potential therapeutic approaches, there are triggering receptor expressed on myeloid cells 2 (TREM2) and music therapy. TREM2 has been identified as a key genetic factor and potential therapeutic target for AD. TREM2, predominantly expressed in central nervous system (CNS) microglia, is involved in crucial microglial functions such as proliferation and phagocytosis. TREM2 also plays a role in regulating inflammatory responses and cell signaling pathways. Meanwhile music therapy has emerged as a promising non-pharmacological approach for managing AD symptoms, with evidence suggesting it can improve cognitive function, emotional well-being, and overall quality of life. This review evaluates both non-pharmacological and pharmacological treatments for AD, focusing on music therapy and the role of TREM2. We will discuss the current evidence supporting them and their potential mechanisms. Additionally, the review will explore a proposed connection between music therapy and TREM2, promoting further research into their combined effects. By providing a comprehensive overview, this review seeks to guide future studies and enhance therapeutic approaches for Alzheimer's disease.

Introduction

Alzheimer's disease (AD), the most common cause of dementia, is a neurodegenerative disease marked by progressive cognitive decline as well as behavioral and neuropsychiatric symptoms (Fang et al., 2017). Most patients diagnosed with AD initially exhibit memory impairment, which can then progress to executive dysfunction and difficulties with language and recognition. AD patients can also have trouble with daily life activities ranging from using technology to eating and dressing, increasing their reliance on family caregivers. AD affects an estimated 40 million people worldwide, mostly consisting of people over the age of 60, and with this number expected to double every 20 years, it has become a growing health concern worldwide (Scheltens et al., 2016).

Currently, there is a lack of effective treatment options for AD, and most treatments are focused on relieving the symptoms rather than a cure. This may be due to the fact that the exact cause of AD is still unknown. While the cause is unknown, extensive research has shown the accumulation of amyloid β -protein ($A\beta$) plaques and neurofibrillary tangles (NFTs) are the main pathological features of AD (Scheltens et al., 2016). $A\beta$ plaques are formed from the extracellular accumulation of peptides, predominantly $A\beta_{42}$, which are folded into beta-pleated sheet structures. These peptides are a result of amyloid precursor protein (APP) cleaved by the β - and γ -secretases. When there is abnormally increased processing of APP by the β - and

γ -secretases or an imbalance in the production and clearance of these peptides, they accumulate (DeTure & Dickson, 2019). A β plaques have been shown to drive NFTs formation, neuronal cell death, and neuroinflammation, which subsequently causes cognitive decline (Y. Li et al., 2023). Injecting A β into the brains of transgenic mice with tau mutations led to an increase in NFTs, suggesting that A β enhances tau pathology (Bolmont et al., 2007). NFTs, thick bundles of hyperphosphorylated Tau near the cell surface of neurons, can also trigger neuronal cell death and disintegration. The tau proteins that make up NFTs are hyperphosphorylated and abnormally folded in patients with AD leading to a loss of functioning, increased inability to stabilize neuronal microtubules to prevent tangling, and increasing aggregation. The volume and location of NFTs have been correlated with neuronal loss and disease severity (DeTure & Dickson, 2019).

Scientists have also discovered that inflammation in the brain plays a critical role in the pathogenesis of AD. Microglial cells are the macrophages of the central nervous system (CNS) that search for pathogens or deteriorating neurons as part of the first line of defense in the innate immune response (Cameron & Landreth, 2010). Normally, microglia help maintain synapses by pruning unnecessary synapses, modifying synaptic connections, and promoting new synapse formation (Cornell et al., 2021). However, the brains of patients with AD have shown increased levels of microglia, especially around A β plaques. When there is stress or damage, such as from the accumulation of A β plaques and NFTs found in AD, receptors on microglia bind to A β fibrils, activating an inflammatory response (DeTure & Dickson, 2019). Another immune cell abundant in the brain, astrocytes, plays a role in the additional inflammatory responses that occur in AD patients, causing neurotoxicity. However, this review paper will focus on microglia and its respective inflammatory response due to its particular importance to TREM2. TREM2 is a transmembrane receptor in the microglia of the CNS and mutations in the gene encoding it have been determined as one of the genetic factors in AD pathology.

While we are aware of the implications of TREM2 on the risk of AD, we have yet to determine the best therapeutic approach to utilizing these clear pathological pathways in the treatment of AD. This article will discuss the efficacy of both the nonpharmacological and pharmacological treatments of Alzheimer's disease, focusing on music therapy and TREM2. This will provide a reference for future studies into these two therapies. It will also propose a possible connection between the two therapies, promoting further research into this topic.

Music Therapy

What is Music Therapy?

Music therapy (MT) is the use of music with a certified therapist to improve certain therapeutic areas, such as communication, expression, and movement, and address physical, emotional, mental, social, and/or cognitive needs. For many years, it has been used as a nonpharmacological treatment for patients with dementia, including AD patients, in nursing homes and hospitals (Sato et al., 2015). Since MT has a variety of approaches and techniques, it provides dementia patients with diverse possibilities for treatment. With an increasing amount of

research demonstrating the benefits of MT, music can play an important role in improving the neuropsychological, cognitive, and behavioral symptoms of AD.

Music has been found to influence various aspects of the human body; however, this article will concentrate specifically on its effects related to AD. Music can be especially useful for increasing attention and improving mood by distracting AD patients from negative stimuli such as depression, pain, and anxiety. Music also affects all major limbic and paralimbic structures of the brain, which are responsible for generating and regulating emotions (Koelsch, 2009). Since emotions are known to affect the endocrine and immune system, MT may influence the hormone levels and inflammation in AD patients. Several studies have shown that music both stimulates cognitive activation and reduces neuropsychiatric symptoms, leading to improvements in mental wellbeing and cognitive processes such as memory, executive function, and speech in AD patients (Lyu et al., 2018).

Different Applications of MT for AD

Music and its elements such as rhythm and melody have been utilized in diverse ways to provide a treatment for patients with dementia. This section will summarize the different applications of MT for patients with dementia, especially AD, including active music therapy, MT involving caregivers, listening to music, and background music.

Active music therapy (AMT) involves the making of music with AD patients individually or in a small group within a therapeutic setting, and requires the use of a qualified music therapist. In AMT, sound elements and music are used for musical activities, involving musical improvisation and/or music exercises. These can range from singing songs to playing instruments and rhythmic movement (Raglio et al., 2014). Satoh M et al. had 10 AD patients sing their favorite songs for 6 months using karaoke to observe if the neuropsychiatric symptoms of AD such as psychomotor speed and memory improved. The Sound Training for Attention and Memory (STAM) protocol for dementia utilized structured exercises with musical elements such as clapping to a drum to improve cognitive function in dementia patients. With this protocol in a randomized and controlled trial, they found an increase in scores for the Immediate Prose Memory Test (MPI), Deferred Prose Memory Test (MPD), and Attentional Matrices, indicating significant improvements in attention and memory (Ceccato et al., 2012). These studies indicate that AMT can be used to improve multiple cognitive deficits associated with dementia. In addition, psychologically, AMT has been shown to improve communicational and relational skills. A randomized and controlled study involving singing activities found that AMT significantly improved speech content and fluency in dementia patients, as measured by the Western Aphasia Battery (Brotons & Koger, 2000). Therefore, there is strong evidence supporting AMT with numerous successful scientific studies that include randomized and controlled clinical trials.

Music therapy can also involve family caregivers, including AMT with caregivers or caregiver singing. AMT with caregivers consists of musical activities for both the patient and the caregivers where the music therapist facilitates the relationship between the two. Caregiver

singing is when the family caregiver performs songs and/or vocalizations, melodies without lyrics, in a personal setting such as the patient's home. Both therapies strive to improve communication and relationship between the patient and the caregivers. Nursing and care can frequently induce stress and exhaustion in caregivers, and the dementia patients may react aggressively and defensively. This approach causes dementia patients to focus more on the caregiver, potentially creating a positive relationship and reducing the patients' resistance to different nursing activities such as assisting in dressing and escorting (Raglio et al., 2014). Lena M Hammar et al. studied the impact of caregiver singing on decreasing resistiveness and increasing positive emotions. They found that resistant behavior such as pulling away was significantly reduced, and positive emotions such as pleasure increased in 10 dementia patients during caregiver singing intervention. Other studies also showed caregiver singing increasing mutuality in the interactions between caregivers and dementia patients as well as enhancing calmness and sincerity in dementia patients (Götell et al., 2009). These studies, however, did not include samples of a big size and used qualitative data analysis, making it difficult to confidently conclude the benefits.

Listening to music has been used by many researchers as a receptive musical intervention. It aims to reduce behavioral and psychological symptoms of dementia as well as improve cognitive functions. After listening to a Mozart piano sonata, spatial-temporal reasoning, the ability to mentally transform 3-D objects in space, improved in AD patients (Johnson et al., 1998). In another study where the AD patients listened to Mozart's Sonata and Pachelbel's Canon, the experimental patients showed less decline in the Cognitive Abilities Screening Instrument (CASI) and CASI-estimated mini-mental state examination scores compared to the control group, though these differences were not statistically significant. Further analysis of the cognitive domains within CASI revealed a significant improvement in abstraction, the ability to deal with ideas and concepts, in MT intervention than in the control. However, regarding other cognitive domains, there was no difference between the control and the MT group (C.-H. Li et al., 2015). Listening to preferred or familiar music, in particular, significantly improved symptoms of dementia. Eva M. Arroyo-Anlló et al. found that listening to familiar Spanish songs either stabilized or improved self-consciousness (SC) in patients with mild to moderate AD. The group listening to familiar songs also had better scores than the group listening to unfamiliar songs in both the Mini-Mental State Evaluation (MMSE) and Frontal Assessment Short (FAS) tests.

Though uncommon, some studies use background music as a therapy for patients with dementia. Background music involves playing music in a certain environment, not intended for specific patients. Having music in the background serves a role in relaxation and increases well being. Playing Swedish songs and pop music as background music during dinner reduced irritability and depression in dementia patients, which resulted in the patients eating more (Ragneskog et al., 1996). Vivaldi's 'Spring' movement from 'The Four Seasons' was also used as background music during recall tests in AD patients. The test results revealed that background music improves autobiographical memory, memories from one's life (Irish et al., 2006).

When the results of these different applications of MT were compared, some were more effective than others. In a study where AD patients were randomly split up into active, receptive, and control interventions, active music therapy improved cognition, behavior, and function while listening to preferred music only served to stabilize neuropsychiatric symptoms (Gómez-Gallego et al., 2021). Additionally, Mayumi Sakamoto et al. compared a group of AD patients passively listening to music, a group participating in interactive activities such as singing and dancing, and a control group with no music. They discovered that the interactive group had a greater long-term reduction in behavioral and psychological symptoms of dementia based on the Behavior Pathology in Alzheimer's Disease (BEHAVE-AD) Rating Scale compared to both passive music intervention and the control. These studies suggest that the applications of MT that require the dementia patients to actively participate are the most beneficial in many aspects of improving symptoms of dementia.

Beneficial Effects of MT

Music therapy has been proven to be beneficial to many different symptoms of dementia. With the ability to reduce levels of anxiety, depression, and aggressiveness in addition to improving cognitive function, music therapy has the potential to improve not only the lives of AD patients but also the caregivers that they rely heavily on.

In addition to the beneficial effects of each type of MT explained above, MT has an important connection to hormone levels. Sarah Cheour et al. measured the levels of salivary testosterone and cortisol in mild AD patients before and after MT. Music therapy was shown to increase the production of salivary testosterone while improving Mini-Mental State Examination (MMSE) scores. Another study observed the changes in 17β -estradiol levels after MT. There was a significant increase in 17β -estradiol levels in AD patients with low hormone levels, indicating MT's ability to restore normal hormone levels (Fukui et al., 2012).

Changes in hormone levels have been shown to be extremely important in AD pathology. As people age, the brain levels of testosterone in men and estradiol in women, particularly during menopause, decrease. This age-related reduction in sex hormones has been associated with greater risk of developing AD (Akwa, 2020). Studies found brain testosterone levels to be lower in men with AD than control subjects, and inversely related to soluble A β levels. Similarly in women, AD patients showed significantly lower estradiol (E2) levels in their brain than women of the same age without dementia (Rosario et al., 2011). Estrogen plays a protective role on nerves and regulates cell proliferation. Additionally, estrogen reduces the β amyloid peptide content in neurons, a common pathological feature in Alzheimer's disease, and protects against β peptide neurotoxicity (Nilsen et al., 2006). Neurosteroid levels were also observed to be significantly lower in AD patients than healthy old adults (Akwa, 2020). Neurosteroids such as progesterone and allopregnanolone are steroids synthesized in the brain that influence brain development, have neuroprotective effects, and regulate neuroinflammatory responses (M. Wang et al., 2024). There were decreased concentrations of both dehydroepiandrosterone (DHEA), a hormone used to make androgens and estrogens, and progesterone (PROG), a hormone that plays

an important role in the menstrual cycle and pregnancy, in certain regions of the brain, including the frontal cortex, striatum, and hippocampus in AD patients (Akwa, 2020). Therefore, MT's natural ability to increase hormone levels can potentially be beneficial in treating AD.

Music therapy also provides benefits without the negative side effects of pharmaceutical treatments of AD. The current pharmaceutical treatments for AD have many adverse side effects and are hard to account for in patients with comorbidities. The most common pharmaceutical treatment for AD is acetylcholinesterase inhibitors (AChEIs), such as donepezil, galantamine, and rivastigmine. AChEIs have various side effects, such as anorexia, vomiting, and muscle cramps. They also can lead to more severe side effects, such as long-term liver damage (Massoud & Léger, 2011). Another pharmaceutical treatment for AD is a class of drugs called glutamate regulators, such as memantine. This class of drugs regulates the activity of glutamergic neurons, facilitating synaptic plasticity and neuronal development, and therefore, improving the cognitive symptoms of AD (Chen et al., 2017). This drug is more tolerated by patients, however, it still has side effects, which include dizziness and headaches (Massoud & Léger, 2011). MT, on the other hand, has not shown any significant side effects and has the ability to improve many different symptoms of dementia at once, suggesting a greater importance of MT as a treatment for AD.

Limitations to MT

Despite the beneficial results from these clinical trials, there is still a lack of scientific evidence to declare MT as an effective treatment for AD. This may be due to the fact that most of the studies involving MT did not have a truly representative clinical trial. In most of the studies, many patients withdraw from the study, resulting in not enough subjects for an accurate conclusion. Some studies had a dropout rate as high as 61.5%. The main reasons for these patients dropping out were due to the lack of variety in music and the impatience to complete MT (C.-H. Li et al., 2015). Additionally, though active music therapy was the most effective when compared with other types of MT, patients with severe dementia had trouble participating in these musical activities and expressing emotions (Sakamoto et al., 2013). This indicates that active music therapy may be limited to patients in early or mild stages of AD.

The long-term effects of MT have yet to be studied in depth. Most studies only observed the short-term effects of MT, measuring the improvements in behavior, mood, and cognition during intervention. Even the studies that observed the long-term effects of MT have shown inconsistent durations for which improvements in dementia symptoms lasted. Some studies mentioned that the effects of MT disappeared after four weeks (Svansdottir & Snaedal, 2006). Others stated that the effects did not last more than three months after MT was used for three months (Lyu et al., 2018). This indicates that MT most likely requires consistent intervention, however, the high dropout rate suggests a difficulty in the willingness of AD patients to consistently participate in MT.

It is also important to note that most studies involving music therapy did not stop anti-dementia medication. In other words, MT was used as an addition to the ongoing treatment

rather than as the main treatment for dementia. This makes it difficult to evaluate the potential for MT to be an effective stand-alone treatment for AD.

TREM2

What is TREM2?

Triggering receptor expressed on myeloid cells 2 (TREM2), a transmembrane receptor in the immunoglobulin superfamily, is predominantly expressed in microglia of the CNS and has been linked to Alzheimer's disease (AD). TREM2 contains an extracellular domain composed of a single V-type immunoglobulin domain, an ectodomain, a single transmembrane helix, and a cytosolic tail (Deczkowska et al., 2020). The extracellular domain of TREM2 has the ability to bind to A β , lipopolysaccharide (LPS), and various apolipoproteins such as ApoE, which function as ligands that can activate TREM2 signaling. The extracellular domain of TREM2 can be cleaved by α -secretase enzymes (including ADAM10 and ADAM17) to release soluble TREM2 (sTREM2), which has been associated with increased clearance of A β and reduced AD (Y. Li et al., 2023). Importantly, due to the absence of a signal transduction or trafficking motif in its tail, TREM2 must be associated with the intracellular adapter protein DNAX-activation protein 12 (DAP12) and DAP10. When TREM2 interacts with ligands, DAP 12 and DAP10 are phosphorylated, initiating intracellular signal transduction and therefore, allowing the microglia to execute their essential roles as the brain's macrophages (Deczkowska et al., 2020). Though TREM2 was first discovered to contribute to Nasu-Hakola disease (NHD), it plays a specific role in the development of AD as well. It is involved in microglial activation around amyloid plaques to prevent accumulation of A β (Konishi & Kiyama, 2018). It has been shown, with overexpression, to improve the pathological symptoms of AD, including plaque load and cognitive impairment (Lee et al., 2018).

Mutations in TREM2's encoding gene have been identified as risk factors for AD. A hypomorphic missense mutation, R47H, significantly raises the risk of Alzheimer's disease (AD) (S. Wang et al., 2020). This mutation results in the loss of ligand-binding ability, causing the phagocytosis of the ligands that interact with TREM2 such as A β and ApoE (Deczkowska et al., 2020). This phagocytosis results in an inability to bind to A β , resulting in a reduction in the clearance of A β . Other TREM2 variants like R62H also contribute to increased risk, though to a lesser extent (S. Wang et al., 2020).

TREM2's Role on Inflammation and Microglia

TREM2 and its various functions have been extensively studied in the context of Alzheimer's disease (AD) and microglial activity. This section will summarize the different roles of TREM2 in AD, including its impact on microglia-mediated inflammatory responses and its influence on microglial phagocytic function and survival. While the literature around this topic is extensive, this review will focus on the main signaling pathways that can be tied to a therapeutic

approach that combines the noninvasive treatment of MT and manipulation of the appropriate TREM2 pathway.

TREM2 plays an important role in the microglia-mediated inflammatory response. Specifically, TREM2 overexpression decreases the microglia-mediated inflammatory response. TREM2 also reduces inflammation and improves cognitive function via the PI3K/AKT/FoxO3a signaling pathway (Y. Li et al., 2023). When TREM2 is activated, it interacts with an adapter protein called DNAX-activating protein of 12kDa (DAP12), which subsequently activates the phosphatidylinositol 3-kinase (PI3K) enzyme. PI3K then phosphorylates and activates AKT (also known as Protein Kinase B), which is a key regulator of cell survival and metabolism, and promotes cell survival by inhibiting pro-apoptotic pathways and factors. AKT phosphorylates the transcription factor FoxO3a, leading to its inactivation. In its phosphorylated state, FoxO3a is unable to activate genes involved in pro-inflammatory responses and oxidative stress, reducing inflammation in the brain (Y. Wang et al., 2020). Additionally, TREM2 can enhance the phagocytic function of microglia as well as regulating the proliferation, or rapid growth, and survival of microglial. Recent studies have demonstrated that microglia bind to A β through TREM2, consequently limiting the spread of pathological phosphorylated Tau (Y. Li et al., 2023).

TREM2 knockdown has been shown to increase the microglia-mediated inflammatory response (Y. Li et al., 2023). In microglia, the absence of TREM2 leads to increased transcription of pro-inflammatory factors such as tumor necrosis factor alpha (TNF α) and nitric oxide synthase-2 (NOS2), contributing to the formation of A β plaques and neurodegeneration (Takahashi et al., 2005). TREM2 functional deficiency also leads to a weakened response of microglia to A β plaques, aggravating neuronal damage. Studies have shown that TREM2 knockdown lessens microglia phagocytosis and reduces A β plaque formation (Y. Li et al., 2023).

TREM2 as Potential Treatment for AD

TREM2's role in microglia function and inflammation, described above, highlights its significance in Alzheimer's disease (AD). TREM2 helps microglia support neuron recovery and enhances their neuroprotective effects by regulating inflammatory responses and increasing microglial survival. The essential role of TREM2 in AD suggests its potential as a biomarker or therapeutic target for future AD diagnosis or treatment. Though there have rarely been any human clinical trials involving TREM2, research with AD mouse models have provided valuable information on the use of TREM2 for potential treatments of AD. This section will summarize the TREM2 therapies that have been researched, including the use of soluble TREM2 (sTREM2), monoclonal antibodies, and lentivirus transfection.

Recent studies have researched the development of a TREM2 agonist that when tested on mouse models showed improvements in AD symptoms, indicating the possibilities for activating TREM2 as a treatment for AD. TREM2 agonist, AL002c, treatment in an AD mouse model increased microglia proliferation, enhanced the phagocytic activity of microglia, improved risk-taking and anxiety behavior, and reduced the microglial-mediated inflammatory response. In

the first-in-human phase I clinical trial for AL002c, it caused no serious side effects and increased microglia activation, indicating the safety and tolerability of this antibody (S. Wang et al., 2020). Another monoclonal antibody, Ab-T1, that binds to the extracellular domain of TREM2 was shown to activate microglia and reduce neuroinflammation as well as improve cognitive function. This antibody demonstrated high affinity for both human and mouse TREM2, suggesting its effectiveness in recognizing and binding to TREM2 (Fassler et al., 2021). With successful results, both antibodies are promising candidates for further investigation in the treatment of AD. Using these antibodies or developing better equivalents, proves there is potential for targeting TREM2, allowing significant advancements in managing and treating AD.

Research into soluble TREM2 (sTREM2) has also shown potential in addressing AD. Increased levels of sTREM2 have commonly been associated with AD. sTREM2 levels are found to be elevated in the cerebrospinal fluid (CSF) of patients with sporadic AD, which is why sTREM2 has been considered a biomarker for AD (Y. Li et al., 2023). However, sTREM2 has been found to play a much more complex role. Though sTREM2 is elevated during the early symptomatic stages of AD, sTREM2 could also have protective effects. Through a direct stereotaxic injection of a recombinant sTREM2 protein into the hippocampus of AD mouse models, a study observed the reduction of the accumulation of A β plaques, enhancement of microglial proliferation, and improvements in spatial memory. The study also used Adeno-Associated Virus (AAV) to deliver the gene encoding sTREM2 into the brains of AD mouse models and study the long-term effects of sTREM2. sTREM2 was found to significantly decrease overall plaque accumulation in both the hippocampus and the cortex (Zhong et al., 2019).

Many studies have demonstrated that overexpressing TREM2 can significantly improve symptoms of Alzheimer's disease (AD). Various methods, such as using transgenic mice or in vitro models, have provided valuable insights into TREM2's potential benefits. One study using a lentiviral vector to overexpress TREM2 in the brains of AD mice, showed significant reductions in amyloid-beta deposition, neuroinflammation, and cognitive deficits (Jiang et al., 2014). These findings suggest that TREM2 can potentially be targeted to treat AD by utilizing monoclonal antibodies, sTREM2, and AAV and lentiviral vectors.

Limitations to TREM2 Targeted Treatments

While there are promising therapies involving TREM2 that have been studied, targeting TREM2 still has its limitations. One major limitation is the risk associated with all invasive therapies, which is that it could lead to unintended complications, especially considering the delicate nature of the brain. Most of the proposed therapies have only used mouse models to test their efficacy. Humans could react differently to the therapy or have severe side effects.

Additionally, TREM2 plays specific functional roles at different stages in AD, making it difficult to develop a single treatment targeting TREM2 that accounts for all stages of AD. A study comparing the role of TREM2 in AD mouse models at early and late stages of the disease found that TREM2 deficiency reduced amyloid plaque number and area in the early stages of

AD, while in later stages, there was an increase in plaque size and accumulation (Jay et al., 2017). Having complete opposite effects when at different stages of AD, TREM2 therapies may require specificity and consideration of disease progression, making it difficult to create effective treatments.

Similar to music therapy, there are unknowns with the long-term effects of TREM2 therapies. The progression of neurodegenerative diseases is often slow and variable, making it difficult to predict the long-term effects of TREM2 therapies. Additionally, since TREM2 affects the inflammatory response in the brain, the immune system could adapt to TREM2-targeted therapies over time, reducing their efficacy or leading to resistance.

Connection Between MT and TREM2

Through this review multiple studies were discussed showing the potential benefits of music therapy and TREM2 on reducing the progression and symptoms of AD, and potentially improving patient outcomes. Independently, both approaches are promising and provide therapeutic hope to the population suffering from AD; however, is there a world where these two therapies can interact? Though music therapy and TREM2 seem completely irrelevant to each other, there is a possible connection between the mechanisms of both therapies with regard to AD.

As explained previously, music therapy has been observed to increase levels of estrogen and other sex hormones in AD patients. Estrogen has been found to activate the PI3K/AKT pathway. Estrogen, specifically 17β -estradiol, binds to estrogen receptors (ERs) such as ER α (Estrogen Receptor alpha), located on the cell membrane or inside the cell. The activated ER α can interact with and activate Phosphoinositide 3-Kinase (PI3K). This activation leads to the inhibition of the apoptosis signal-regulating kinase 1 (Ask1) pathway, which would otherwise promote apoptosis in response to amyloid- β (A β) toxicity (Mateos et al., 2012). Since TREM2 has also been associated with the PI3K/AKT pathway, this suggests that MT and TREM2 have a connection through a single pathway. This gives insight into the mechanisms of MT and TREM2, and how they could affect each other. Given its role in promoting cell survival and inhibiting apoptosis, the PI3K/AKT pathway is a promising therapeutic target for AD. This pathway is where multiple neuroprotective signals converge, including those mediated by TREM2 and estrogen. In the TREM2 study, PI3K/AKT activation leads to the downstream activation of FoxO3a, contributing to anti-inflammatory effects and preventing apoptosis. In the estrogen study, PI3K/Akt activation is essential for protecting neurons from A β toxicity, further highlighting the pathway's central role in promoting cell survival and preventing apoptosis.

Currently, the direct use of estrogen in the treatment of AD is controversial. Hormone replacement therapy (HRT) has had inconsistent results, showing both a negative correlation between HRT on the risk of dementia and a positive correlation between HRT and the risk for dementia. A short-term hormone therapy using estradiol found improvement in visual and semantic memory, indicating the favorable effects of HRT on dementia (Wharton et al., 2011). On the other hand, a menopausal hormone therapy with oestrogen and progestin was shown to be

strongly associated with the risk of developing dementia, including AD (Pourhadi et al., 2023). Another type of hormone therapy involving estrogen and progestin was also shown to increase the risk of dementia in postmenopausal women aged 65 years or older and was not able to prevent cognitive decline (Shumaker et al., 2003). Additional studies have indicated that the positive effects of hormone therapy may be due to providing the therapy at a specific time, also known as the critical window theory. One study found that hormone therapy may reduce the risk of AD only when initiated near menopause and instead increase risk when started later in life (Whitmer et al., 2011). Hormone replacement therapy can also cause side effects such as increasing the risk of breast cancer, blood clots, heart disease, and stroke (Cho et al., 2023). Therefore, the direct use of it as a therapeutic target is limited. However, naturally increasing estrogen levels through a noninvasive method such as MT, can firstly, provide the beneficial effects of HRT without the risk, and secondly, provide a novel approach to enhancing TREM2 activation without directly treating a patient with estrogen. This approach combined with the development of a therapeutic TREM2 treatment can significantly increase TREM2 activation, increase A β clearance, and reduce inflammation, resulting in improving AD outcome.

Furthermore, the use of MT with a TREM2 treatment could have other beneficial effects on inflammation. As mentioned, MT has been shown to reduce stress, anxiety, and depression. These negative emotions are, when prolonged, associated with increased inflammation (Kim et al., 2022); therefore, by combining MT with TREM2 treatment, there is the utilization of a noninvasive therapy that can improve inflammation through a reduction of chronic distress, and a more invasive therapy that can reduce inflammation through microglia activity.

While these two therapeutic approaches are seemingly extremely different, there are connections that, if studied, can improve outcomes in AD. Combining agents that activate TREM2, such as the TREM2 therapies discussed above and MT should be further explored as a potential therapeutic strategy for AD and other neurodegenerative diseases.

Conclusion

Music therapy (MT) and TREM2 can both be considered as potential treatments of Alzheimer's Disease (AD), alleviating behavioral and cognitive symptoms and having neuroprotective effects. However, they are currently not perfect solutions, as limitations still exist. Further research should be conducted to verify their effectiveness, clarify their mechanisms, and identify any potential risks. Despite these challenges, MT and TREM2 show promise as valuable components in the evolving field of AD treatments.

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The Social Impact of Successful Business People: How Wealth Creation and Spending Benefit Society By Ruihan Sun

Abstract

Over the past few decades, the distribution of wealth has become increasingly uneven (Swanson). In the US, the share of overall wealth held by the top 1% increased from around 25% in 1980 to more than 40% today (Bagchi & Svejnar). Given the severity of wealth inequality, successful business leaders are often criticized for earning and spending tremendous amounts of money while less affluent people struggle to make ends meet. Therefore, it is important to know whether business leaders benefit society under this configuration. On the whole, successful business leaders benefit society both by making and spending their money. However, this conclusion is only valid if business leaders make and spend their money legally. Monopolistic practices, tax evasion, and illicit competition harm others' interests. Likewise, funding political campaigns, buying insider information, and bribery are also beyond our scope of discussion, since all of these illegal behaviors are conducted at the expense of others' interests.

Making Their Money

To begin, our life would not be as enjoyable without the innovations developed by successful business people while making money. Their innovations have improved our quality of life to a large extent. For example, Bill Gates started Microsoft in 1975; today, it became the most commonly used office software worldwide because it dramatically increased working efficiency (Vailshery). "Excel changed the way business works, making it easy to do calculations and put charts on their data," said Derek Burney, Chief Executive Officer at Corel Corp (Smith). However, this invention did not appear overnight. In fact, Excel was invented on the basis of its precursor Multiplan, and the process involved substantial R & D efforts spanning more than five years (Sharer).

Some people argue that it is the technological experts, not the business leaders, whose work leads to innovation and better quality of life (Goodall). This construct is partially correct because some experts who give birth to new inventions are business leaders as well (Stackpole). However, experts alone do not craft that life-changing product. Economic incentives and business scale effects drive innovation and commercialization, bringing technology from the lab to life.

To explain, let's first think about the motivation for people to innovate. According to Schumpeter's innovation theory, innovation can increase productivity and promote society's development (Sweezy). However, people make efforts to innovate not merely because they want to contribute to society but because they want to gain personal interest. According to Adam Smith, the founder of liberal economics, "It is not from the benevolence of the butcher, the brewer, or the baker, that we expect our dinner, but from their regard to their interest" (Smith). This reveals the fundamental motive of business behavior: pursuing one's own interest.

However, this selfishness effectively fosters technological innovation because it generates a strong motivation for businesses to invest in research and widely applicable technologies. Formulated later, Incentive Theory as proposed by Bolles also suggests that people's behaviors are driven by the promise of rewards (Bandhu et al.). Therefore, business people do their business for their own interests, but this process promotes innovations as a positive side effect. Business decisions have a large impact on technological advancement. Nobel Prize-winning economist Paul Romer showcases the rate at which new technological advances are based on two factors: the stock of existing knowledge and labor inputs as research efforts. Both factors rely on deliberate investment in research and development, which can lead to innovations that are integral to keeping the economy in a state of sustainable development. Robert Solow, another Nobel Prize-winning economist whose work connects to Romer's, states that sustained economic growth is impossible without technical change (The Royal Swedish Academy Of Science). According to the Cobb-Douglas production function, because of the decreasing marginal return of capital, capital formation will contribute less and less to economic growth. Instead, it is only through technological innovations that the economy can grow sustainably. Therefore, innovations can generate greater output and form sustainable growth and this process cannot be achieved without business people's presumably selfish motivation to make more money.

Apart from a profit-driven motivation, business people foster innovation and thus higher quality of life through economies of scale. A scale effect refers to a specific pattern: as a business reaches a scale, the marginal cost of increasing production will decrease (Jones). This phenomenon enables innovative yet lab-based technologies, which are usually expensive, to become convenient and affordable for everyday consumers. For example, consider the spread of drones in China. Initially, drones were costly niche technologies primarily for specialized uses such as military surveillance. However, as Chinese companies like DJI scaled up production, they were able to reduce costs significantly through economies of scale (Mao et al.). The reduced production cost leads to lower prices, which make drones accessible to common consumers, fostering the further adoption of innovation.

Therefore, the process of a successful businessman making money in a legal and competitive market is not a zero-sum game but a process that generates widespread benefits through increased productivity. Imagine a smaller scenario: a village initially has 11 fishermen who can catch 110 fish per day, and each of them receives 10. One day, one of them invented a better strategy that enabled the village to have 220 fish per day. In return for his innovation, he receives an extra 20% of fish on top of the original 10 fishes (32 fishes) and the rest receive 18.8 fishes (Mje). By this logic, business people increase the efficiency of production through innovation, and the outcomes can be shared, with business people only in fact claiming a portion of the benefits of innovation.

Another opposing viewpoint is that technological innovations brought out by business people will inevitably drive income inequality (Law et al.). As new technology appears, people who acquire those technologies will create more value and earn more compared to those who do not acquire these technologies. MIT professor Daron shows that 50% to 70% of the growth in

US wage inequality between 1980 and 2016 was caused by automation (Rotman). Therefore, new innovations will inevitably widen income inequality as society develops. However, this reality does not negate the fact that business people are benefiting others when making their money. Back in the time when people lived in small communities, there was little inequality because everyone worked and gained relatively the same. When farming techniques advanced, social classes appeared, and aristocracies embraced farming because of the improved efficiency. As technology advances more, there is a growing group of people who constitute the new “technological upper class,” and the inequality between this segment and the majority will be even greater. However, the overall quality of a modern ordinary American’s life is better than that of the King in the Middle Ages, or a person of any previous generation, thanks to technological advancement. For example, the overall life expectancy is 43.6 for women and 48.7 for men in the Middle Ages, whereas this number today for world population is 76 and 70, respectively, and it is even higher in developed countries like the US (Says et al. & Worldometer). This condition improves along with improvement in quality of life for the elderly, as modern medical care and the internet make the elderly both physically strong and socially connected (Amaker et al.). Similarly, people have access to rapid telecommunications and are able to travel between continents in a few hours, all inconceivable in a more leveled but more ancient society.

Inversely, income inequality may even be an asset as a motivation for innovation (Wang et al.). Aligned with what Adam Smith states, people work hard to innovate for more money and a better life. Therefore, if there is no income inequality, in which everyone gets the same wage no matter what their contribution is, then no one would have an economic motivation for hard work and creativity in business. As the Greek philosopher Aristotle says, “The worst form of inequality is to try to make unequal things equal,” suggesting that absolute equality will bring unfavorable economic and social consequences (Miller). In a relatively equal society, everyone would not earn much. Historically, both China and the Soviet Union adopted a planned economy model before 1979, guaranteeing a high level of income equality (Alexeev & Gaddy). The Soviet Union collapsed, while China grew from a GDP of \$149.4 billion in 1979 to \$17.96 trillion in 2023 (China Bureau of Statistics & World Bank). The reason for such a huge disparity is that China adopted market economy reforms in 1979 to provide an economic incentive for innovation (Kowalewski). Although this reform drove income inequality to an unprecedented level, with a Gini index of 0.467 in 2022 (Statista), it created a market environment that favored business and innovations, boosting China to be the second largest economy in the world.

Besides, when business leaders attempt to make their money, their demand for employees creates an abundance of job opportunities. Startups create an average of 3 million new jobs annually (Kane). The rate of creating new jobs is even higher when investing in R&D. In average, one million dollars invested in R&D will lead to five new job opportunities (World Economic Forum). Therefore, business leaders also benefit others by employing them and making them enjoy the wealth that they generate collectively.

Spending Their Money

When successful business leaders spend their money, they stimulate the economy by boosting consumption and investment, and the effect is amplified by the multiplier. Because successful business people have large amounts of wealth, they can afford to consume luxury brands and products that would otherwise not possess market demand. For example, business passengers represent 75 percent of an airline's profits because they are more likely to buy last-minute tickets and upgrade to higher classes (Stevenson). When business leaders spend their money on luxury cabins, they also benefit economy class passengers by generating more revenue for the airline and therefore pulling economy class prices down. This effect is amplified by the expenditure multiplier since this initial injection of money sets off a chain reaction in the economy. Therefore, the initial consumption may contribute to the development of multiple industries.

In addition, investment decisions—especially those with high risks—made by successful business people are also vital for promoting innovation and economic activity. The inherent risk an investor takes is usually positively associated with the plausible rewards (Kouwenberg & Ziembra). For example, successful surgeon and business leader Dr. Soon-Shiong invested \$110 million in NantHealth, a pioneering startup aiming to treat cancer using immunotherapy (Nanalyze). Medicine development is a high-risk investment that requires not only the accumulation of money but also a long return period, so it would be impossible without a vast amount of investment.

Moreover, successful business people also benefit society by giving their money to charity causes. For example, The Giving Pledge, launched by Bill Gates and Warren Buffett, consisted of over 200 business leaders who have pledged to donate at least half of their wealth (McCollim & Schmitz). Through dispersing their money, business leaders benefit others by providing them with healthcare, education, and a better quality of life.

Conclusion

Successful business leaders benefit others both when they make and spend their money. When making their money, their pursuit of personal gains drives innovation, leading to economic growth, job creation, and better quality of life. Business leaders' selfish behaviors can lead to the collective benefit of society as a whole (Mandeville). When they are spending their money, they satisfy their own needs while contributing to the economy through consumption, investment, and devotion to charity causes.

Although this process will inevitably lead to an increase in income inequality, this inequality is worthwhile since it makes everyone better off in this non-zero-sum game and provides motivation for further innovation (Nemala). Therefore, it is crucial to discern the overall economic benefits of legitimate business leaders from those smaller numbers of illegal business pursuits.

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Genetic Determinants of Taste Perception and How They Influence Individual Food Preferences By Sophia De Mattos

Abstract

Differences in individual food preference are influenced by genetic variation, which ultimately affects food selection and health. The aim of this paper is to investigate how specific gene variations can affect human susceptibility to particular flavours, specifically bitter and sweet tastes, ultimately determining how these factors can impact individual dietary choices. Methods such as genome-wide association studies (GWAS) and polygenic risk scores (PRS) have previously been used to identify genes associated with a particular trait, and an individual's genetic liability to that trait. Genetic variations may account for variations in taste sensitivity and perception. Consequently, understanding how much genetic factors impact how people develop their own eating habits and taste preferences is crucial for developing public policy that addresses nutritional behaviours. In order to better broaden our awareness of how taste and food preferences develop, I reviewed the genetic polymorphisms that account for heterogeneity in taste and food preferences. Continuous research in this area has created many new possibilities in the field of nutrition, such as using genetic testing in personalised nutrition to identify genetic variations within individuals and allow for more tailored dietary recommendations.

Keywords: taste; dietary choices; gene; genetic variation; food preference; TAS2R; taste perception; nutrition

1. Introduction

Worldwide, the prevalence of unhealthy eating habits has increased due to changes brought about by globalization, particularly in low- and middle-income nations. This has increased morbidity and mortality from diet-related noncommunicable diseases (NCDs) (Ford et al., 2017; Lachat et al., 2013; Popkin, 2006). Therefore, it is crucial to understand the factors that influence food preferences and choices to develop and carry out public health intervention programs that focus on nutritional behaviour.

Differences in individual food preference are influenced by genetic variation, which ultimately affects food selection and health. Various environmental, cultural, and nutritional factors influence people's food preferences. There have been rapid advances in the field of molecular genetics that have completely changed our knowledge of how individual differences exist in many facets of human behaviour. These developments enable researchers to carry out large-scale genetic association studies to gain a deeper understanding of the function of certain gene loci in sensory perceptions, food intake, and preferences (Robino et al., 2019). Most research to date has concentrated on pinpointing particular genes and characteristics linked to sensory experiences (such as taste and smell). One of the most researched areas of taste genetics, for instance, is bitter taste, which is related to the TAS2R38 gene, which gives humans the capacity to taste compounds like 6-n-propylthiouracil (PROP) and phenylthiocarbamide (PTC).

More specifically, genes involved in peripheral taste transduction, central taste processing, and polymorphisms of taste receptors are involved in genetic variation in taste perception (Bachmanov & Boughter, 2012). Individuals can be classified as supertasters, tasters or non-tasters based on their response to bitter tasting compounds like PTC and PROP (Figure 1).

This review focuses on finding the correlation between genetic variability and food preferences. Specifically, what the genetic determinants of taste perception are, and how they influence individual food preferences and dietary choices.

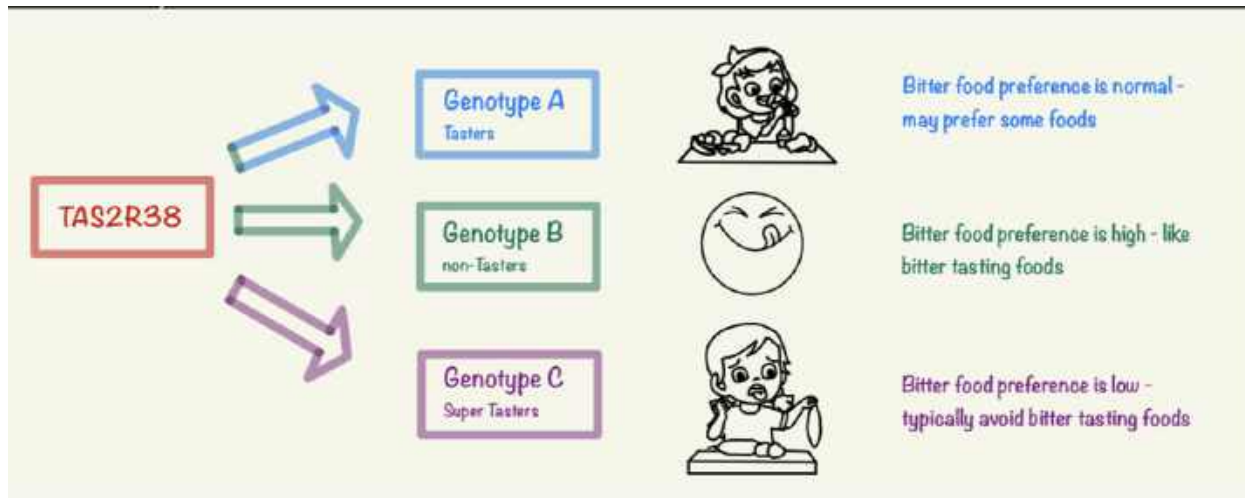


Figure 1. Classification of individuals with genotypes for supertasters, tasters and non-tasters, specifically based on the TAS2R38 gene which allows for the perception of bitter taste. Modified from Watson, B. (2016, December 30) Applications of Understanding the Relationship Between Gene Expression and Taste Preference

It is of significant public health importance and interest to the food industry to obtain an accurate understanding of the effects of genetics on eating preferences/habits and their repercussions for food-related disorders. Genetic variation in taste perception influences human nutrition and health and can act as a biomarker of disease susceptibility. Finding the genes causing taste variety within and between species could assist people in making better food choices and regulating their consumption. For instance, people who are more sensitive to bitter tastes may be less likely to eat vegetables, or people who are more sensitive to texture are less likely to eat certain fruits (Drewnowski & Gomez-Carneros, 2000). In today's modern world, genetic testing in personalised nutrition can identify these genetic variations, allowing for more tailored dietary recommendations. For example, people with a variation in the gene MTHFR affecting folate metabolism, can be advised to consume more foods rich in folate before they feel symptoms (Fenech, 2010). The MTHFR gene codes for the production of the MTHFR protein, which aids in the body's absorption of folate. Folate is necessary for the body to synthesis DNA and alter proteins. A variation in the DNA sequence that deviates from the predicted DNA

sequence is called a gene variant. MTHFR C677T is the most prevalent variation of the MTHFR gene.2. (CDC, 2022).

Studies and Research

Here, I posit that there is a significant association between specific genetic variations in taste receptor genes, particularly those related to bitterness (e.g., TAS2R genes), and individual taste perception. Individuals with certain genetic profiles will exhibit heightened or diminished sensitivity to bitter tastes, leading to distinct patterns of food preferences and dietary choices. A Genome-Wide Association Study (GWAS) can be used to identify genomic variants that are particularly linked to a risk for a certain trait or disease. Using this strategy, the complete human genome can be screened to find correlations between millions of genetic variants within an individual (Hutter M., 2024). Similarly, Polygenic Risk Scores (PRS) are commonly combined with GWAS to identify genes associated with a particular trait, and an individual's genetic liability to that trait (Polygenic Risk Scores | CDC, 2022). A single-base DNA polymorphism called a single nucleotide polymorphism, or SNP, is an example of a genomic variant that can be found using these techniques. Researchers look at these SNPs to identify the genetic components of a given characteristic or illness, like diabetes. In order to ascertain the potential genetic etiology of diabetes, they utilize SNPs as genetic markers to identify regions of the genome that exhibit similarities in individuals with the disease (Gunter, 2024). This can also be determined through Heritability studies, which measure how well the differences in people's genes account for the differences in their traits. Many of the studies analysed in this review used these methods to identify specific genomic variants related to the research question, thus testing the hypothesis.

2. Genetic-Wide Association Studies

We are in the era of the genome sequence. Pharmacogenomics, pharmacogenetics, and preventative and personalized medicine are just a few of the many uses of this information that are transforming medicine and providing scientists with countless opportunities for research and clinical practice (Ikegawa, 2012).

The GWAS technique has emerged as one of the most widely used methods for identifying the genes linked to complex characteristics and illnesses throughout the last ten years. By genotyping a large number of participants for many genetic markers across the full genome and assessing their relationships with the trait of interest, these studies enable the discovery of novel gene variants and genomic locations. The most prevalent type of DNA sequence variation is caused by SNPs. These polymorphic markers are the most practical and helpful for mapping genes that could affect treatment response (Ikegawa, 2012).

In fact, one of the first GWA research on coriander preference was conducted with a sizable cohort of European participants who responded to an online survey about whether they find cilantro to be bitter or pleasant (Figure 2). The study found one significant association with cilantro soapy taste which was confirmed in the cilantro preference population (Robino et al., 2019). One of the most researched olfactory receptors is the OR6A2 receptor, which has been

shown to be activated by a variety of odorants. The SNP rs72921001 was found to be located on chromosome 11 among eight olfactory receptor genes: OR2AG2, OR2AG1, OR6A2, OR10A5, OR10A2, OR10A4, OR2D2, and OR2D3 (Eriksson, N. et al., 2012). The C allele is associated with both detecting a soapy smell and disliking cilantro. The OR6A2 olfactory receptor appears to be the most promising candidate underlying the association with cilantro odour detection of the olfactory receptors encoded in this region. Additionally, a wide range of odorants have been found to activate this receptor (Robino et al., 2019). All of these odorants are aldehydes with several of them playing a key role in cilantro aroma, such as decanal and (E)-2-decenal (Eriksson, N. et al., 2012). Thus, this gene is a significant candidate for cilantro odour detection and preference in humans.

	N	Proportion female	Age (SD)
Tastes soapy	1,994	0.566	49.0 (15.0)
Does not taste soapy	12,610	0.489	48.3 (15.2)
Total	14,604	0.500	48.4 (15.2)
Dislikes cilantro	3,181	0.487	47.1 (16.6)
Likes cilantro	8,906	0.420	43.8 (14.5)
Total	12,087	0.438	44.7 (15.1)

Figure 2. Summary of the cohorts used in the GWA analysis as well as the results - whether they voted cilantro as tasting soapy or not soapy (Eriksson, N. et al., 2012).

3. Genes Associated with Taste Receptors

It has been proven that genetic factors influence taste perception. In particular, it is the variability within these factors that establishes the differences in human taste preferences. Precision nutrition, often referred to as nutritional genetics, nutrigenetics, or personalized nutrition, enables people to receive diets tailored to their personal biology. The allele frequencies of frequent single nucleotide polymorphisms (SNPs) that affect the expression of genes involved in the metabolism of some of the most common foods consumed by humans vary dramatically among populations, according to studies of global human genomic variation.

Direct to Consumer Genetic Testing (DTC-GT) - type of genetic testing

Testing a single base location or sequencing a full genome are two examples of genetic testing. Large DTC-GT companies often use commercially available devices that type between 600,000 and 700,000 locations that have previously been recognized as changeable in different human populations (J. Scott Roberts & Ostergren, 2013). Over the past ten years, there has been

a dramatic increase in the number of businesses providing tests that have allowed tailored dietary or nutritional recommendations to be made based on each person's unique genetic information. The risk of monogenic disorders, such as intolerance and sensitivity panels (e.g., caffeine and alcohol), macronutrient and energy metabolism (e.g., NAFLD), weight management and obesity (e.g., FTO), and vitamins and mineral requirements (e.g., vitamin D metabolism), is what DTC-GT companies offer instead of a clinical diagnosis (Figure 3) (J. Scott Roberts & Ostergren, 2013).

Gene	SNP	Nutrition and Health Issue	Genotype Differences		
<i>CYP1A2</i>	rs762551	Caffeine Metabolism	C/C slow metabolizer	A/C slow metabolizer	A/A rapid metabolizer
	rs1229984		G/G	A/G Increased ETOH metabolism	A/A Increased ETOH metabolism
<i>ADH1B</i>	rs2066702	Alcohol Metabolism	G/G	A/G Increased ETOH metabolism	A/A Increased ETOH metabolism
<i>PNPLA3</i>	rs738409	Non-alcoholic fatty liver disease	C/C	G/C Increased fat accumulation	G/G Increase fat accumulation
<i>FTO</i>	rs9939609	Obesity and Appetite	T/T	A/T Increased adiposity	A/A Increased adiposity
<i>APOE</i>	rs7412	Cardiovascular and Alzheimer's Disease	T/T Lowest AD risk	C/T	C/C Increased AD risk
	rs429358		T/T Lowest AD risk	C/T	C/C Increased AD risk
<i>MTHFR</i>	rs1801133	Folate Metabolism	C/C	T/C Diminished enzyme activity	T/T Diminished enzyme activity
<i>GC</i>	rs7041	Vitamin D Transport	TT	TG	GG Lower Serum 25(OH)D
	rs4588		CC	C/A	AA Lower Serum 25(OH)D
<i>FADS1</i>	rs174537	Long-Chain Fatty Acid Biosynthesis	G/G Most efficient	T/G Varied efficiency	T/T Inefficient

Figure 3. Summary of some examples of well-studied single nucleotide polymorphisms (SNPs) and their respective effects on nutrition and health (J. Scott Roberts & Ostergren, 2013). The specific gene that the SNP resides in, and the genotype differences within that gene are also displayed.

Human Variation in TAS2R38 Gene

Humans can taste 5 basic flavours: sweet, sour, salty, bitter and umami (savoury). These tastes and their corresponding taste receptors/genes are summarised in Figure 4. Focusing on the TAS2R38 gene (bitter taste), it is expressed in taste cells on the tongue. The T2R38 bitter taste receptor has been shown to bind to a total of 23 different ligands thus far. Notable ligands like PTC (phenylthiocarbamide) and PROP (6-n-propylthiouracil) have been thoroughly investigated and are well-known within this reservoir of bitter taste data. Furthermore, T2R38 has been

observed to interact with other interesting ligands, such as cyclamate, an artificial sweetener, limonin, a molecule typically found in citrus fruits, and chlorpheniramine – an antihistamine used to treat allergic disorders. The diverse range of ligands recognized by the T2R38 receptor adds to our understanding of the complex molecular interactions involved in the perception of bitter taste.

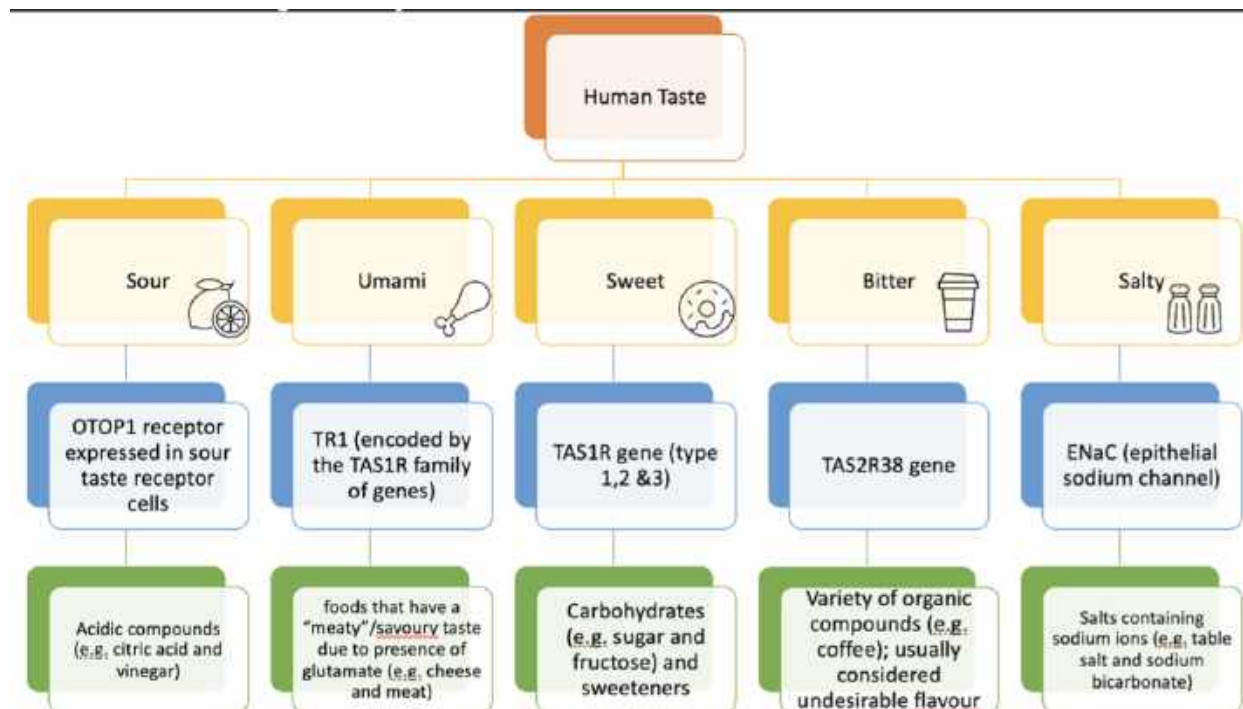


Figure 4. Summary of the 5 different human tastes, their corresponding taste receptors/genes, and the stimulant factors that activate the genes/receptors.

PTC and PROP carry the chemical group N-C=S and the perception of these chemicals has been associated with super tasting (El-Sohehy et al., 2007). Because TAS2R38 genotypes are associated with PROP-tasting phenotypes, it can be argued that this gene is a determinant for super tasting capabilities. These chemicals are not traditionally found in food or beverages however their chemical compound is similar to a lot of naturally occurring chemicals, making them useful tools to study taste preferences.

The perceived bitterness of cruciferous vegetables, such as broccoli, results from glucosinolates and their hydrolysis products, particularly isothiocyanates and other sulfur-containing compounds. According to prior research, broccoli's feeling of bitterness may be partially attributed to genetic inheritance through the gene TAS2R38 (Lipchock et al., 2013). Similar to watercress, mustard greens, turnip, broccoli, and horseradish, rutabaga's bitter taste is perceived by humans based on a gene that influences the TAS2R bitter receptor, which senses the plant's glucosinolates. Rutabaga is twice as bitter for sensitive people (PAV/PAV genotype;

supertasters) as it is for insensitive individuals (AVI/AVI). For rutabaga, the variation for the mixed type (PAV/AVI) is negligible. As a result, sensitive individuals may find some rutabagas excessively bitter to eat, influencing their food preferences (Lipchock et al., 2013).

To predict taster status regarding bitter taste, the SNPs that result in amino acid substitutions in the TAS2R38 gene need to be identified. There are two common haplotypes that consist of three SNPs (A49P, V262A, and 1296V), which show a strong association with PTC taster status (Bufe et al., 2005). A haplotype is a physical grouping of genomic variants (or polymorphisms) that tend to be inherited together. A specific haplotype typically reflects a unique combination of variants that reside near each other on a chromosome (Kim et al., 2003). The A49P substitution specifically, has been used as a marker SNP to identify taster status (Mennella, J. A., 2005).

Ultimately, these studies found that an indirect effect of the ability to taste bitter compounds has been observed in the consequent avoidance of foods containing these bitter-tasting substances (El-Sohemy et al., 2007). The health implication of this is that many of these bitter tasting foods contain antioxidants, which are crucial to obtain for bodily functions. Many types of bitter tasting dietary compounds may be especially bitter to individuals with super tasting capabilities, these include polyphenols, methylxanthines, isoflavones, flavonoids, glucosinolates, and sulfamides. Because the TAS2R38 gene has only recently been associated with bitter taste, few studies have been conducted that examine the link between this genotype and food preferences.

Variation in Human Sweet Taste Preference

Humans also differ in their perception of sweet taste. It has been demonstrated that genetic variables account for at least some of the variance in sweet taste, regardless of the mechanisms underlying the variation resulting from environmental or genetic factors (Bachmanov et al., 2011). Human sweet taste perception is determined by the T1R gene family, in the oral cavity, which includes 3 genes: taste receptor type 1, member 1, 2 or 3 (TAS1R1, TAS1R2, TAS1R3) (Diószegi et al., 2019). Model organism research contributes to our understanding of the genetic factors behind taste preference variation in sweet foods. Because numerous species have available inbred strains, laboratory animals provide a significant advantage in this research. Genetically, all the animals of an inbred strain are the same. As such, genetic variation is represented by variations between strains, while variation within strains is caused by non-genetic (environmental) variables.

Phenotypes, or traits, are the genetic equivalent of measurements of the preference for sweet tastes. The term "phenotype" refers to an organism's observable traits that are shaped by both its genetic composition and its surroundings (Bachmanov et al., 2011). Distinguishing the influences of genetics and environment on phenotype is the aim of the genetic analysis. Taste phenotypes in humans are often expressed as a perceptual difference between samples or as a rating of sensation intensity on a scale with verbal descriptors (Bachmanov et al., 2011). These methods enable the assessment of the taste sensation's hedonic value, quality, intensity, and

sensitivity. By evaluating consumption or cravings for sweet foods using questionnaires or intake records, it is possible to assess the preference and liking for sweet flavours in humans.

In a study conducted by Diószegi et al., 18 genes had confirmed relationships in the instance of 41 polymorphisms (Diószegi et al., 2019), some of which are summarized in Figure 5. Sugar intake/consumption (as determined by the food frequency, the three-factor eating questionnaire, and the three-day weighted dietary record) was only taken into consideration as a preference if it was linked to meal choice. Sucrose detection thresholds and intensities, as well as preferences for sweet-tasting items, were measured using other phenotyping techniques (Diószegi et al., 2019).

Gene	SNP	Applied tastant/ method	Number of studies with confirmed association	Findings
TAS1R2	rs3935570	Sucrose, sugar intake (FFQ)	1	GG or GT vs. TT had significantly higher detection thresholds [and lower suprathreshold sensitivity ratings (AUC)] but only in individuals with BMI \geq 25. (No effect on sugar consumption.)
TAS1R2	rs12033532	Sucrose, sugar intake (FFQ)	1	Individuals with a BMI \geq 25: G allele carriers had significantly higher detection and lower suprathreshold sensitivity ratings (AUC), higher intake of total sugars, sucrose, fructose, and glucose. Individuals with a BMI $<$ 25: significantly lower detection thresholds and no effect on suprathreshold taste, lower intake of total sugars, sucrose, fructose, glucose, and lactose
TAS1R2	rs35874116	Intake of sweet food (three factor eating questionnaire)	2	CC and CT vs. TT associated with higher intake of sweet foods. Overweight Val carriers consumed less sugars, sucrose, fructose, and glucose than the homozygotes.
TAS1R3	rs307355	Sucrose	1	Strong association with decreased sucrose AUC scores (reduced taste sensitivity to sucrose associated with T alleles)
TAS1R3	rs35744813	Sucrose	2	Strong association with decreased sucrose AUC scores (reduced taste sensitivity to sucrose associated with T alleles). Adults with no T alleles preferred a lower concentration of sucrose than did those with one or two T alleles (no association in children).
TAS2R38	rs713598	Intake of sweet tasting foods (3-day, weighed dietary records, test meal)	2	The PP/PA genotype was associated with a higher intake of (energy dense) sweet tasting foods in children. AP or PP children consumed more chocolate chip cookies at the test-meal than children who had the AA genotype.
TAS2R38	rs713598	Sucrose, food preference questionnaire	3	PP children preferred higher concentrations of sucrose in water and beverages containing more sugar than AA children (AP intermediate preference). GG subjects did not prefer sweet foods (dessert and chocolate). P allele more common in children with lower sucrose thresholds
TAS2R38	rs1726866	Sucrose	1	Children with one or two bitter-sensitive A alleles had lower detection thresholds (more sensitive to the taste of sucrose).
TAS2R38	rs10248939	Sucrose	1	Children with one or two bitter-sensitive V alleles had lower detection thresholds (more sensitive to the taste of sucrose).
TAS2R38	A49P (rs713598), A262V (rs1726866), V296I (rs10248939)	Berry products liking	1	Majority of PAV/PAV and PAV/AVI children, liked the sweetened, dried bilberries with rather high sugar content.
TAS2R38	A49P (rs713598), A262V (rs1726866), V296I (rs10248939)	Sweet food intake (FFQ)	1	PAV homozygotic individuals consumed more sweet foods than did the AVI homozygotic subjects.

Figure 5. Summary of the genetic wide association studies relating to sweet taste preferences. Sourced from (Diószegi et al., 2019).

In humans with African, Asian, European, and Native American ancestry, all three TAS1R genes are polymorphic; these polymorphisms include those that alter the amino acids of the T1R proteins. When compared to other human genes, TAS1R2 exhibits a higher degree of diversity: its polymorphism rate ranks within the top 5–10% of all investigated human genes (Bachmanov et al., 2011). It was anticipated that the high rate of TAS1R2 mutation would lead to variations in the perception of sweet taste. SNPs in the TAS1R3 promoter that do not code for amino acids have been linked to human sucrose sensitivity, according to a study (Fushan et al., 2009). These polymorphisms alter TAS1R3 gene transcription, as evidenced by their influence on promoter activity in an in vitro luciferase reporter assay.

4. Linking Our Food Preferences and Health

Several studies have examined the connections between taste receptor genes and how they influence food intake and preferences, which may have an impact on one's nutritional and general health (Robino et al., 2019). A few examples of these studies will be discussed.

Anthropometric and adiposity measurements, for instance, and eating habits are related to differences in the TAS2R38 bitter taste gene. Women with the rs1726866 SNP allele that is PROP-insensitive have been found to exhibit increased disinhibition; conversely, BMI and waist circumference were found to be higher in PROP non-taster women who exercised less dietary constraint (Dotson et al., 2010). In another investigation, the three TAS2R38 genetic variants were linked to variations in body fat percentage, but no meaningful associations with BMI or eating habits were discovered (Keller et al., 2013).

Additionally, a higher desire and consumption of sweet foods have been linked to SNPs in the TAS1R2 and TAS1R3 genes, which codify for sweet taste receptors and have also been linked to an increased risk of dental caries (Kulkarni et al., 2012). The bitter taste receptor mRNA's taste cell levels have also been connected to variations in bitter taste perception, suggesting that gene expression should be included when analysing the association with health factors (Robino et al., 2019). Moreover, recent research revealed that lean and obese individuals had different fungiform taste papillae gene expression profiles. The results demonstrate that altered taste bud gene expression is linked to obesity. Further, the findings imply that the tastebud environment differs significantly between lean and obese individuals and that variations in sensory gene expression are a factor in this modified microenvironment (Archer et al., 2019).

5. Conclusion

It can be concluded from these findings that specific genes have a significant correlation with our taste perception. This was observed in the TAS2R38 variants (rs713598, rs1726866, rs10246939) which are associated with preferences for bitter taste. Bitter taste preference is specifically influenced by the perception of chemicals associated with super tasting and non-tasting, such as PROP and PTC for bitter tasting foods. Because TAS2R38 genotypes are associated with PROP-tasting phenotypes, this gene is a determinant for super tasting capabilities. This would mean that anyone with the super tasting TAS2R38 gene will have a

natural aversion towards bitter tasting foods, resulting in a health implication as many of these bitter tasting foods contain antioxidants, which are crucial to obtain for bodily functions.

Additionally, the data presented in this review shows that the differences in how sweet and bitter tastes are perceived are partly explained by variation in the genes encoding sweet taste receptors. Several other genes from the TAS1R gene family affect sweet taste responses in addition to the sweet taste receptors. These genes are engaged in both peripheral and central mechanisms at different stages of the pathway that process sweet tastes. Several methods of genetic testing can be utilised to allow for tailored dietary or nutritional recommendations to be made based on each person's unique genetic information, such as GWA studies, Polygenic Risk studies (PRS) and DTC-GT tests.

6. Discussion

With the completion of genome sequencing projects and studies for several species, including humans and mice, genetics has made significant advances in recent years. The development of genomic resources has greatly aided genetic studies and strengthened their potential as a means of identifying the mechanisms underlying sweet and bitter taste in humans.

Taste is one of the most important factors contributing to food preferences and genetic differences in individual taste perception can explain differences in eating habits. Polymorphisms of taste receptors, genes involved in peripheral taste transduction, and central taste processing are specifically linked to genetic diversity in taste perception. The link between heredity and taste preference has been demonstrated by numerous investigations discussed in this report. Whether it be TAS2R38 gene influencing bitter taste perception or the OR6A2 (olfactory receptor) being responsible for cilantro taste preference, finding the genes that cause taste variety could assist people in making better food choices and regulating their consumption. Techniques and methods, such as the GWA studies and DTC-GT tests, have made this research possible and continue to provide possibilities for revolutionary medicine, such as preventive and personalized medicine, pharmacogenomics, and pharmacogenetics. This review highlighted the strong relationship between genetic variation in specific genes and the resulting effect on individual food preference and dietary choices. In addition to this, the contributions to nutrition and health were also discussed.

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Influence of Social Media Marketing on Generation Z's Financial Decision-Making By Julie Liu, Caroline Zhou, Isabelle Lewis, Shriya Tummala

Abstract

In the rapidly developing world of social media, various businesses and companies have chosen to implement online marketing techniques to appeal to their younger audiences, particularly members of the Generation Z population. This research paper will investigate the effects of advertising and marketing utilized through social media platforms on the financial decision-making habits of individuals within the Generation Z population. To fully understand the topic at hand and the results presented in the study, a review of the psychological theories behind financial decision-making and past studies relevant to the subject were first presented. Following the literature review, the methods carried out in the study to collect data, as well as the considerations kept in mind throughout the process, were presented. Using a digital survey and data collection from focus groups allowed the study's researchers to provide a thorough account of the findings along with quantitative analysis. This was written in the results section of the paper, accompanied by descriptive graphs to further evaluate the findings. The paper continued with a deeper analysis of the data collected, an interpretation of the paper's findings, and the significance of the findings in the present day. At the end of the paper, it was concluded that there is a direct correlation between social media marketing and the financial decisions of Generation Z. This study identifies this relationship and advocates for increased digital awareness within social media platforms to mitigate poor spending habits in Generation Z.

Introduction

Financial decisions play a crucial role in determining the course of people's lives. From grocery shopping to paying off debt, virtually every part of people's daily lives involves financial decision-making, or more specifically, how and where to use money. Over the past few decades, it has become increasingly important to have strong financial decision-making skills and make informed decisions regarding how and when to spend or save money, especially if the decision or purchase can lead to sizable costs. With inflation rates and costs of living rising rapidly, as well as loans becoming more and more expensive, individuals must develop strong financial decision-making skills to ensure financial stability, avoid large amounts of debt, and save money for retirement. Research has shown that people who understand basic financial concepts are, on average, able to save more for retirement, make smarter investments, and manage debt more effectively compared to those without strong financial decision-making skills (Crawford, 2023).

Certainly, many financial decisions are made through influence from external sources. For example, peer opinions, advertisements, and media can lead to a desire to purchase products that may be out of one's budget, leading to poor financial decision-making (Mannion, 2024). Social media, specifically TikTok and Instagram, are external sources that can influence spending habits among consumers. With over 4.9 billion people using social media platforms worldwide, social media marketing has become an increasingly popular form of product

advertising (Baluch, 2024). Many companies and businesses utilize social media as a form of marketing by promoting new products, interacting with customers through comments, and creating content to increase brand recognition and outreach to potential customers. In fact, social media marketing, as of 2020, has become the third largest advertising channel, accounting for over 13% of global spending on advertising (Yousef, 2021). Furthermore, spending on social media advertisements in the United States is predicted to reach 82.88 billion USD annually by the end of 2024 (Shalabi, 2024). In the future, social media marketing will continue to grow. About 44% of advertisers plan to invest more in social media marketing, while over 80% of American marketers have expressed interest in using influencer marketing on social media as of 2023 (Tibaldi, 2023).

Social media marketing can have positive effects on businesses but negative impacts on consumers and their financial decisions. For companies, social media marketing has led to benefits such as friendly and close relationships with consumers, increased brand loyalty, reduced advertising expenses (as social media advertising is typically less expensive than other methods), access to a larger customer base, and consumer trend tracking—as social media analytic tools allow companies to track changes in consumer preferences. These benefits have encouraged and promoted the rise of small businesses, with 87% of small businesses believing that social media has helped them grow because 90% of consumers visit a brand’s social media page before visiting their physical store (Lindner, 2024). However, social media marketing can pose many dangers and consequences for consumers and prompt poor financial decision-making. In particular, the algorithms of social media platforms boost the views, likes, and clicks of paid advertisements for companies, leading to consumers constantly being exposed to product advertisements (Frazier, 2024). Consumers see the same advertisements every time they open social media and hence cannot escape their desire to purchase the products being advertised. Even more, social media subjects consumers to online reviews, such as comments on advertisement posts, as well as continuous product recommendations from influencers with sponsorships, which all potentially increase the likelihood of consumers being influenced to recklessly purchase the product. Furthermore, personalized social media advertisements, which utilize a user’s behavior and interests on social media platforms to show products aligned with the user’s preferences and browsing history, allow advertisements to become undeniably targeted toward what a user would buy, thus resulting in overspending.

Statement of Problem

The negative consequences of social media marketing on individuals’ financial decision-making can prove to be detrimental to their financial stability and society’s long-term economic health. The negative impacts of social media marketing on personal finance have long been established in literature. However, there has been a lack of research done on the role and influence that social media marketing has on the financial decisions of Generation Z, which is the population most prevalently and frequently impacted by social media. The Generation Z population entails young people born between the years 1997 and 2012. This generation was

formed during the rise of social media and has lived most of their lives with the influence of the internet and web. Technology has become a crucial part of their daily lives, with immense power to influence not only their perspectives but also the decisions they make. The Generation Z population, moreover, represents the near future of the global economy, and hence, it is essential for this generation to attain strong financial decision-making skills to ensure that the future economy is productive and healthy.

Research Question

The purpose of this research study was to develop a model and analyze trends to determine whether social media's influence on financial decision-making is positive or negative. The model was developed using a survey conducted through virtual means, with data gathered from a sample of 63 survey respondents.

With this model, this research study explored the impacts of social media marketing on the financial decision-making of, specifically, the Generation Z population. Current research has found that social media can significantly affect the financial decision-making of individuals, and since members of Generation Z normally frequently use social media, this generation became the focus of this research paper. After analyzing the models formed, a conclusion was reached as to how social media affects the financial decision-making of Generation Z and, more notably, the consequences that social media marketing has on their spending habits.

Thesis

The thesis of this research paper is that social media marketing can lead to poor financial decision-making and reckless spending among members of the Generation Z population.

Psychological Theories Behind Financial Decision-making

Before exploring the research question, it is crucial to evaluate the psychological theories and concepts behind making financial decisions and fully understand how external factors can impact these decisions. Two categories of financial decision-making can be affected by external factors: household finances and investments or savings (for example, buying stocks and saving for retirement). Social media marketing mainly affects household finances, which involves making decisions in areas such as rent, insurance, house furnishings, appliances, food, transportation, telephone, and other utilities. However, due to the interconnectedness of financial decisions, an individual's investments and savings may also be affected by social media marketing.

At its core, financial decision-making is influenced by an individual's cognitive mind and processes, which can be explained by several psychological theories. This research study will look at the following psychological theories: prospect theory, loss aversion, anchoring and adjustment heuristics, confirmation bias, overconfidence bias, herding behavior, and regret aversion. All of these theories present valuable information and insights into the cognitive processes in individuals that influence their financial decision-making skills.

First, the prospect theory, founded by Kahneman and Tversky, addresses how people make decisions when they are faced with more than one choice and have additional alternatives besides their top choice. In this case, there are certain risks involved with picking each choice, and individuals must decide between the options by weighing the different risks (CFI, 2024). The prospect theory states that people make decisions based on the possible losses and gains that may result from each option.

As an essential part of the prospect theory, loss aversion refers more specifically to the idea that individuals avoid losses. Thus, when faced with more than one choice, with one having fewer possible losses compared to the others, individuals will generally pick that safer option because there is a high chance that it leads to the least losses (Columbia, 2020). Loss aversion typically causes conservative financial decision-making, which may have positive or negative effects. For example, loss aversion can negatively impact an investor's financial decision-making when they prioritize fearing losses over gains and choose conservative investing strategies that limit the growth of their investments (Bajaj, 2024).

Anchoring and adjustment heuristics is another important psychological concept to understand for financial decision-making. In this case, anchors refer to the initial information that individuals are presented with. Anchoring and adjustment is a cognitive heuristic in which individuals adjust their judgments based on the initial anchors that were exposed to them. Anchoring and adjustment heuristics impact decision-making because they can lead to bias when individuals follow only their initial judgments, which could be based on limited knowledge. For example, in the realm of financial decisions, when a salesman initially offers a very high price (an anchor) to start negotiations, the final price tends to be higher than if the salesman had initially offered a low price.

Confirmation bias, a concept discovered by psychologist Peter Wason, talks about the tendency of people to favor information that aligns with their beliefs and values (Sage, 1998). This bias generally leads to selective attention, which is when individuals ignore information that they don't agree with when making decisions. In particular, having a confirmation bias will likely cause biased financial decision-making when consumers disregard potential risks or dangers in purchasing something only because doing so agrees with the consumers' personal beliefs and values. For example, one might purchase a house without having the funds necessary to do so, merely because they believe that owning a house can give them more independence compared to renting an apartment.

The overconfidence bias reflects the tendency of humans to underestimate how big a risk is due to being overconfident in their abilities. In regards to financial decision-making, the overconfidence bias can induce excessive risk-taking behaviors in individuals, such as reckless spending and over-investing, because individuals are either confident that they will not lose money or believe in their ability to recover from financial losses. Thus, the overconfidence bias can negatively impact an individual's financial decision-making, leading to accumulating debt after they spend or invest more money than they have.

Herding behavior is a psychological concept that compares people with a herd of animals, elucidating how people commonly “follow the crowd” and imitate group behaviors rather than make decisions independently and on their own after weighing benefits and costs (PMC, 2010). For example, an investor who doesn’t do their research and just follows what other investors do would be a good example of someone who exhibits herding behavior. This herding behavior could potentially lead to consequences when the group decision is not favorable, but it can also lead to benefits if the individual makes poor financial decisions while the group doesn’t.

Regret aversion, a cognitive theory named by Kahneman and Tversky in 1979, describes how regret can influence decision-making. More specifically, regret aversion explains how people are more inclined to make decisions merely to avoid feeling regretful about not making the decision afterward. For example, investors may make the wrong decision and invest in a high-risk stock because they don’t want to regret not doing so in the future (PMC, 2010).

With these psychological theories in mind, researchers can gain a deeper understanding of the cognitive processes behind the financial decision-making of consumers. With this deepened understanding, it will be easier to analyze and evaluate social media marketing’s influence on financial decision-making. More importantly, by acquiring more knowledge on psychological processes, such as those discussed above, people can better acknowledge and address their cognitive biases, leading to further development of mitigation strategies to promote and encourage more informed, rational, and beneficial financial decision-making.

Review of Literature

To fully grasp the effects of social media on the financial decision-making of members of the Generation Z population, it is necessary to complete an observation and analysis of previously conducted studies and research on the subject. With marketing algorithms becoming increasingly popular on social media platforms such as Instagram and TikTok, it is evident that a wide amount of research has already been done to observe the potential connection between a consumer’s experience online and their financial habits, mainly using various surveys and reports. In this section, an examination of a few of these relevant studies will be performed and recorded to provide background information on the topic and may serve as further evidence to use when concluding this research study.

First, a survey performed in August 2023 by Deloitte, a British multinational professional services network, will be evaluated. The data collected in the survey supports the idea that more and more young adults are turning to social media for financial guidance. More specifically, this previously conducted survey illustrates that about 25% of a group of 2,500 banking customers aged 18 to 24 have had their financial decisions influenced by public social media platforms. Additionally, the survey found that over 20% of this age group have also chosen to invest money based on recommendations that they have received via social media. Without a stable background in financial principles, such investments may be risky, especially at such a young age, and lead to unintended and unexpected consequences.

A second survey, conducted by the National Association of Personal Financial Advisors (NAPFA), corroborates with Deloitte's findings through its independent data collection. The survey, carried out by Atomik Research, comprised an observation group of approximately 2,006 adults aged 22 to 64. Concerning the scope of this research paper, the next section of the analysis will focus solely on the Generation Z portion of the survey's observation group. The findings of the survey reveal that 30% of Americans who fall within Generation Z express concern regarding their lack of financial preparedness for retirement, leading to them turning to online platforms for guidance. In particular, the report indicates that approximately 25% of Generation Z Americans seek financial guidance from social media platforms, with YouTube and TikTok emerging as the two most popular choices.

Furthermore, a 2023 report by the International Council of Shopping Centers revealed a direct relationship between social media advertising and the spending of Generation Z members. In fact, 85% of Generation Z respondents reflected that social media influenced their purchasing decisions. Additionally, 85% of men and 86% of women from that same testing group explained that they are more likely to consider buying something after seeing a social media advertisement on the product. Due to the reported positive relationship between Generation Z spending and social media advertising, numerous brands have now turned to social media marketing to attend to the demographic of the generation. While traditional channels remain popular to this day, social media marketing has been proven to have a much larger impact on individuals in the Generation Z demographic. However, while the report did indicate that social media has a large impact on the choices of Generation Z members, the International Council of Shopping Centers also found that 56% of respondents in the testing group are first influenced by family members and friends when making purchases. Additionally, 54% of the testing group expressed that product reviews also have a significant impact on their choices. Finally, 47% of the group revealed that third-party review websites and forums influence their spending habits.

Another report from Yes Lifecycle Marketing exerts similar findings. The report revealed that 80% of Generation Z members make financial decisions based on social media platforms. The organization collected data regarding the specific platforms that have such impacts. The report found that Instagram was the most popular among Generation Z, with 44% of those surveyed saying that they use it. 32% of subjects use TikTok and 21% gravitate towards YouTube. The report further reveals that 74% of millennials, 58% of Generation X, and 41% of baby boomers are also financially influenced by social media.

In summary, the extensive literature review highlights the undeniable influence of social media on the financial decision-making of Generation Z members. Combining findings from multiple reputable sources reveals a common trend: young adults have become increasingly reliant on social media platforms for financial guidance, and this has had a significant impact on their investment choices, spending habits, and overall financial preparedness.

More specifically, the Deloitte study highlighted the susceptibility of young adults to the influence of social media, with a quarter of respondents acknowledging the impact of these platforms on their financial decisions. Similarly, the NAPFA research study supports these

findings, especially among Generation Z, where a large portion of the group expresses concerns about their retirement preparations and actively seeks financial advice online, especially on platforms such as YouTube and TikTok. Furthermore, in its 2023 report, the International Council of Business Centers found a direct correlation between the spending habits of Generation Z members and social media advertising, and most respondents admitted to being influenced by social media marketing strategies. However, it is important to note that while social media has a significant influence on purchasing decisions, family members and friends, as well as product reviews and third-party forums, also play a central role in shaping consumer decisions in the Generation Z demographic. Lastly, the Lifecycle Marketing report further reinforces the spread of social media's influence, as a staggering 80% of Generation Z members make financial decisions based on advertised content on these platforms. The dominance of Instagram, TikTok, and YouTube in this regard underscores the importance of understanding and leveraging these channels to effectively conduct financial education over utilizing them for cruel marketing strategies for younger demographics.

Overall, this literature review illuminates the complex interactions between social media and the financial behaviors of the Generation Z population, highlighting both opportunities and challenges. While social media offers unprecedented access to financial information and resources for more people, it also exposes young adults to potential risks and misinformation, especially given their limited backgrounds in financial literacy. Addressing these challenges requires a multifaceted approach that combines financial education initiatives, responsible marketing practices, and regulatory measures to enable members of Generation Z to make informed financial decisions in our increasingly digital and interconnected world. Only through such concerted efforts will people be able to mitigate the harmful effects of social media and, instead, harness its potential as a tool for economic empowerment and inclusion.

Methods

The methodology utilized in this investigation mainly entails the creation, distribution, and subsequent gathering of data via Google Form surveys. These carefully designed surveys shed light on the various ways that social media platforms affect the lives of Generation Z members around the globe. Each questionnaire was carefully designed to include questions and collect data about the average screen time and usage of participants, demographic data, and a self-assessment on a quantitative scale from 1 to 10 of the participant's perceived influence regarding their financial decisions from social media. Questions ranged in topics from asking about the psychological effects of social media on participants to its financial implications and effects. For example, spending habits were a topic asked of participants and considered when formulating the questionnaire's prompts. The questionnaire also included a limited number of open-ended questions where respondents wrote short answers on their opinions regarding social media and its future implications, whether financially or mentally, on themselves and society. Each question was required to be answered by participants, and no questions were permitted to be left blank.

Recruitment of Participants: To guarantee a strong and varied sample of respondents, the design for recruitment of survey participants included people from a range of geographic areas and sociocultural backgrounds. The surveys were disseminated through a variety of online channels, such as social media educational forums and community-focused websites, among others. With each channel spreading the survey (for example, an Instagram story with the survey link) came a caption that informed participants of the purpose of the Google Form and what the data collected would be used for, ensuring informed consent and debriefing for all participants. To capture a spectrum of experiences reflective of various cultural and societal contexts, a concerted effort was made to engage participants from a multitude of regions, including well-known locales such as the United States, Great Britain, and Canada. Respondents were not recruited based on any criteria other than being a member of the Generation Z population. This was proved and authenticated by the respondents' birth years. Each respondent was not allowed to discuss the questionnaire's contents while filling out the Google Form with other people to prevent peer pressure or influence from others. Additionally, each respondent was only allowed to complete the form once and could not change their answers once submitted.

Data Collection: Survey responses were gathered with great care, taking both participant anonymity and ethical guidelines into consideration. To protect each respondent's privacy and confidentiality, no personal or identifiable information was requested. The information gathered from the surveys was carefully selected and safely stored only for further examination for the research study—to guarantee the accuracy and consistency of the results reported—and was not utilized for any other purposes. During the sampling and analyzing processes of the collected data, factors like age range, location, and dedicated time on social media were utilized to divide the participants into groups of the same size with similar demographics (such as age or location). Once divided, a third of each group was used for sampling—each third having an equal chance of 33.33% of being selected for sampling. After sampling, overall percentages were also calculated that did not involve sampling specific groups or participants. This thorough and generalized method of sampling participants made for a simple random sampling strategy that prevented researcher bias while accurately and thoroughly representing all the data collected from the surveys.

Other sources: Apart from the primary data obtained from survey responses and personally collected by researchers, this research study also synthesized insights from a wide range of scholarly and journalistic sources for supplementary corroboration. A 2023 study published in the Kansas City paper that examined the relationship between social media and personal finance is one example of a noteworthy piece from a reliable online source that was analyzed for this research study. The 2023 study emphasized the widespread impact of social media platforms on people's financial practices. One noteworthy quotation from the study summarized that social media has revolutionized the way people approach personal finances, with millennials and

members of Generation Z increasingly turning to online platforms for financial advice and decision-making. A 2023 report from the International Council of Shopping Centers (ISCS) also explained how social media can have a significant impact on Generation Z's purchasing habits. An especially moving statement was repeatedly highlighted in the report: 85% of Generation Z admits that social media influences their shopping decisions. By incorporating outside sources such as the ISCS, this research study aims to confirm its findings and place them in the larger context of the conversation about social media's influence on modern society.

Ethical Considerations: The welfare and autonomy of participants were given full priority in this research study, with ethical principles guiding every aspect of the data collection process. Every participant provided their written consent to participate in the research study, and precautions were taken to protect participants from any risks or harm that could result from their participation in the study. The integrity and ethical soundness of the research methodology used here were further ensured by strict adherence to the ethical guidelines mandated by institutional review boards. Participants were not asked to respond to questions about personal information that was not necessary for the paper and were informed of the purpose of each question through text on the Google Form.

Biases and Limits: Since participant recruitment was voluntary, biases may still exist despite diligent efforts to obtain a representative sample. Notably, the results may be biased and have limited applicability to a global setting due to the disproportionate representation of respondents from first-world countries. This limitation could be made worse by the dearth of responses from third-world nations, so it is important to interpret the study's findings carefully and consider a larger socio-economic framework. In addition, the small sample size surveyed may hinder the accuracy of the study's results and result in an inability for the study to represent a large-scale population. The security measures taken to preserve the integrity and safety of all participants also restricted the questions and amount of information that could be utilized in the study or used to make conclusions. This lack of detail may lead to an oversimplified verdict that is biased or unfavorable to one perspective or another.

Participant Engagement: Throughout the study, a deliberate effort was made to promote meaningful engagement with participants. For a large part of this survey, the designers asked others for input: interactive platforms were used to promote conversation, and participants were given opportunities to share their thoughts outside of the parameters of pre-formulated survey questions. This study aims to clarify the complex dynamics underlying Generation Z's relationship with social media platforms and elevate the generation's voices by placing a high priority on participant engagement and collaboration.

Results

Demographic Profile: This research study encompassed a demographic range of ages from 13 to 25 years old, with the majority falling within the age bracket of 15 to 16 years. In terms of gender distribution, 70.7% identified as female, while 27.6% identified as male. Geographically, respondents hailed from various states within the United States, including CA, AZ, NY, FL, GA, IW, IN, MA, OH, MD, and PA. Participants were also drawn from 2 other countries: Canada and the United Kingdom.

Figure 1. Average Time Spent per Week by Respondents on Platform Usage

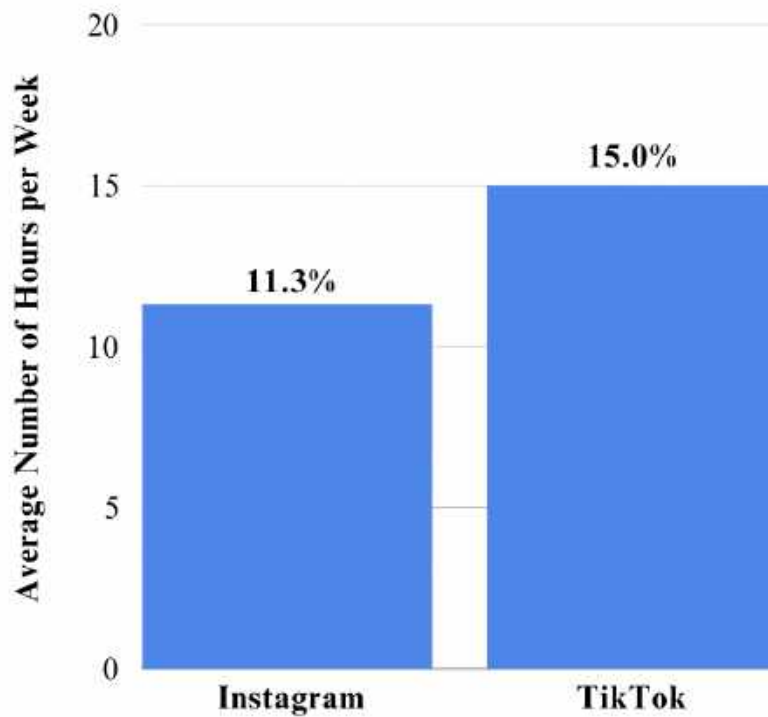
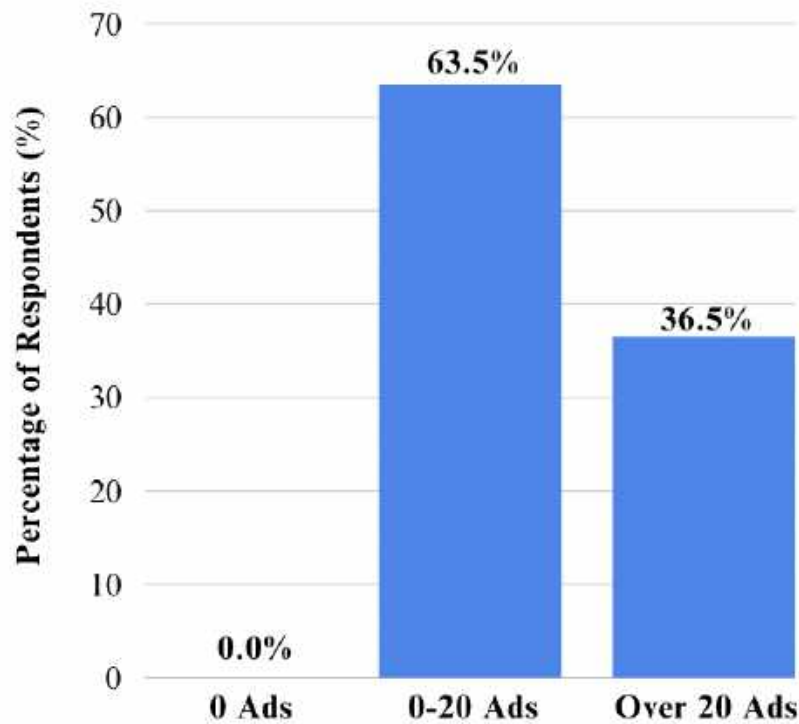


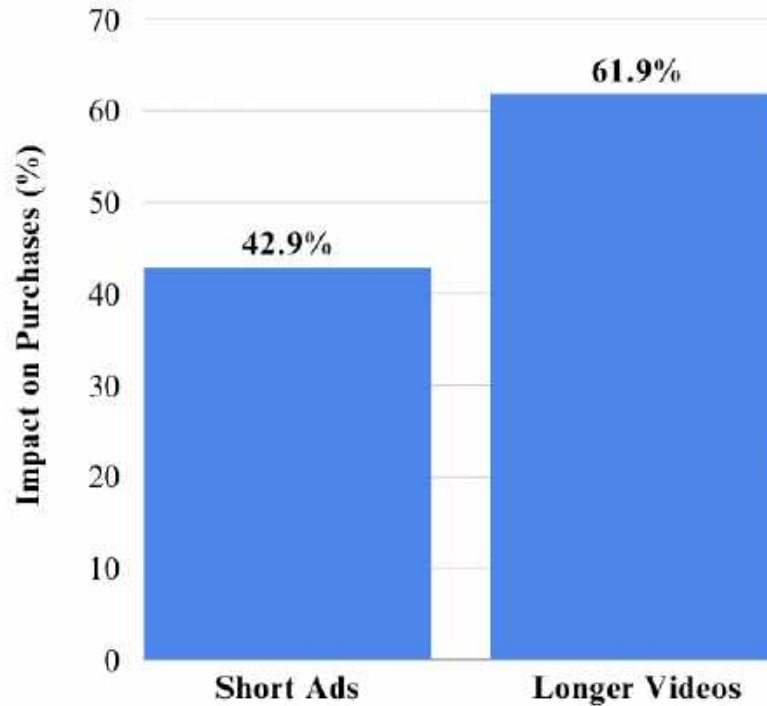
Figure 2. Number of Ads Seen per Week by Respondents



Platform Usage and Engagement: Among the 63 surveyed individuals, 54 reported using Instagram, spending an average of 11.3 hours per week on the platform (*Figure 1*). Meanwhile, 44 respondents engaged with TikTok, dedicating an average of 15 hours weekly to the platform (*Figure 1*). Notably, 36.5% of all participants reported encountering more than 20 advertisements while using these platforms each week, with no participants reporting having no exposure to advertisements (*Figure 2*).

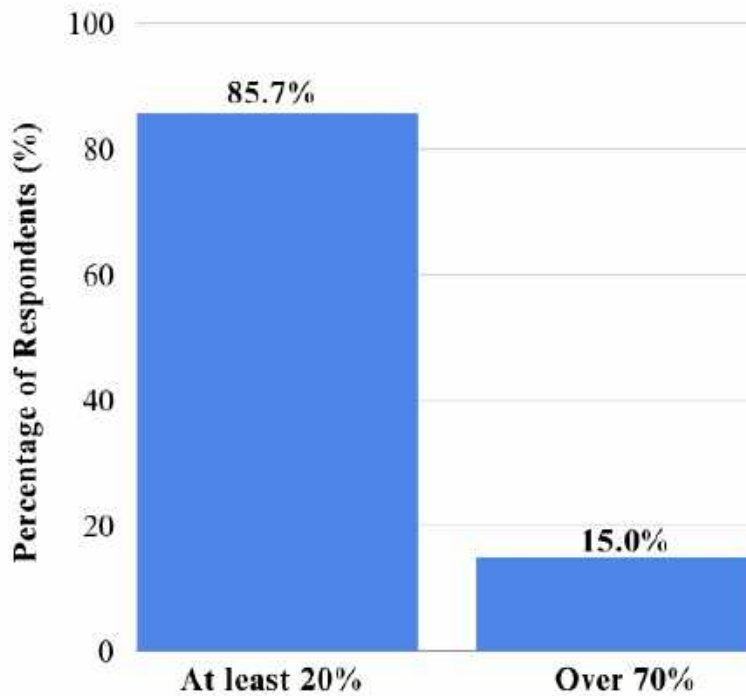
Nature of Advertisements: Of the participants who reported seeing over 20 ads, 15.9% noted that the majority of ads they saw advertised physical products and merchandise rather than digital entities such as programs, websites, or games. Moreover, 31.7% of all respondents indicated that approximately half of the ads they encountered on social media platforms promoted physical objects.

Figure 3. Percentage of Respondents Impacted by Longer and Shorter Ads when making Shopping Decisions



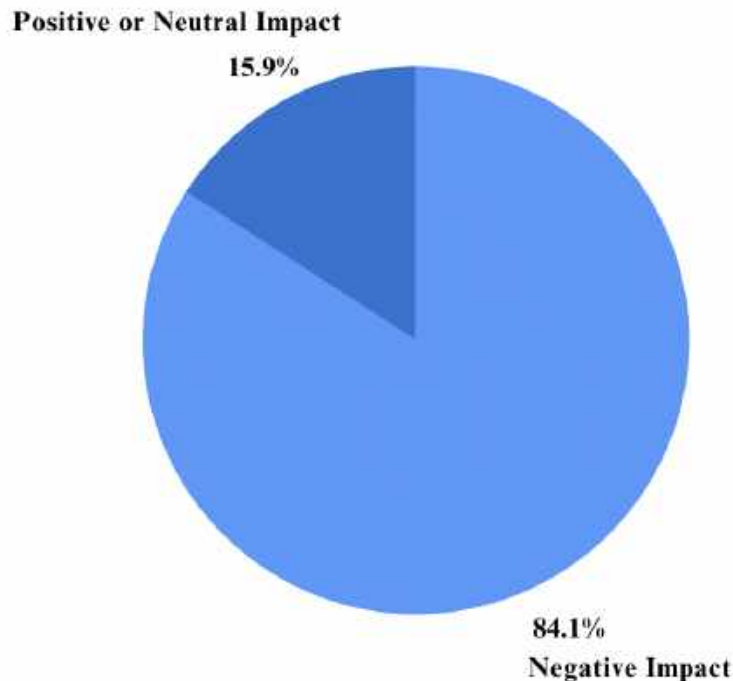
Influence on Shopping Decisions: An intriguing finding emerged regarding the impact of advertisements on Generation Z consumer behavior. Specifically, 42.9% of surveyed participants affirmed that short advertisements on social media platforms significantly influenced their shopping decisions and future financial commitments (*Figure 3*). An even larger portion (61.9%) of respondents conveyed that longer-form videos wielded substantial influence over their purchasing choices (*Figure 3*).

Figure 4. Influence of Ads and Social Media on Purchases of Respondents



Overall Influence on Purchases: An overwhelming majority, constituting 85.7% of all participants, acknowledged that advertisements and long videos on social media platforms played a role in at least 20% of their purchases. Even more alarmingly, 15% of total respondents indicated that social media marketing influenced over 70% of their purchasing decisions (*Figure 4*).

Figure 5. Perceived Negative Impact of Social Media on Generation Z's Financial Decision-making by Respondents



Perceived Impact on Financial Decisions: A significant proportion of all respondents (84.1%) expressed that they had negative perceptions regarding the influence of social media on Generation Z's financial decisions (*Figure 5*). This sentiment was echoed in qualitative feedback, where respondents voiced concerns over consumerism-driven behaviors and the detrimental effects of social media on learning and personal growth. A few participants also expressed the negative impacts that the habit of “overspending” and the driving force of “consumerism” has had on their purchases (Beixin Y. and Joy K.).

Thematic Analysis: The data collected from the research study corroborates the researchers' initial thesis, positing that cognitive biases and psychological factors emanating from social media marketing do exert a considerable influence on financial decision-making among members of Generation Z. Fear of missing out (FOMO), peer pressure, and the allure of aesthetically-driven consumerism emerged as prominent psychological themes that ultimately allowed social media to become a large influence in financial decisions. The results of this study underpin the overarching argument that social media has a potent influence on the financial behaviors of young adults.

The qualitative feedback and comments provided by participants in the study further substantiate the study's findings:

1. “Social media has created a vicious cycle of cycling through aesthetics and products we truly do not need.”
2. “Social media numbs the brain and inhibits us from learning and growing.”
3. “I don’t like that we are driven by consumerism.”
4. “The power social media has on Generation Z’s financial decisions is scary.”

In summary, the findings of this research study underscore the pervasive impact of social media on the financial decisions of Generation Z, with cognitive biases and psychological factors playing a pivotal role in enlarging its influence. The results of this study elucidate the need for greater awareness and critical engagement with social media platforms to mitigate the adverse effects that social media has on financial literacy and consumer behavior.

Practical Applications of Results

According to the 2023 United States Census, the rate of child poverty has doubled from 5.4% to 12.4% within the past two years (2021-2023) and is showing no signs of stopping. As the child poverty rate in the United States continues to increase rapidly, it has become even more apparent and important for children and young people to learn and educate themselves regarding ethical and attainable spending habits. Unfortunately, habits such as impulse spending that have been expedited through advertisements on social media have added to the high child poverty rates seen in modern society. From ongoing research conducted across the world, children from the age of 13 and possibly younger have begun to feel influenced and impacted by the advertisements they see across different online social networks. This is alarming as the global economy continues to fight with soaring inflation levels in 2024, with no signs of improvement anytime soon.

It is estimated that members of Generation Z spend an average of 844 USD annually on impulse purchases influenced by social media marketing (Bankrate Survey, 2023). This number, compared to the average salary of 37,300 USD for the working members of this generation (and combined with the daunting fact that over a third of the Generation Z population is unemployed), makes for a concerning disproportional ratio of money spent versus money made. In fact, it can be argued that some of the ratios (money spent versus money made) could be negative.

Furthermore, according to the United States Bureau of Labor Statistics’ 2022 Consumer Expenditure Survey, the average American individual spends around 44,000 USD every year, and a typical American household spends almost 73,000 USD annually. As the annual average total expenditure amount of both individuals and households continues to rise rapidly, with the average income growing at a significantly slower pace, it has become increasingly important for ethical and practical purchases to be made in order to preserve the health of the global economy and limit the negative influence that social media has on the spending habits of Generation Z members.

In a more positive light, members of Generation Z have shown efforts in reducing their spending habits, with 73% of the population pledging to “modify their lifestyles” (Bank of America, 2023). This effort comes in the wake of the dangers that unethical and spontaneous

spending brings and an acknowledgment of the harmful role that social media plays in enforcing bad spending habits time and time again. The ways in which Generation Z members plan to change their lifestyles vary. However, many focus on the idea of cutting back on their social media usage and reducing the time they spend on various platforms such as Instagram and TikTok.

A limitation regarding the research study conducted includes a limited number of responses to the survey sent out. The survey received 63 responses in total, which does limit the amount and scope of the data collected. However, the data that was collected followed trends expressed in previous studies and was corroborated by research studies that garnered data from significantly larger sample sizes. Although the data collected in this research study was limited, it still reflected stability in its results and supported the hypothesis that social media negatively affects Generation Z's spending habits. A recommendation for further research studies on the same topic would be to access and survey a larger group of the Generation Z population in order to gain more insight and data on the subject. Another suggestion would be to conduct research on the ways in which Generation Z spending can be hindered or affected by third parties, such as the government, other institutions, and other members of Generation Z because social media marketing is only one factor that leads to poor financial decision-making.

Nonetheless, the impact and role that social media continues to serve in the realm of financial spending remains immense and powerful. According to the results of this research study, corroborated by multiple other reputable sources, it is highly plausible that social media negatively impacts financial decision-making, and thus, change, modification, and awareness of the issue are essential and necessary to improve the global economy that will soon be led by members of Generation Z.

Significance of Results

The results from the data collected in this research study are important, as they clearly show that advertisements on social media platforms heavily impact Generation Z's spending habits. This elevated rate of reckless spending in youth will eventually have a domino effect and negatively impact their abilities to save for larger purchases that come with adulthood. Common large purchases in early adulthood can include college tuition, a first car, a first home, and more. An upsurge in spending due to social media marketing can either hinder their abilities to make these necessary large purchases or increase the amount of debt that they take on at a young age without a steady income. The trends identified and researched in this study are alarming, as they depict the youth of our country (Generation Z members) going on a rocky road to financial success or failure. The heightened rate of debt that this generation collectively will gain from their poor spending habits will eventually also negatively affect the rest of the globe as it can cause inflation to increase even more rapidly and uncontrollably.

The research gathered from other academic journals suggests that social media affects more than just financial decisions. In fact, 60% of Generation Z members look towards social media for their weekly news (Morning Consult Pro, 2024). This considerable percentage bolsters

the claim that social media has a powerful hold over the world's youth today. It is not only able to influence purchasing decisions but can also choose what vital pieces of information are spread to the younger generations.

A practical use for the results of this research study can include implementing more financial teachings and education in schools. According to Ramsey Solutions, only 25 states require high school students to take a financial literacy class before they graduate. An example of a state that does not require such a class is New York, and there are only 20 out of the total 533 public high schools in New York that offer personal finance classes (Office of the NYS Comptroller, 2024). Including a personal finance class in every high school can have a positive impact on Generation Z's financial literacy, teaching them how to effectively and logically make reasonable financial decisions.

Conclusion

In summary, this research study shows the significant impact of social media marketing, especially on platforms such as Instagram and TikTok, on the financial decision-making of Generation Z individuals. Since members of Generation Z had to mature into an era dominated by social media, their information and perspectives have been shaped by influencers and peer opinions, leading to poor spending habits and financial behavior. Data collected through the surveys conducted in this research study, as well as from the compilation of current literature, shows that social media has a huge influence on young people's financial decisions. A large portion of Generation Z uses social media for financial guidance, and many make investments or purchasing decisions based on recommendations or advertisements that they receive through social media platforms.

Additionally, the rise of social media marketing has been shown to be directly related to increasing reckless spending rates and higher amounts of debt among Generation Z members, which often is caused by impulse purchases and, in turn, leads to more financial stress. Cognitive theories such as the perceptual theory, loss aversion, anchoring and adjustment heuristics, confirmation bias, overconfidence, herd behavior, and depression provide researchers with insights into the cognitive processes involved in financial decision-making. More specifically, through these psychological and cognitive theories, it is evident that young adults especially are vulnerable to being influenced by external sources such as social media and are currently being exposed to those sources more and more. However, while social media marketing is powerful, it is important to understand that it is only one of many factors that shape financial decisions. Family members and friends, product reviews, and third-party websites can also significantly influence one's spending habits. Hence, while social media marketing may lead to poor financial decision-making, it is not the sole factor that determines the financial behaviors of Generation Z members.

It is evident that marketers are aware of the influence that social media has on members of Generation Z, and thus intentionally target their social media advertising at young people when promoting their products. Not only that, but many companies have already invested large

sums of money into social media marketing, and even more plan to invest in the upcoming years, leading to social media having an even stronger presence and influence in the advertising field. The algorithms on social media platforms collect data to target product advertisements to specific consumers who are more likely to purchase the product based on their search or browsing history, allowing companies to more easily grab the attention of their target market and influence a purchase. While this social media marketing algorithm is beneficial for businesses, it can be devastating to young people who are not financially literate as it encourages more reckless spending. The data collected from the survey in this research study, along with previous research conducted, can be used to conclude that social media algorithms do, in fact, have a strong financial hold over youth today and that the negative impacts of social media marketing should be taken seriously and addressed promptly.

Hence, the results of this study highlight the importance of equipping members of Generation Z with strong financial knowledge and skills to navigate the complex social media marketing environment. Educating youth about advertising tactics, mindful spending, and good financial habits is essential to aid them in developing strong critical thinking skills and responsible financial behavior. Encouraging more education in financial literacy is key to reducing the negative impacts of social media on the financial decision-making of Generation Z. By helping young people make informed financial decisions and resist the temptation to spend impulsively, society can promote more financial well-being and long-term economic prosperity.

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Ethical Pitfalls of Practical AI Implementations By Jimin Park

Artificial intelligence, the greatest invention in the 21st century, impacts all aspects of human life. As artificial intelligence developed, people can access information easier than in the past. They learn knowledge through the internet and believe that all the information that is provided from AI is all true. Also we unconsciously absorb others' opinions or information that might not be true. When I searched the image of 'school girl', the first picture that popped up was the picture of women wearing cropped shirts and barely covering skirts. On the other hand, the first image of 'school boy' was a smiling boy who was wearing a usual uniform with a backpack. This is an example of how society reflects two genders differently and how AI could impact an individual's bias. People absorb bias through AI and the implementation of AI becomes a societal challenge. Artificial Intelligence enhances the biases that are generated when machine learning faces the challenges of filtering subtle discriminations in a social context, such as gender and racial inequality.

Description of Bias in Society

While society is enhanced and individual opinions are respected, bias still exists in society, which is deeply rooted in history and based on an individual's observation, childhood memories, or internet usage. People consciously think that bias is a bad societal issue and should be eliminated, but the deep unconscious mind might have bias. Most of the time, people easily generalize one side of the aspect or unconsciously absorb information from the internet. At this point, Artificial Intelligence plays a crucial role in societal bias. However, AI only contains small fractions of data, not double edges of data. The reason is that they get untrained massive data, which greatly impacts social bias. There are more than 180 biases remaining in society, such as gender discrimination, LGBTQ+ bias, and race/ color discrimination (Desjardins). First, gender discrimination might start in childhood or be rooted from history.

Gender discrimination is defined as a restriction created by the barrier, which is that they are a certain gender, and doesn't give equal opportunities or human rights to every gender (Gender Discrimination: Inequality Starts in Childhood). Gender prejudice might be faced when they are young. The cause could be "social norms regarding expectations", inequality of the resources, or their observations. Furthermore, society defined the gender's role based on both descriptive norms (which is the expectation of what group members do - girls are more sensitive than boys - typical social stereotype) and injunctive norms (which is what should be done (e.g. boys should not cry)) (Zou, Savani). In addition, it could also be rooted in history and through an individual's biological ability. Biologically, such as the ability to breastfeed, which only women have, the differences between the genders are rooted in sexual divisions of labor. Therefore, society defined men as more strengthened in economic work and women as confined to the domestic sphere. This deeply rooted inequality remains in society and affects an individual's life.

Next is about LGBTQ+ bias in society. LGBTQ+ is the term of different identities, including terms of lesbian, gay, bisexual, trans, queer, questioning, intersex, asexual, and more

identities (Defining LGBTQ Terms And Concepts). Stonewall Riots is one of the most impactful protests of LGBTQ+ in 1969. The New York State Liquor Authority punished and made it illegal to serve alcohol to known or suspected LGBT individuals and explained that the mere gathering of homosexuals was “disorderly.” People who identify themselves as LGBT don’t have a place to express themselves without worry. As this protest shows that people known LGBTQ+ individuals encounter higher rates of rejection, violence, suicide, and homelessness compared to heterosexual-identified individuals. For example, students who are LGBTQ+ have more possibility to drop out of school than other peers. LGBTQ+ social norms also can be rooted in childhood. Disney, one of the most popular American film productions for children, struggles to represent LGBTQ+ in their animations. In fact, they only describe heterosexuality to power and magical heights.

Another debatable discrimination in society is race/ color discrimination. Race/ color discrimination is when someone is treated unfairly due to their race or other personally identifiable qualities (such skin tone, hair type, or specific facial features) or when someone is treated unfairly according to their skin tone (Race/ Color Discrimination). For example, the media represents certain races/ color negatively and it is the progress that media imports stereotypes toward certain groups of people. Moreover, they exaggerated the fact of a certain group of people. In the media, 59 percent of black families are portrayed as poor, but account for just 27 percent of black families in poverty. Furthermore, 17 percent of white families are depicted as poor in the news media, but the actual rate was 66 percent of the American poor (Jan). Those several types of bias in society absorb and use as a data of Artificial Intelligence. This is an urgent problem, and it will have a massive impact on society.

Process of how AI absorbs Bias

Artificial Intelligence is generated by humans, meaning that people have a huge impact on the reason why Artificial Intelligence represents bias toward a certain group of people or demonstrates one side of an issue. To begin with, Artificial Intelligence defined a technology that allows machines and computer applications to mimic human intelligence, learning from experience via iterative processing and algorithmic training. (How Does AI Actually Work?) In general, Artificial Intelligence obtains information through the massive amount of data that they train the algorithms from the patterns and the features based on their analysis. In addition, they train those tons of data very quickly, and the aim of AI is to model human behavior. Based on this background, ChatGPT, one of the Artificial Intelligences that provide information to people, relies on a technique called unsupervised learning, where it learns patterns and structures from a vast corpus of text data (Addy). Furthermore, they provide the information through the trained data that a massive amount of publicly available text from the internet, including books, articles, websites, forums, and other sources. ChatGPT or other AI tools try to curate and preprocess the data to remove any personal information or biases. However, it might not filter all the inaccurate data due to the massive amount and different standards to filter certain information.

According to the Data, Power and Bias in Artificial Intelligence by Susan Leavy, Barry O’Sullivan and Eugenia Siapera, the research was focused on whether the COMPAS system reveals racial bias or not. The concept of bias is subjective and it depends on how people define it. One of the examples from Sumpter, while Tables 1 and 2 exhibits only 854/2464 = 35% for Whites (see table 2), it shows that 2174/3615 = 60% of African Americans (see table 1) in COMPAS are considered higher risk. It represents a strong racial bias since 1901/3615 = 53% of African Americans were actually reoffended which is less rate than predicted (see table 1). On the other hand, this was 966/2454 = 39% for White (see table 2), suggesting that the rate was higher than the prediction. This misinterpretation occasionally occurred and formed bias in AI systems. (Leavy, O’Sullivan, Siapera 3)

Table 1: Recidivism rates in the COMPAS system for African American defendants (via [Sumpter, 2018]).

African American	High Risk	Low Risk	Total
1) Reoffended	1,369	532	1,901
2) Didn’t reoffended	805	990	1,714
Total	2,174	1,522	3,615

Table 2: Recidivism rates in the COMPAS system for White defendants (via [Sumpter, 2018]).

White	High Risk	Low Risk	Total
1) Reoffended	505	461	966
2) Didn’t reoffended	349	1,139	1,488
Total	854	1,600	2,454

Under Representation in AI and Reflection of belief of Data setter

Furthermore, AI enhances bias through the underrepresentation of minority people and misidentifying certain groups of people. On the internet, there is a lot of underrepresentation of women and people of color in technology, and the data of under-sampling of certain groups forms AI, meaning that it could lead to prejudice in society. According to computer scientist Joy Buolamwini, founder of the Algorithmic Justice League and a poet of code, “one government dataset of faces collected for testing that contained 75% men and 80% lighter-skinned individuals and less than 5% women of color – echoing the pale male data problem that excludes so much of society in the data that fuels AI.” This substantiates that the data is trained by certain gender and color of people. Amazon, the American multinational technology company focusing on e-commerce, cloud computing, online advertising, and artificial intelligence

(Amazon(Company)), has a debate on whether Amazon's facial technology is generating bias. According to the study, authored by the University of Toronto's Inioluwa Deborah Raji and Joy Buolamwini, a researcher at Massachusetts Institute of Technology, Amazon recognition - commercial AI system for analyzing faces had much higher error rates when predicting the gender of darker-skinned women in images, compared with lighter-skinned men (Buolamwini). Amazon causes harmful discrimination through this tool and can be offensive to certain groups of people. Furthermore, the result of inaccuracies in facial recognition technology can play a crucial role in an innocent person being misidentified as a criminal and can be treated with unreasonable and unwarranted police scrutiny. Additionally, if black woman tries to use a facial recognition system, then she has to wear white-mask to be identified. This means a lot that this company potentially denies the identities of certain groups of people and subsequently it will cause a brutal bias in the world.

Amazon is not only a case that amplifies bias in society, but also a text-to-image artificial intelligence model such as Stable Diffusion and DALL-E create bias, despite efforts to detoxify the data fueling their results. Stability AI, maker of the popular image generator Stable Diffusion XL, enhances outdated Western stereotypes, transferring sometimes bizarre clichés to basic objects, such as toys or homes. According to The Washington Post, Post ordered Stable Diffusion XL to provide an image of various countries. As a result, they generated classical curved roof home for China, rather than Shanghai's high-rise apartments; idealized American houses with trim lawns and ample porches; dusty clay structures on dirt roads in India, home to more than 160 billionaires, as well as Mumbai, the world's 15th richest city (Tiku, Schaul, Chen). This is the image of a typical stereotype of what an average person from North America or Europe thinks, and it clearly reflects the misidentification of Asian countries. Likewise, DALL-E 3 also displays a tendency toward Western point-of-view of the world and they generate images that disproportionately represent individuals who appear White, female, and youthful. Therefore, these images could unconsciously import an individual's opinion and create a bias that cannot shake off completely.

Artificial Intelligence makes modern life easier and accessible for everyone. However, people have to remember that there are always flaws in rapid change. AI amplifies the biases that arise when machine learning confronts the difficulties of detecting subtle discriminations in a social context, like gender and racial disparities. The bias made by AI can impact in many aspects, also means that it could navigate people's opinion based on the information that is provided in AI. In addition, AI is human-made, meaning that it can be very subjective. Bias created by artificial intelligence will be an indelible problem for society, and people should pay more attention to this change to prevent this. In order to do this, people need to think in a more critical way toward AI and how companies respond to this situation. Moreover, individuals should also contemplate how they will respond to this change. In short, advancement of technology contributes a lot of positive effect on society, but it could display wrong or biased information.

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Predictive Modeling of Stock Prices to Identify the Best-Performing Model and Observation of Dependency on Historical Prices by Atish Reddy Amistapur

Summary

Investing in stocks is a complicated process that takes into account many factors, which can potentially dissuade inexperienced investors from trading in stock markets. Stock price prediction in stock markets can be used to help investors make better investment decisions, allowing investors to generate profits off of their investments and make informed decisions on which stocks to invest in.

For this model, I'm going to be building four different types of models which are linear regression, neural networks, decision tree and random forest. These models will then be combined with the help of the Multiplicative Weight Update by being assigned equal weightage and altering it based on error. This is done so that we can identify the model that performs the best and gives the most accurate stock price predictions, which in all cases was the linear regression model. A trading bot was also built to check if the linear regression model can generate returns on investment, which generated a profit on investment for every company that was selected for the dataset and fared better in comparison to an investment strategy that focuses on holding shares.

Introduction

Stocks are securities that represent the ownership of a company. A stock market refers to the buying and selling of shares on online platforms. Investors like to invest in stocks because they believe that the company's value will increase over time. If they invest early, there is potential for them to earn large sums of money if the company grows. However, there are so many factors that go into valuing a stock, such as the performance of a business financially, the state of the economy, market sentiment, etc. This can make it difficult for inexperienced investors to make investment decisions that could fetch them profits and could dissuade more people from even trying to invest in stocks in fear of losing money. Therefore, it is difficult for a person to choose a company to invest in and earn money off their investments as a whole. A model that can predict stock prices can greatly benefit people who are new to investments. Therefore, this project aims to reduce the uncertainty potential investors could experience in deciding which stocks to invest in through the use of a stock price prediction model.

Related Work

When considering an approach towards building a stock price prediction model, it usually integrates systems that have components from either machine learning, deep learning, or both. Both systems are forms of artificial intelligence that can learn and identify patterns to make predictions on their own with little to no human interference. There have already been attempts to use these systems. For example, in April 2020, Sidra Mehtab et al. created a stock price prediction model using 8 classification and 8 regression models that are based off of statistical

and machine learning approaches. In August 2020, Jingyi Shen et al. created a short-term stock price prediction model with the use of a deep learning system and feature engineering. So many techniques have been found that in November 2021, Nusrat Rouf et al. chose to publish a review paper that listed all the methodologies, developments and potential future of stock price prediction models over the last 10 years to give an overview of these models.

Methods

First, to get the stock prices, the data source used to acquire the prices is Yahoo Finance. This is a reliable source because it has access to a wide range of tickers globally, providing historical as well as real-time data on stock price shifts. The data does not lack any information about stock prices, so no preprocessing is required.

For the dataset, the model will take the last 5 years of open prices recorded on Yahoo Finance. For simplicity, the model will only take into account the last 3 open prices as features to predict the new stock price. This feature was selected since a relationship can be modelled between the price changes by considering historical prices, allowing for a relatively accurate prediction. Its engineered in such a manner that the prices are weighted based on recency. Though there are other factors that influence stock prices, using a technical analysis method can help investors earn returns very quickly. However, it should be noted that there is a large scope for improvement as nothing about the business's information itself is integrated into the model.

To build the combined models, we need to choose a few models for evaluation. The models I will be choosing for this model will be the linear regression model, neural networks, decision tree and the random forest model. Each one approaches the stock price prediction differently, allowing for variety.

Models: Linear Regression

Linear regression models predict the relationship between variables by assuming there is a straight-line connection. Since my model has 3 independent variables (last 3 prices) the model will follow a multiple linear regression model.

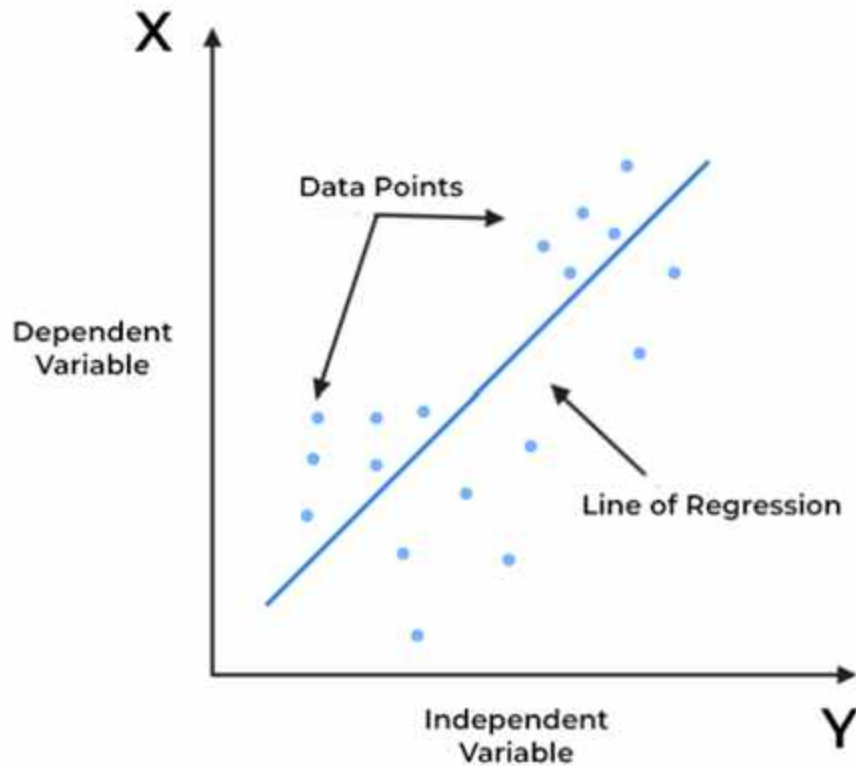


Figure 1: Visualisation of linear regression

This is how a linear regression model looks like (Kanade, 2023). This model follows some assumptions when generating the relationship between the variables. They are:

- **Homogeneity of variance:** there is no significant variation in the error in the error of the predictions produced across all the values of the independent variable (Final stock price)
- **Independence of observations:** There are no hidden relationships among variables.
- **Normality:** The data follows a normal distribution
- **Linearity:** The line of best fit produced from the dataset is a straight line

The formula used to calculate the values generated from the multiple linear regression model is:

$$Y = \beta_0 + \beta_1 X + \dots \beta_n X_n + \epsilon$$

Where:

- y = the predicted value of the dependent variable. In this case it's the predicted stock price
- β_0 = the y-intercept
- $\beta_1 X_1$ = the regression coefficient of the first independent variable. It shows how the dependent variable increases concerning the first independent variable. In this case it's the first open stock price (the oldest open stock price taken into consideration)
- $\beta_n X_n$ = the regression coefficient of the last independent variable. In this case it's the third open stock price (most recent day)

- ϵ - the error of the model

When finding the line of best fit that depicts the correlation between the predicted stock price and the previous open stock prices, it calculates three things:

- The coefficients that generate the smallest error
- The t statistic of the model – it evaluates if each regression coefficient is different from zero. A value that shows a discernible difference from zero indicates that the independent variable (the historical stock price) in question has an impact on the dependent variable (predicted stock price)
- The p-value associated with the t statistic - it calculates the probability of the t statistic occurring by chance if the null hypothesis of there being no correlation between the independent variables and the dependent variables is true. When the p-value is usually less than 0.05, the null hypothesis is rejected, and the model comes to the conclusion that there is a correlation between these variables.

Neural Network -

Neural network is an artificial intelligence model inspired by the human brain. It is used to identify patterns in the data given to it with the help of layers so that it can make predictions for the stock price. Below is a visual depiction of the neural network

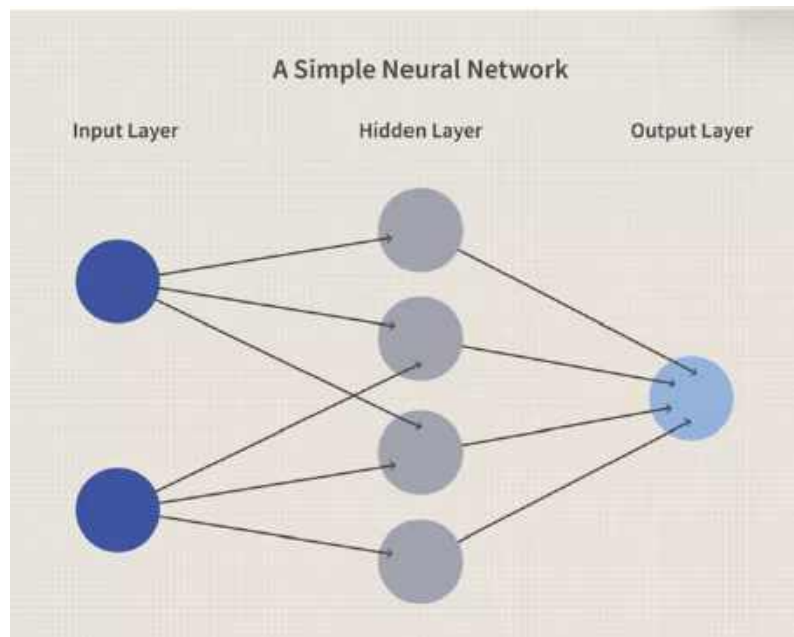


Figure 2: Visualisation of neural network

This is the structure of the neural network (Chen, 2024). It comprises of two main parts:

Layers

1. Input layer: This is the layer that collects the data
2. Hidden layers: These are the layers that do all the calculations in order to identify the patterns in the data.

3. Output layer: Generates the final prediction of the stock price

· Neurons: These are represented by the lines connecting all the layers in the network. In the case of this model, they represent weights randomly assigned which are then multiplied with the 3 stock prices. It then checks how it performs with respect to the actual data. If there is a large error observed in the calculations, then the weights will be altered in the next iteration to generate a more accurate prediction.

Overall, the network is usually run hundreds if not thousands of times to improve its accuracy in predictions. However, increasing the number of iterations the model goes to will also increase the time taken for the model to be able to make predictions. Therefore, there must be a balance between the number of iterations run and the time taken for it to be done

Decision Tree –

A decision tree is a model used either for classification or regression tasks. Its main goal is to divide data into subsets with the help of conditionals that pertain to specific features.

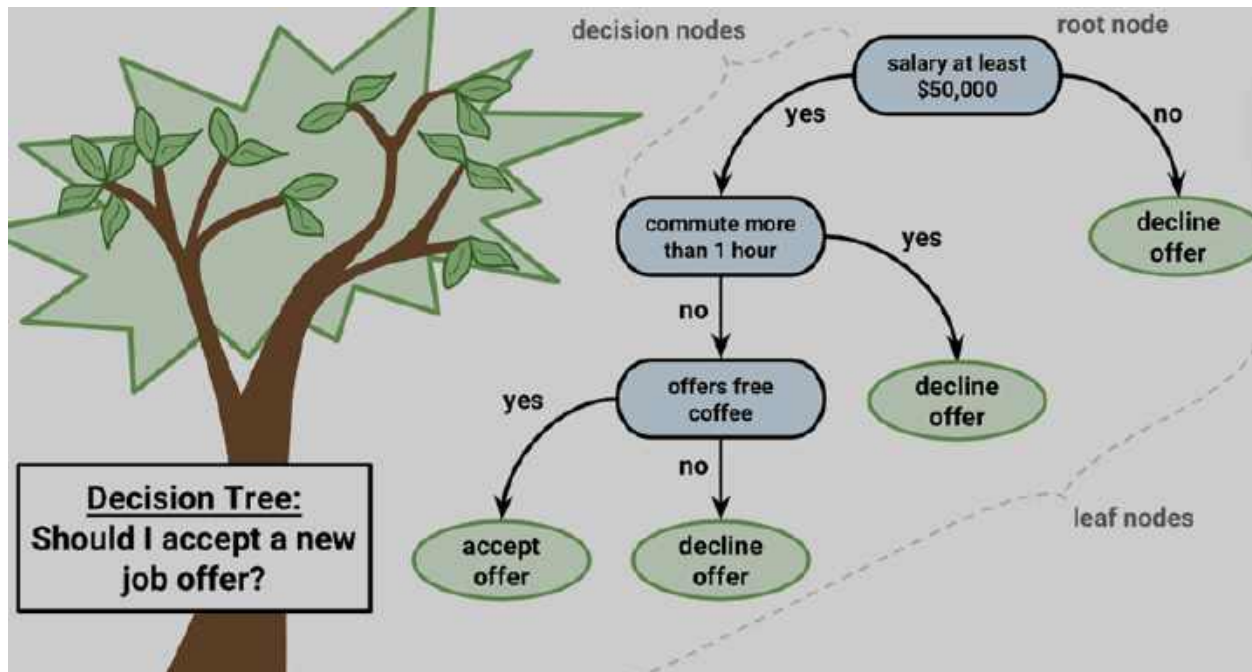


Figure 3: Process of decision tree

This is an example of what a decision tree could look like (Singh, 2020). It mainly comprises of four parts:

- Root node: This node represents the entire dataset given to the model
- Decision nodes: These are the features or conditions that the model uses to split the data
- Child nodes: The subsets of data that have been split by the decision nodes
- Leaf nodes: These are the final values generated by the model. Since our model is a regression model, it represents the predicted stock price values.

This process of splitting data continues until one of these conditions are met:

- The maximum depth of the tree is reached – this is usually predetermined in the code itself. For example, if the max depth of the tree is set to 3, then only 3 decision nodes are run
- No more information can be gained
- Minimum number of samples remain in a node

Random forest

The random forest algorithm randomly generates decision trees with different subsets of features to ensure there is no correlation between them and then merges them to generate more accurate predictions. The process is used to create these predictions is as follows:

1. **Bagging (Bootstrap Aggregating):** This is a technique that creates different training datasets. Since it involves sampling from the dataset with replacement, there are chances of there being an overlap in the values used in datasets.
2. **Creation of decision trees:** Random Forest models use a random subset of features for each tree. This means that instead of taking into account all the features of a dataset, it only uses a subset of features. This reduces the correlation between decision trees and the risk of overfitting.
3. **Training of trees:** Each decision tree is allocated a different bootstrapped training set and uses it to make a prediction
4. **Final Prediction:** The forest generates the final prediction by taking the average of all the predictions made by each tree.

Training

The models are trained on historical data from yahoo finance. Using the train test split module in sklearn, the data is split into training and testing data randomly, with 67% of the data being used to train the model as a part of the training set and the other 33% being the testing dataset which is used to evaluate the model's performance to check for any underfitting or overfitting issues.

To gauge their performance, I chose 10 companies from different sectors and calculated the mean squared error to check the deviation of the values produced by these models in comparison to data from the testing dataset. For the neural network, I set the max iterations to 1000 while I took two different variations of the decision tree and random forest models, varying the depth of them.

Results

Mean Squared Error of Model

Company	Linear Regressi	Neural Networ	Decision tree	Random forest	Decision tree	Random forest (depth
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	on	k	(depth = 5)	(depth = 5)	(depth = 8)	= 8)
Apple	7.45	8.49	12.46	9.15	12.96	9.21
JP Morgan	4.46	6.27	7.52	5.46	8.80	5.87
AstraZeneca	0.94	1.17	1.31	1.87	1.41	1.86
Walmart	0.42	0.56	0.63	0.55	0.69	0.58
T-Mobile	3.99	5.29	5.90	4.89	5.78	4.74
Netflix	130.74	137.05	235.65	154.95	259.66	164.79
Coca Cola	0.62	0.69	0.89	0.80	0.92	0.80
Xcel Energy	0.79	0.94	1.02	0.91	1.36	0.99
Tesla	63.61	69.62	83.41	70.55	108.19	72.81
Adobe	130.97	133.88	156.52	140.40	187.01	142.40

Figure 4: Mean Squared Error of each model

From the results in Figure 1, we can see that on average, the linear regression model performed the best as it had the lowest mean squared error. Another thing to note is that the size of the error for each model for each company is different, with Netflix having on average the highest mean squared error for each model. This could be due to the volatility of the stock price, or how much the stock price fluctuates in a given time period. This could make it more difficult to accurately predict stock prices and therefore create disparities in the mean squared error for different companies. Companies with more volatile stocks will have a higher mean squared error and vice versa. Also, the value of the stock may be larger; AstraZeneca has a stock value of around \$80, while Netflix has a stock value of over \$600. It could therefore lead to slighter larger deviations in larger stocks, which therefore contributes to the higher mean squared error and can explain why stocks such as AstraZeneca have a low mean squared error while it's the opposite for Netflix.

Multiplicative Weight Update

Now, how do we combine the models into one model and give preference to the best model? Since we do not know which model is the best, we will first assign equal weights to every model at 0.25. So, the program trains itself by asking every model what the stock price of a ticker will be tomorrow, giving equal weight to every model. After collecting all the data, it will compare the predictions of each model with the actual stock price that was recorded the next day, calculating the absolute error. Then, through a process called Multiplicative Weight Update, it will skew the distributions towards the more accurate models by calculating the percentage by which each model was off from the actual stock price and then reduce the weight of the model by a factor of $1/(2^{\text{error}})$. This ensures that there is no chance for negative weights to be produced for a model or a division by zero error which, despite being extremely unlikely, is a possibility that should not be ignored. To ensure that all the weights add up to 1, the weights of all the models will go through a process called normalisation. This process causes the new weights to be summed up and then the new weight of each model will be divided by the new sum of all the

models' weights to maintain the proportions of weights and make the weights sum up to 1. For example, if there were two models, with model one having reduced by 20% to a weight of 0.4, and model 2 reducing by 40% to a weight of 0.3, the new weights will be added, becoming 0.7, and then both of the weights will be divided by 0.7, giving the new weights of 0.57 and 0.43, adding up to 1. This will ensure models with lower errors have a higher weight compared to other models.

Company	Final weight of model					
	Linear Regression	Neural Network	Decision tree (depth = 5)	Random forest (depth = 5)	Decision tree (depth = 8)	Random forest (depth = 8)
Apple	1.0	9.4e-29	6.4e-84	8.4e-33	6.9e-80	8.6e-34
JP Morgan	1.0	3.9e-34	1.6e-68	1.1e-19	2.3e-83	5.6e-31
AstraZeneca	0.999	5.9e-11	2.7e-17	5.2e-14	2.2e-20	3.6e-16
Walmart	0.999	1.4e-10	1.6e-15	4.4e-09	3.3e-19	3.2e-12
T - Mobile	1.0	8.0e-31	5.0e-48	2.3e-28	6.5e-44	5.9e-21
Netflix	1.0	4.2e-23	1.2e-308	3.5e-116	0.0	4.2e-163
Coca Cola	0.991	9e-3	7.2e-15	2.0e-08	1.1e-19	1.2e-10
Xcel Energy	0.999	1.2e-08	2.8e-13	6.1e-08	1.6e-22	1.6e-10
Tesla	0.999	6.9e-15	1.7e-120	3.0e-35	1.4e-175	3.2e-44
Adobe	1.0	7.0e-22	6.3e-125	9.6e-42	1.0e-260	2.9e-74

Figure 5: Final weights of all models after Multiplicative Weight Update

From the results in Figure 2, we can conclude that the Linear Regression model performs the best out of all the models, generating the most accurate predictions. It attained a final weight of at least 0.99 when predicting stock prices for all 5 companies. The other companies had negligible.

Validation

Now, to validate the model's ability to help people make profitable investments, I decided to build a trading bot as well. The idea behind it is simple, a budget will be set and if the model predicts the stock price will increase the next day compared to the open price, then the bot will buy one share if it has the budget for it. If the model predicts the stock price will fall the next day

compared to the open price, then the bot will sell one share if it has any. When the time period of 5 years elapses, the bot will sell all the shares it has to show how much money its shares are worth and show how much the budget has increased or decreased with respect to its original budget. Since this model does not take into account factors such as the type of sector the company is in, the trading bot can be extrapolated to all types of companies without raising any bias.

For this trading bot, I am going to set the budget to \$10000 and use the same 10 companies I used to show the mean squared error and final weights of each model. I am going to use the linear regression model for predictions since the results in Figure 2 indicate that it has the most accurate results. Also, to factor in transaction costs, I assumed them to be 0.5%, deducting it from the final budget accordingly.

Company	Starting Budget (USD)	Final Budget (USD)
Apple	10000	34232.55
JP Morgan	10000	19200.45
AstraZeneca	10000	17396.03
Walmart	10000	18197.79
T - Mobile	10000	22540.57
Netflix	10000	53034.78
Coca Cola	10000	14654.38
Xcel Energy	10000	13093.84
Tesla	10000	74304.65
Adobe	10000	28477.54

Figure 6: Profits earned from investments with the stock price prediction model (1 to 1 buying and selling of shares)

Company	Starting Budget (USD)	Final Budget (USD)
Apple	10000	208936.49
JP Morgan	10000	120097.33
AstraZeneca	10000	91638.87
Walmart	10000	72006.99
T - Mobile	10000	95967.09
Netflix	10000	657935.37
Coca Cola	10000	96347.12
Xcel Energy	10000	90887.47
Tesla	10000	334185.62
Adobe	10000	638162.17

Figure 7: Profits earned from investments with the stock price prediction model (3 to 1 buying and selling of shares)

Company	Starting Budget (USD)	Final Budget (USD)
Apple	10000	100454.49
JP Morgan	10000	46189.32
AstraZeneca	10000	28229.75
Walmart	10000	54585.74
T - Mobile	10000	67589.69
Netflix	10000	149013.20
Coca Cola	10000	43887.48
Xcel Energy	10000	39237.67
Tesla	10000	77324.68
Adobe	10000	33893.33

Figure 8: Profits earned from investments with the stock price prediction model (3 to 3 buying and selling of shares)

From this, it can be concluded that choosing a method that adopts a high volume, high-risk method (buying 3 and selling 1) can generate the most profits. However, for investors unwilling to take that level of risk, it can be noted that even the model that buys 1 and sells 1 and the model that buys 3 and sells 3 also generate profits.

Discussion

What is the purpose of this model? Using stock price prediction models, investors can decide whether or not they should buy or sell shares of a company to maximise returns or lower their losses, making smarter investments. In addition to helping investors make investment decisions, It can also be used in the development of trading bots, allowing for the automation of stock trading, as it will have the knowledge required to make profitable investments.

However, some believe holding stocks may be better than buying and selling shares like the trading bot. Below is a figure showing the return on investment earned by just holding stocks over the last 5 years, and compares it with the return on investment earned by following the buying and selling method the trading bot does. The data used for this comes from Yahoo Finance (as of August 6th 2024) and the results generated by my 1 buy and 1 sell trading bot and 3 buy and 1 sell trading bot

Company	Return on investment from holding stocks	Return on investment from trading bot (1 to 1)	Return on investment from trading bot (3 to 1)
Apple	310.29%	242.33%	1989.36%
JP Morgan	82.97%	92.00%	1100.97%

AstraZeneca	81.92%	73.96%	816.39%
Walmart	93.97%	81.98%	620.07%
T - Mobile	151.88%	125.40%	859.67%
Netflix	97.42%	430.35%	6479.35%
Coca Cola	36.61%	46.54%	863.47%
Xcel Energy	-2.16%	30.94%	808.87%
Tesla	1215.60%	643.045%	3241.86%
Adobe	83.16%	184.78%	6281.62%

Figure 9: Comparison of different investment methods

This shows that actively buying and selling stocks with the aid of the model can generate more profits than passively holding shares. However, the disparity reduces more as the scale with which the stock price increases rises. For a company like Xcel Energy, for example, its stock price reduced over the last 5 years, but the model was able to generate a profit of roughly 31% through short-term trading. A company such as Tesla, however, which had an increase of 1215.60%, was only able to generate a profit of 643% increase in comparison.

If we consider the 3 to 1 trading bot, however, the bot performs better across all companies compared to just holding shares. For example, it generated a profit of 6479.35% for Netflix stocks, much higher compared to earning 97.42% from holding shares. This shows that depending on the level of risk an investor is willing to take, he or she can increase their earnings by a much higher amount than just holding shares, and that taking more risk in buying shares is a better option for investors if they follow the prediction of the model.

Another thing to note is that this model does not consider factors such as high price, dividends, stock splits, volume and closing price. There are two reasons why I have not considered these factors:

- Negligible impact: For example, the volume of stocks traded had a coefficient of $1 \cdot 10^{-9}$ for the linear regression model. That is a value so low that the model would be better off omitting it altogether.
- Lower investment on returns: While the models with these factors generate lower means squared errors, when put into the trading bot, it produced lower profits compared to the trading bot that only considered open prices

Trends

When it comes to identifying trends in the predictions of our models, the gradients of the independent variables of the linear regression model can help us identify the overall price changes that are occurring.

The sum of the Linear regression gradients:

- If the sum is greater than 1: The predicted stock price of the company will either be in between the highest and the lowest of the three last open prices or more than all three of them.
- If the sum is equal to 1: The predicted stock price will be in between the highest and lowest of the open prices recorded in the last three days

· If the sum is less than 1: The predicted stock price will either be in between the highest and lowest of the last three open prices or less than all three of them.

Since we are unaware of all the conditions the neural network, decision tree and random forest pass through the dataset to generate predictions, it is difficult to make out any trends.

Limitations and Future Work

There are, however, limitations to this model. The model predicts stock prices on the basis of the dataset given to it. If there are anomalous results that have come from external factors (recessions, elections, etc), it can affect the model's ability to accurately predict stock prices. On that same note, since it doesn't consider these factors, it cannot predict these anomalous results when they occur. It can also only predict prices in the short term, with this model being able to predict the price only for the next day. While this model can be extrapolated to predict the price one week or even one month in the future, the mean squared error increases drastically as the timeframe increases.

The limitations highlight how there is a large scope for improvement in the stock price prediction model. So, to improve the model, it could be trained on a much larger dataset over a longer time period, allowing it to identify trends in stock prices better and predict where it will move. The model could also consider other features such as business performance and the state of the economy by giving the model access to websites that provide news on current affairs as well as financials in order to give a more accurate prediction of stock prices over a longer period of time.

Conclusion

When people analyse which stocks to invest in, they use a complex process that takes into consideration many factors. However, judging from the results that have been produced by this model, it is possible to predict stock prices just by taking historical open prices from the previous 3 days. More complex approaches can be taken to produce more accurate stock price predictions, but it is possible to make money off investments when utilizing models that only consider prices such as this one. However, more work needs to be done on the model to validate whether the model can predict prices in the long term by only using the historical open stock prices it has access to.

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The Ripple Effects of Geopolitical Conflicts: Analyzing the Economic Fallout and Pathways to Stability By Uchit Bhatta

ABSTRACT

Geopolitical tensions have grown more common in recent years. Conflicts and disputes between countries now affect the global economy in big ways. This study looks at how geopolitical tensions impact economies. It uses examples from different nations and historical events. The paper examines how these tensions change trade, investment, and economic growth. It also explores what leaders do to keep international relations steady. To show the economic effects of geopolitical tensions, the paper includes relevant data and graphs. It ends by talking about why international teamwork and solving conflicts matter for economic success. The study also gives ideas on how to stay stable when facing geopolitical problems.

INTRODUCTION

In our connected world today, events in global politics affect the worldwide economy. When countries clash over beliefs, land, or resources, it can upset trade, investments, and economic progress. The world is changing, with new powerful nations challenging the usual control of the United States and its friends. This shift makes conflicts and unsteady situations more likely to happen.

This paper is an examination of the economic effects subsequent to political struggles, using examples from different countries and historical periods. It measures how the dispute and conflict, between any countries in world can hit a trade flow, supply chain or investment; due to this economic growth goes downwardly position by position. This paper also analyses attempts to preserve international order and the adverse economic implications of foreign policy tensions. Examples of Geopolitical Tensions and Their Economic Consequences

The US CHINA Trade War

The trade dispute, started back in 2018 and between the US and China has been one of the major reasons for both sides having seen lasting consequences on their economies. The tariffs of a broad swathe of goods have disrupted supply chains and raised costs for businesses, their customers and have added to an economic slowdown. A possible threat is the potential 0.8% decline in global GDP by 2030, if a trade war started according to an IMF study referenced above (IMF).

The conflicts have spread to other areas, like technology and investment. The United States has limited the export of advanced technologies to China and has closely examined Chinese investments in the U.S. In response, China has worked on improving its own technology and has promoted spending within the country to decrease its dependence on selling goods to the U.S.

The trade war has led to political effects beyond economics. The United States and China are both trying to gain more power in Asia and around the world. The U.S. has made its relationships

with countries like Japan and South Korea stronger. Meanwhile, China is pushing forward with its Belt and Road plan, which is a big project to build infrastructure that links Asia, Europe, and Africa together.

THE RUSSO-UKRANIAN WAR

The dispute between Russia and Ukraine, which escalated in 2022, has caused major economic problems for both countries and the world economy. By the start of 2024, the fighting has greatly reduced Ukraine's economy, with predictions showing that its total economic output has fallen by about 45% since the start of the conflict. At the same time, Russia's economy has also suffered, with forecasts suggesting a decrease of around 8% because of international penalties and losing important markets.

The war has caused major changes in the way countries relate to each other, with Russia becoming more distant from Western nations and forming a stronger partnership with China. This situation has made people worried that the fighting could get worse and might even involve NATO and Russia directly.

The financial effects of the war go beyond just Russia and Ukraine. The problems with trading food and energy have made prices go up worldwide, causing difficulties for people in many countries to afford everyday items. The war has highlighted the vulnerability of global supply chains to geopolitical shocks and the need for greater diversification and resilience.

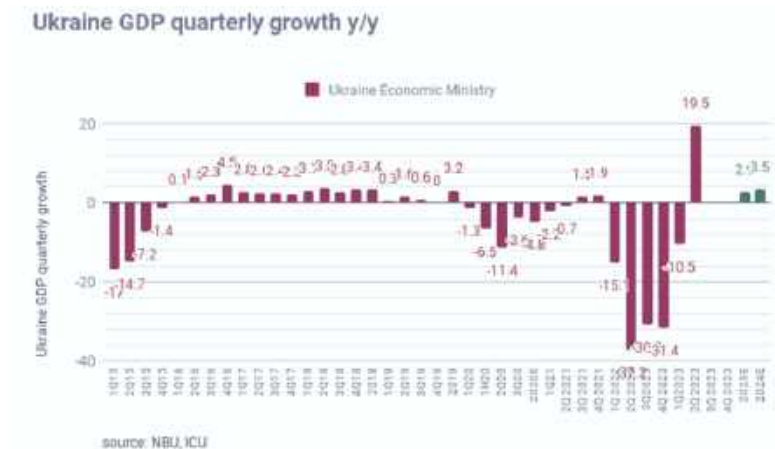


FIGURE X : IMPACT IN UKRAINE’S GDP DUE TO RUSSO-UKRAINE WAR

The Middle East Tensions and Energy Security

Tensions in the Middle East have been a long-standing cause of economic instability and fluctuations. Conflicts in this area have interrupted the flow of oil and gas, causing prices to rise and affecting economies worldwide. The recent incidents involving ships in the Red Sea have rekindled fears of supply chain interruptions and increased worries about the safety of shipping lanes in the area.

A worsening of the conflict in the Middle East could endanger energy supplies for the entire world and Europe. The Strait of Hormuz is a key passage for global energy, with 30% of

the world's oil and 20% of its liquefied natural gas moving through it each day. Any issues in this passage could significantly affect oil and gas prices and potentially impact the energy supply in the euro area, especially as European countries are becoming more dependent on energy from the region.

The impact of conflicts in the Middle East goes beyond just energy. The area is a key player in worldwide trade and investment, and fighting can interfere with this. Take the conflict in Yemen, for instance. It has caused problems for trade along the Red Sea and through the Bab el-Mandeb Strait, which is a very important route for global trade.

The Geopolitical Consequences of the COVID-19 Pandemic

The COVID-19 pandemic caused major changes in how countries interact with each other. Countries fought to get vaccines and medical supplies, and they are pointing fingers at each other for causing the virus to spread. The pandemic has made the relationship between the U.S. and China worse, as both countries say the other is not handling the situation well.

The pandemic has also had a major impact on the economy. Because of rules that kept people at home and stopped travel, there had been a big drop in business activity around the world. The pandemic has shown that the way goods are made and moved around the world can be easily disrupted, and it's important to make these systems stronger and more diversified.

The pandemic has caused lasting effects on the world's economy, with many nations dealing with large amounts of debt and slow economic growth after the crisis. This situation has made countries more competitive in trying to get investments and trade deals, as they look to bring in more foreign money and boost their sales abroad.

EFFORTS TO MAINTAIN STABLE INTERNATIONAL RELATIONS

1. The United Nations (1945)

Established in the aftermath of World War II, the United Nations (UN) aims to promote international cooperation, peace, and security. The UN provides a platform for dialogue among member states and engages in peacekeeping missions to stabilize conflict zones. For example, the UN has been involved in peacekeeping operations in regions such as the Democratic Republic of the Congo and South Sudan, helping to maintain stability and facilitate humanitarian aid.

2. The North Atlantic Treaty Organization (NATO) (1949)

NATO was formed as a military alliance among Western nations to provide collective defense against potential aggressors, particularly during the Cold War. The principle of collective defense enshrined in Article 5 of the NATO treaty has contributed to regional stability in Europe and North America. NATO has also engaged in diplomatic efforts to resolve conflicts, such as its involvement in the Balkans during the 1990s.

3. The Helsinki Accords (1975)

The Helsinki Accords were signed by 35 nations during the Conference on Security and Cooperation in Europe (CSCE). The Accords aimed to improve relations between the Communist bloc and the West, emphasizing respect for human rights, economic cooperation, and the inviolability of borders in Europe. The Helsinki process fostered dialogue and cooperation among countries, contributing to the eventual end of the Cold War.

4. The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) (1968)

The NPT is a landmark international treaty aimed at preventing the spread of nuclear weapons and promoting peaceful uses of nuclear energy. The treaty has established a framework for nuclear disarmament and non-proliferation, with regular review conferences to assess progress. The NPT has been instrumental in curbing the proliferation of nuclear weapons among states.

5. The Paris Agreement (2015)

The Paris Agreement is a global accord aimed at addressing climate change through collective action. Nearly every country in the world has committed to reducing greenhouse gas emissions and limiting global warming. The agreement demonstrates the importance of international cooperation in tackling shared challenges and fostering sustainable development.

6. The Abraham Accords (2020)

The Abraham Accords, signed between Israel and several Arab nations, including the United Arab Emirates and Bahrain, represent a significant diplomatic breakthrough in the Middle East. These agreements aim to normalize relations and promote economic cooperation, demonstrating the potential for dialogue and negotiation to resolve longstanding conflicts in the region.

There has also been some official visits of state delegates to maintain peace between countries. Some non disclosed agreements also has been made between different states. Also this paper only consists of major geopolitical conflicts which has worldwide economical effects.

MEASURES TO SOLVE GEOPOLITICAL TENSIONS

1. Promote Dialogue and Understanding

Encouraging open communication and dialogue between conflicting parties is essential for resolving differences and building mutual understanding. Engaging in active listening and empathetic conversations can help bridge divides and foster a culture of respect. As

noted in the Voice of Salam, listening to hear others, rather than just waiting to respond, is crucial for establishing meaningful connections and promoting peace in communities

2. Foster Economic Equality

Addressing economic disparities is vital for maintaining peace. As highlighted in the New Internationalist, sharing wealth fairly and ensuring equal access to resources can reduce tensions and prevent conflict. Societies with lower levels of inequality tend to experience less violence, as economic fairness fosters trust and cooperation among citizens

3. Strengthen International Institutions

Supporting and strengthening international organizations, such as the United Nations, can enhance global cooperation and conflict resolution efforts. These institutions play a critical role in mediating disputes, enforcing international law, and promoting dialogue among nations. Engaging with these organizations helps create a framework for collective security and peacekeeping.

4. Encourage Gender Equality

Promoting gender equality is essential for sustainable peace. Research indicates that when women participate in peace processes, the likelihood of lasting peace increases significantly. The New Internationalist emphasizes that true equality between men and women can help mitigate conflict and foster a more inclusive society

5. Invest in Education and Awareness

Education plays a crucial role in promoting peace by fostering understanding and tolerance among diverse groups. Initiatives that educate individuals about conflict resolution, cultural sensitivity, and the importance of empathy can help build a more peaceful society.

CONCLUSION

Geopolitical tensions have significant economic consequences, disrupting trade, investment, and economic growth. As the world becomes increasingly multipolar, the potential for conflict and instability has increased. However, leaders have made efforts to maintain stable international relations and promote economic cooperation, recognizing the importance of a stable global economy for the prosperity of their nations.

To mitigate the negative effects of geopolitical tensions, it is essential to promote international cooperation and conflict resolution. This includes strengthening international institutions, promoting dialogue and diplomacy, and addressing the underlying causes of tensions, such as resource scarcity and ideological differences. By working together to promote stability and cooperation, nations can create a more prosperous and secure global economy.

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Comprehensive review: North Korean Physical Attack according to South Korean presidents' political policy toward North Korea By Youhyun Kim, Jean Yu, Soomin Yi

Abstract

Despite the division between South and North Korea lasting over 75 years, the motives behind North Korea's numerous attacks on South Korea remain unclear. Thus, to delve into this matter, we have explored various Korean news platforms.

Interestingly, no distinct patterns have emerged concerning North Korea's provocations toward South Korea. Nonetheless, since Kim Jong-un took the leadership of North Korea, there has been a marked rise in missile attacks targeting South Korea.

For many years, South Korea has provided substantial support to North Korea, primarily through donations of rice, money, and even COVID medication during the pandemic. Despite these humanitarian efforts, North Korea has responded by advancing its missiles, rockets, and nuclear weapon development.

Keywords: South Korea, Korean war, North Korea, South Korean President, Political science

Introduction

Typically, when someone receives a benefit, there is an obligation to reciprocate. However, this principle does not hold true in the context of South-North Korean relations. Despite the efforts of numerous South Korean presidents to address border issues and promote unity, North Korea has persisted in launching physical attacks against South Korea due to a multitude of conflicting factors. The Korean Peninsula has been divided for nearly 75 years since the Korean War. (90) Although the exact reasons for the division remain unclear, several internal and external factors shape the relationship between the two countries. (92) Internally, North Korea's drive for power maintenance, succession, and control plays a significant role. (92) Externally, the factors include the disruption of communist influence and the geopolitical tensions involving the United States, Russia, and China. These elements have collectively influenced North Korea to continue its physical and psychological assaults on South Korea, irrespective of the South Korean president's policies towards the North. However, even with their importance, there has been no study examining the connection between South Korean presidents, their political policies toward North Korea, and North Korea's military attack during that period. By unraveling the complexities of the data on these three issues, we could foster optimistic expectations that might improve relations between the two countries.

Method

Our primary focus was on the connection between the presidents of North and South Korea's governments. Our search turned up a variety of information from official Korean news sources and websites, including "YONHAP NEWS," "OhmyNews," "KBS WORLD News," "Encyclopedia of Korean Culture," "National Museum of Korean Contemporary History," "Gangneung Grand Culture," "Kyunghyang News," "NAVER News," "Seoul News," "Hankookilbo," "Chosun Media," "MBS News," "NewsOne," "National Archives of Korea," "NIS (National Intelligence Service)," "unikorea (Ministry of Unification)," and "mois (Ministry of Public Administration and Security)." As official Korean public institutions, all of those websites offer data that has been certified. Also, we utilized nationally official websites such as "rfa (Radio Free Asia)," "Britannica," and some papers on the University level.

Results

Brief background information of the former presidents in South Korean History

Syngman Rhee was the first President of South Korea, serving from 1948 to 1960. As president, Rhee assumed dictatorial powers. He proposed the 'Unification by Northward Advance', which meant that he would use force to reclaim the territory lost to the communists. He was a founder and a member of the Liberal Party.(93,94)

Po-sun Yun was the second president of South Korea, serving from 1960 to 1962. His approach to North Korea was relatively moderate. He was a member of the Democratic Party.(95)

Chung Hee Park was a South Korean military general and politician who served as the third president of South Korea from 1963 until his assassination in 1979. Park is renowned for his pivotal role in South Korea's economic growth. He took a strong stance of anti-communist and responded to North Korea with firm action.(96,97)

Kyu-hah Choi was the fourth president of South Korea, serving from 1979 to 1980 after the assassination of Park Chung Hee. He was independent without party affiliation.(98)

Doo Hwan Chun, the fifth president of South Korea, was born into a low-class family and served in the military for several years. Chun rose to power rather quickly after his role in the Vietnamese war in 1970. He is responsible for the 12/12 incident in 1979. Later in 1996, Chun was sentenced to life in prison for various wrongdoings.(99,100)

Tae Woo Roh, the sixth president of South Korea, was a close friend of Chun. Because of Chun, Roh was almost guaranteed to win in the election, and this sparked controversy within the citizens. Roh is known for his efforts to eradicate gang-related violence. He was also closely involved in the 12/12 incident along with Chun, and was sentenced to 22 years and 6 months in prison.(101)

Young Sam Kim, the seventh president of South Korea and part of the Democratic Liberal Party, worked to abolish political corruption, and punished Roh and Chun for their crimes during their ruling. Kim also caused the IMF crisis that almost brought the country to bankruptcy.(102)

Dae Jung Kim, the eighth president of South Korea and part of the Democratic Party, is renowned for receiving the Nobel Peace Prize for his efforts to resolve conflicts between North Korea and South Korea. The meeting between Kim Dae Jung and Kim Jong Il was the first official encounter hosted to work towards unification between the two countries.(103)

Moo-hyun Roh, the sixteenth president of South Korea, pursued ‘Democracy with the nation’, ‘Balanced development society living together’, and ‘Northeast Asia era of peace and prosperity’. He remains an important figure in South Korea history for his efforts to advance democratic values and social progress.(104)

Myung-bak Lee, the seventeenth president of South Korea, adopted a policy that promotes harmony between inter-Korea cooperation and international cooperation. He pursued a practical and productive policy towards North Korea, aiming to enhance the well-being of both South and North Korean residents and to make a foundation for unification.(105)

Geun-hye Park is the eighteenth president of South Korea and the first female president. She proposed the “Korean Peninsula Trust Process”, which takes an integrated approach by embracing the strengths of past policies toward North Korea and focuses on building trust between North and South Korea.(105)

Jae-in Moon, the nineteenth president of South Korea, announced a plan for peace on the Korean Peninsula that included the complete dismantlement of North Korea’s nuclear weapons, the establishment of a peace regime on the Korean Peninsula, and the resolution of North Korea’s security and economic concerns.(106)

North Korean Provocations During Different Presidential Terms

President	North Korean provocation against South Korea	Date of occurrence
Syngman Rhee (First-third President)	Battle of the Western Front(1)	1948.12.02
	Battle of Songaksan near Kaesong(2)	1949.05.04
	Battle of Pocheon(3)	1949.06.12
	Battle of Ongjin-Eunpasan(4)	1949.05.21 - 11.15
	Yangyang Incursion Incident(5)	1949.07.04
	Battle of Hill 682 in Chuncheon(4)	1949.08.06 - 08.20
	Korean War(6)	1950.06.25 - 1953.07.27 (Armistice)
	Park Jung-ho Spy Incident(7)	1953.05 - 1957.10.18

	Jeong Guk-eun Spy Incident(8)	1953.08.31
	Pungse-myeon Armed Spy Incident(36)	1954.08.24
Po-sun Yun (Fourth President)	No major provocations	
Chung-hee Park (Fifth-ninth President)	Jinju Armed Infiltrators Incident(9)	1966.05.17
	Sinking of ROKS Dangpo by North Korean Forces(10)	1967.01.19
	Central Front Engagement(11)	1967.04.12
	Hwacheon DMZ Infiltration Incident(11)	1967.04.12
	Sinking of Spy Ship near Gyeokryeolbiyeoldo(35)	1967.04.17
	Western Front U.S. Barracks Bombing Incident(11)	1967.04.22
	Gangneung Godan District Armed Infiltrators Incident(12)	1967.05.21
	Yeonpyeongdo Fishing Boat Shelling Incident(11)	1967.05.27
	Gyeongwon Line Choseong-ri Station Bombing(13)	1967.09.05
	Gyeongui Line Unjeong Station Bombing(14)	1967.09.13
	January 21 Incident(15)	1968.01.12
	Uljin-Samcheok Armed Infiltrators Incident(16)	1968.11.02
	Jumunjin Armed Spy Incident(17)	1969.03.16
	EC-121 Shootdown Incident(18, 91)	1969.04.15
	Hijacking of Navy Broadcasting Vessel I-2(19)	1970.06.05
Bombing of Memorial Gate at the National Cemetery(20)	1970.06.22	
Sinking of Spy Ship near Soheuksando(21)	1971.06.01	

	March 7 Operation(22)	1973.03.07
	Suwon 32 Vessel Sinking Incident(23)	1974.02.15
	Chujado Armed Infiltrators Incident(24)	1974.05.20
	East Sea Spy Ship Sinking Incident(25)	1975.02.15
	Incursion of 30 North Korean Fighters over Baengnyeongdo(26)	1975.03.24
	Gochang Gushipo Spy Infiltration Incident(27)	1975.09.11
	Panmunjom(Joint Security Area) Axe Murder Incident(28)	1976.08.18
	Gwangcheon District Armed Spy Infiltration Incident(29)	1978.11.04
Kyu-hah Choi (Tenth President)	March 23 Operation(30)	1980.03.23
	Spy Ship Infiltration near Pohang(31)	1980.03.25
	Kimhwa District Armed Infiltrators Incident(32)	1980.03.27
	Sinking of Spy Ship near Gyeokryeolbiyeoldo(33)	1980.06.21
Doo-hwan Chun (Eleventh-twelfth President)	Wando-Gun Hoenggando Island Landings of North Korean Armed Communist Guerrillas(34)	1980.11.04
	Gyeong Nam South Sea Spy Ship Incident(35)	1980.12.01
	Pilseunggyo armed communist infiltration incident(32)	1981.06.29
	Jeojin Coast armed communist infiltration incident(32)	1982.05.15
	Imwol-do landings of North Korean armed communist guerrillas(32)	1983.06.19
	Weol-Seung coast landings of North Korean armed communist guerrillas(37)	1983.08.04

	Dok-do spy ship incident(38)	1983.08.13
	Rangoon bombing(20, 39)	1983.10.09
	Dadaepo landings of North Korean armed communist guerrillas(40)	1983.12.03
	Panmunjom(Joint Security Area) shooting incident(41)	1984.11.23
	Cheong-sa-po spy ship incident(42)	1985.10.20
	Gimpo International Airport bombing(43)	1986.09.14
	Korean air flight 858 explosion(45)	1987.11.29
Tae-woo Roh (Thirteenth President)	Western Front Landings of North Korean armed communist guerrillas(46)	1992.02.10
	Panmunjom(Joint Security Area) landings of North Korean armed communist guerrillas(46)	1992.04.14
	Eunha Valley landings of North Korean armed communist guerrillas(47)	1992.05.22
	Workers Party of Korea incident(48)	1992.10.06
Young-sam Kim (Fourteenth President)	An Jae Gu spy incident(49)	1994.06.14
	Imjin River landings of North Korean armed communist guerrillas(50)	1995.10.17
	Buyeo-gun landings of North Korean armed communist guerrillas(51)	1995.10.24
	1996 Gangneung submarine infiltration incident(52)	1996.09.18
	Lee Han Yeong assassination(54)	1997.02.15
	Cheorwon-gun encounter(53)	1997.07.16
	eong Nam Choi/Yeon Jeong Kang couple spy incident(55)	1997.08.02

Dae-jung Kim (Fifteenth President)	Sokcho submarine armed guerrilla infiltration incident(56)	1998.06.22
	Dong Hae North Korean armed guerrilla body discovery incident(57)	1998.07.12
	Gang-Hwa do spy ship(58)	1998.11.19
	1998 Yeosu submersible incident(40)	1998.12.17
	First Battle of Yeonpyeong(59)	1999.06.15
	Crossing NLL of a patrol boat(60)	1999.10.30
	Paju North Korean military shooting(61)	2001.11. 27
	Second Battle of Yeonpyeong(59)	2002.06. 29
	Invasion NLL of MIG-19(62)	2003.02.20
Moo-hyun Roh (Sixteenth President)	Crossing NLL of a patrol boat(60)	2003.05.03
	Eight North Korean fishing boats, nine 40mm cannons and 25 M-60 machine guns fired warning artillery and warning shots(60)	2003.06.01
	Crossing NLL of two patrol boats(60)	2003.06.04
	Firing of four 14.5mm machine gun rounds at the DMZ(63)	2003.07. 17
	Crossing NLL of two patrol boats(60)	2004.06.04
	Crossing NLL of a patrol boat(60)	2004.07.14
	Crossing NLL of a patrol boat(60)	2004.08.14
	Crossing NLL of a patrol boat(60)	2004.09.23
	Crossing NLL of a patrol boat(60)	2004.10.12
	Yeoncheon-gun GOP barbed wire fence cut in two locations(64)	2004.10.26

	Crossing NLL of three patrol boats and fire warning shots from the Navy(60)	2004.11.01
	Crossing NLL of a patrol boat(60)	2004.12.07
	Crossing NLL of two patrol boats(60)	2005.05.13
	Crossing the line of a patrol boat(60)	2005.08.21
	Crossing NLL of patrol boat(60)	2005.10.14
	Crossing NLL of a patrol boat and nine fishing boats(60)	2005.11.13
	Launch of a Daepo-dong No. 2(65)	2006.07.05
Myung-bak Lee (Seventeenth President)	Crossing NLL of a patrol boat(60)	2008.05.17
	Geumgansan tourist murder case(66)	2008.07.11
	Crossing NLL of a patrol boat(60)	2009.09.04
	Battle of Daecheong occurs(67)	2009.11.10
	Cheonan attack incident(68)	2010.03.26
	Yeonpyeong Island bombardment(69)	2010.11.23
Geun-hye Park (Eighteenth President)	Launches of two KN-series missiles(44)	2013.03.15
	Launches of six 300mm rockets(44)	2013.05.18
	Launch of a 300mm rocket(44)	2013.05.19
	Launches of two KN-series missiles(44)	2013.05.20
	Launches of four 300mm rockets(44)	2013.06.26
	Launches of four 300mm rockets(44)	2014.02.21
	Launches of two Scud-series missiles(44)	2014.02.27
	Launches of two Scud-series missiles(44)	2014.03.03

	Launches of four 300mm rockets and three 240mm rockets(44)	2014.03.04
	Launches of twenty-five Frog rockets(44)	2014.03.16
	Launches of twenty-eight Frog rockets(44)	2014.03.22
	Launches of sixteen Frog rockets(44)	2014.03.23
	Launches of two Nodong-series medium-range missiles(44)	2014.03.26
	Coastal artillery warning shots at ROK Navy corvette Hong Si-wook(70)	2014.05.22
	Launches of three 300mm rockets(44)	2014.06.26
	Launches of two Scud-series missiles(44)	2014.06.29
	Launches of two 300mm rockets(44)	2014.07.02
	Launches of two Scud-series missiles, presumed to be Hwasong-6 (SCUD-C)(44)	2014.07.09
	Launches of two Scud-series missiles, presumed to be Hwasong-6 (SCUD-C) or SCUD-ER(44)	2014.07.13
	Launches of around 100 coastal artillery shells and 240mm and 122mm rockets(44)	2014.07.14
	Launch of a Scud-series missile(44)	2014.07.26
	Launches of four 300mm rockets(44)	2014.07.30
	Launches of five 300mm rockets(44)	2014.08.14
	Launch of a new short-range missile(44)	2014.09.01
	Launches of three new short-range missiles(44)	2014.09.06
	Bombardment of Yeoncheon area in response to anti-North Korea leaflets(70)	2014.10.10

	Firefight near the DMZ(71)	2014.10.19
	Launches of five new short-range missiles(44)	2015.02.08
	Launches of two Scud-series missiles(44)	2015.03.02
	Launches of seven SA-series surface-to-air missiles(44)	2015.03.12
	Launch of a KN-series missile(44)	2015.04.02
	Launches of four KN-series missiles(44)	2015.04.03
	Launches of two KN-series missiles(44)	2015.04.07
	Launches of three KN-series missiles(44)	2015.05.09
	Launches of three KN-series missiles(44)	2015.06.14
	DMZ landmine incident(70)	2015.08.04
	Artillery exchange along the Western Front(72)	2015.08.20
	North Korean patrol boat intrusion across the NLL(73)	2016.02.08
	Launch of a coastal artillery(74)	2016.02.20
	Launches of six KN-09 (300mm rockets)(44)	2016.03.03
	Launches of two Hwasong-6 (SCUD-C) missiles(44)	2016.03.10
	Launches of two Hwasong-7 (Nodong) medium-range missiles(44)	2016.03.18
	Launches of five KN-09 (300mm rockets)(44)	2016.03.21
	Launch of a suspected 300mm rocket(44)	2016.03.29
	Launches of three BUKKEUK-5 (new surface-to-air missiles)(44)	2016.04.01

	Launch of a Hwasong-10 (Musudan) medium-range missile(44)	2016.04.15
	Test launch of a submarine-launched ballistic missile (SLBM)(44)	2016.04.23
	Second and third launches of two Hwaseong-12 medium-range ballistic missiles(44)	2016.04.28
	Fourth launch of a Hwaseong-12 medium-range ballistic missile(44)	2016.05.31
	Fifth launches of two Hwaseong-12 medium-range ballistic missiles(44)	2016.06.22
	Test launch of a submarine-launched ballistic missile (SLBM)(44)	2016.07.09
	Launches of two Nodong missiles and one Scud missile(44)	2016.07.19
	Launches of Two Nodong missiles(44)	2016.08.03
	Test launch of a submarine-launched ballistic missile (SLBM)(44)	2016.08.24
	Launches of three SCUD-ER ballistic missiles(44)	2016.09.05
	Launch of a Hwasong-10 (Musudan) missile(75)	2016.10.20
	Launch of a Pukguksong-2 medium-range missile(76)	2017.02.12
	Launches of four SCUD-ER ballistic missiles(44)	2017.03.06
Jae-in Moon (Nineteenth President)	Launch of a new intermediate-range ballistic missile (IRBM)(78)	2017.05.14
	Launch of a medium-range ballistic missile KN-15(78)	2017.05.21
	Launch of a new anti-aircraft missile(78)	2017.05.27
	Launch of a short-range Scud missile(78)	2017.05.29

Launch of multiple missiles, presumed to be 'short-range anti-ship cruise missiles'(78)	2017.06.08
Launch of an ICBM(78)	2017.07.04
Launch of an IRBM-class or higher missile(77)	2017.07.28
Launches of three KN-3 short-range ballistic missile(78)	2017.08.26
Launch of a IRBM 'Hwaseong-12'(78)	2017.08.29
Launch of a IRBM 'Hwaseong-12'(78)	2017.09.15
Launch of a ICBM 'Hwaseong-15'(78)	2017.11.29
Launch of multiple rockets and short-range missiles(78)	2019.05.04
Launches of two short-range missiles(78)	2019.05.09
Launches of two short-range missiles(78)	2019.07.25
Launch of a short-range ballistic missile(78)	2019.07.31
Launches of two unidentified projectiles(78)	2019.08.02
Launches of two projectiles(78)	2019.08.06
Launches of two projectiles presumed to be short-range missiles(78)	2019.08.10
Launches of two projectiles presumed to be short-range missiles(78)	2019.08.16
Launches of two projectiles(78)	2019.08.24
Launches of two KN-25(78)	2019.09.10
Launches of a new submarine ballistic missile (SLBM), Pukguksong-3(78)	2019.10.02
Firing of coastal artillery (Confirmed by the Ministry of National Defense as a violation of the September 19 military agreement)(78)	2019.11.23

Launches of two unidentified projectiles(78)	2020.03.02
Launches of three unidentified projectiles(78)	2020.03.09
Launches of two unidentified projectiles(78)	2020.03.21
Launch of a 'Geumseong-3' (KN-19) and an air-to-ground missile(78)	2020.04.14
GP shooting incident(78)	2020.05.03
Demolition of the Inter-Korean Liaison Office(78)	2020.06.16
Launch of a 'Geumseong-3' (KN-19)(78)	2020.07.05
Civil servant murder case(78)	2020.09.22
Launches of two short-range cruise missiles(78)	2021.01.22
Launches of a short-range cruise missile(78)	2021.03.21
Launches of two new tactical guided missiles (improved short-range ballistic missile KN-23)(78)	2021.03.25
Launch of a new long-range cruise missile(78)	2021.09.11 - 12
Launches of two ballistic missiles (railway mobile missile KN-23)(78)	2021.09.15
Launch of a hypersonic missile 'Hwaseong-8'(78)	2021.09.28
Launch of a new submarine-launched ballistic missile (SLBM)(78)	2021.10.19
Launch of one hypersonic missile type 2(78)	2022.01.05
Launch of one hypersonic missile type 2(78)	2022.01.11
Launches of two short-range ballistic missiles(79)	2022.01.14
Launches of two short-range ballistic missiles(80)	2022.01.17
Launches of two missiles(81)	2022.01.25
Launches of two short-range ballistic missiles(82)	2022.01.27

	Launches of two unidentified projectiles(83)	2022.01.30
	Launches of an unidentified projectiles(84)	2022.02.27
	Launches of an unidentified projectiles(85)	2022.03.05
	Crossing NLL of a patrol boat(86)	2022.03.09
	Launches of four unidentified projectiles(87)	2022.03.20
	Launch of an ICBM-class ballistic missile(88)	2022.03.24
	Launch of a suspected SLBM-class ballistic missile(89)	2022.05.07

Discussion

Some reasons for this series of attacks could be due to the collapse of communism that occurred between the late 1980s and early 1990s. Many notable assaults such as the Gimpo Airport bombing incident happened during this timeframe, and it is possible to infer from this that North Korea strived to maintain its status. Furthermore, these provocations can be seen as a prevention method to keep the citizens from defecting from the country. Such attacks foster a sense of stability within the country because they help to develop a mindset that North Korea is still powerful, especially with the South Korean media that North Korean residents are being exposed to, physical attacks seem to be more effective than previous censorship methods such as propaganda.

A surprise torpedo strike by a North Korean submarine caused the Navy's 2nd Fleet's Cheonan (PCC-772) to sink on March 26, 2010, at approximately 21:22, while the ship was on guard duty 2.5 km southwest of Baengnyeong Island. The attack claimed the lives of 104 crew members. Forty-six individuals perished in a "serious national security incident," while 58 others were saved. (68) Diplomatically, this sinking was controversial. Although the administration declared that North Korea had nothing to do with the disaster, analysts and navies came to the conclusion that a North Korean torpedo was to blame. (107) The question of whether or not this was a North Korean attack is still open, but what is known at this time is that the North Korean torpedo caused the Cheonan to partially sink.

Comparing North Korea's economic status to its well-known national defense status is quite poor. North Koreans began to flee North Korea more frequently under these circumstances. The internet's growth has allowed North Koreans to learn about South Korea's position, which is far more developed than North Korea's. In addition, South Korean dramas and films were popularized in South Korea as well as other countries following the development of the internet. Furthermore, these issues with culture and living conditions are among the causes of North Koreans' recent exodus to South Korea. South Koreans have sent rice and USB drives with South Korean dramas and films to North Korea in large plastic water bottles. (108) This is especially

common among the relatives of those who have been living in North Korea. Good things couldn't return with good things. The Korean government has formally dispatched food and other material supplies to North Korea. (109, 110, 111) North Korea has responded with missile attacks to South Korea, which has continued to provide North Korea with useful and nonviolent support.(78)

Finally, we acknowledge that there are limitations in our study as we are still in the highschool level, and our hypothesis should be more improved and elaborated on. However, we believe that if individuals with a profound understanding in areas such as political science and world history discover this paper and incorporate it into future studies, the purpose for all these attacks may be deciphered and it will be possible to anticipate an optimistic outcome between the two countries.

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