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Do We Have Any Good Reasons to Trust Our Moral Intuition? By João Pedro Landucci Geromel

Introduction

Morality is a broad concept that, depending on who defines it, can take two opposite directions. The most conventional, based on Kantian thought, considers it as an absolute value, something a priori that defines our courses of behavior—a rigid and immutable guiding structure. The other is better defined by the phrase of Protagoras, a sophist who stated that "Man is the measure of all things"; this idea makes explicit the non-necessity of establishing rigid structures for the concept.

Under these perspectives, the more deterministic one is hardly dissociated from religious logic, as it is easier to assume supreme values supported by theological arguments and faith. The second, which is precisely the ideal applied throughout the text, refers mainly to Nietzsche's thought, understanding the moral precept as a created concept, a value judgment.

The concept of intuition, on the other hand, presupposes something instinctive, without conscious and rational thought. However, when analyzing Hegel's historical precept, we will realize that morality cannot be understood as inherent or intuitive. Thus, the objective of the text is to demystify the idealized view of moral intuition, opposing it.

Morality as Illusion

Based on positions related to Kant's abstract formalism, the idea of morality is directed towards an absolute concept, a universal law, which encompasses ethical reality subjugated to the concept of the categorical imperative. This, in turn, assumes the individual's capacity to understand basic precepts on issues related to morality, such as the idea that killing is wrong in any context.

However, such thinking errs primarily when it disregards the sensitive influence as a fundamental structure of individual moral foundation. This mistake can be clearly perceived when an anthropological and less Eurocentric view is applied to moral formation. An example of this can be found in the poem I-Juca-Pirama, from the Indianist phase of Brazilian Romanticism. In the text, the poet Gonçalves Dias portrays the story of a promising warrior and heir to the leadership of his Tupiniquim tribe, whose future is interrupted by the misfortune of being captured by the leaders of a rival tribe (Tupinambá). Unlike his community, this group practices anthropophagy for ritualistic purposes, so ingesting specific parts of warriors' bodies, for instance, can aim to develop such abilities in the consumer. Thus, in the context of the poem, I-Juca-Pirama begs to be released because his father, the tribe's chief, is completely ill and needs his help. After ardent pleading, the indigenous people who captured him lose all interest in using him as a ritual, as a warrior so weak would not be worthy of such an honor. Upon returning to his tribe and recounting what happened, the former promising warrior is renounced, as he was not courageous enough to accept the enemy's honor. Consequently, from an indigenous perspective, killing can be positive and honorable and not morally wrong as Kant asserts.

From this perspective, Kant regresses on issues previously overcomed in Classical Antiquity, considering that Aristotle, even without being a relativist, already reconsidered the concept of absolute truth by stating that it could be accepted or rejected by the individual. Based on this, Hegel understands the fundamental error of abstract formalism by asserting that things only make sense when placed in history, as, for him, humans tend towards Entfremdung (alienation); hence, there is an intrinsic force of externalization in humans, such that they alienate themselves when they come into contact with third-party ideals, becoming strangers even to themselves. Therefore, it is understood that there is no absolute morality and that it is a concept alterable by historical-cultural issues, as individual works blend with the subject's externalization.

For Nietzsche, morality is vis inertiae (inertial force), a precept for the passive to maintain their "herd morality," their individual weakness. Consequently, most Western thought bases, grounded in concepts of "love thy neighbor" and "goodness," reflect a fearful baseness that starts from the precept of subjecting oneself to what one hates: obedience. Thus, all these values that belittle human existence are placed as virtues; "love your enemies" (Matthew 5:44) is what subjects man to doing what he was not destined for.

Hence, Western societies have constituted themselves in a way to subjugate instincts for a supposed peace, which, according to Nietzsche, is deceptive. Concepts such as morality have been confused in everyday use with goodness and, fundamentally, with humility. In this sense, the man who once equated "good" with "noble" found himself in a position where this equation was subverted. Therefore, the hope of having his "soul" saved made such individuals self-delude, understanding their passivity as freedom.

Rome, as an empire, saw itself defeated by Jewish moralism, which still today represents the majority thought through the Christian logic, in the figure of Jesus of Nazareth. However, this society deserves attention because, at its peak, in the context of gladiator fights, military training, and expansionism, it cultivated man's greatness and symbolized in the bird of prey an instinct for the pursuit of greatness in man that excessive moralism later annihilated.

With the dominance of the Apollonian spirit of moral acceptance, resentment is generated in man who, when faced with any adversity, is inhibited from reacting by his values that supposedly liberated him. Therefore, this structure based on the logic of love is actually the origin of hatred. Over time, this negative feeling transforms into a binary view of reality because, being unable to react when challenged, his only alternative becomes demonizing those who do not share his inertia. Thus, morality transforms into a dichotomy where the supposed "moral" is "good" and the divergent "evil."

According to Foucault, morality leads individuals to subjection and, in contemporary logic, presents itself in disciplinary institutions of surveillance, such as schools, prisons, hospitals, and factories, which ensure the perpetuation of social normalization. In this way, there is the maintenance of subject suppression through supposed "absolute truths" that alienate and transform an ostensibly harmless value into a mechanism of power.

Thus, the moralizing element can be associated with the allegory of 1984 by George Orwell. In the book, the "Big Brother," the supreme leader, aims to lead the citizens of Oceania to obedience. In this sense, the "Ministry of Truth," responsible for everything written, delimits "thought crimes," creating a state that suppresses any form of opposition in terms of ideas. In this sense, morality is configured, like the government of "Big Brother," as an instrument of individual alienation. Therefore, morality as an absolute value refers to a thought that promotes the curtailment of free thought and constitutes naive idolatry.

Conclusion

Since morality is a concept grounded in history, it is understood that it is not innate. Thus, it is logical to think of some kind of intuition when it comes to morality, as such behavior apparently objectively reflects mass behavior, in which third-party coercion seems to prevail. Ergo, the instincts, stemming from our evolutionary process, are continually inhibited.

Therefore, a thought converging with amorality is understood as more intuitive, considering that the most instinctive or intuitive behaviors connect directly with the predatory nature of Homo sapiens. From this perspective, it is understood that the concept of intuition does not fit behavior seen as moral, as it is based on the suppression and curtailment of this human nature.

Hence, it is impossible to trust in one's moral intuition, as doing so is accepting one's belittlement by third parties. It is embracing self-predatory and resentful behavior or, as Foucault would say, being "docilized" by submission to the moral precept. This, in turn, is only seen as functional through utopian delusions and, in practical terms, is configured as an illusion. Therefore, there is no good reason to trust our moral intuition.

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Preserving Culture in Song: Musical Storytelling in Asia Throughout History and Looking to the Future By Kyle Zhang

The ancient practice of storytelling connects generations and shapes cultures. Stories can be recorded and transcribed as in written storytelling, spoken as in oral storytelling, or sung and chanted as in musical storytelling. Musical storytelling surpasses oral and written storytelling by fostering a deeper emotional connection, not only engaging audiences through its dynamic performances but also significantly impacting cognitive processes and societal structures. Through its intrinsic ability to evoke and maintain cultural identity and adaptability, musical storytelling offers a unique and profound method for documenting history, transmitting cultural values, and connecting communities across generations, and it is crucial this art form is preserved.

In Asia especially, musical storytelling has been synonymous with cultural expression and historical documentation. "Echoes of Heritage" by Peyton Cherry explores some of these concepts. In Japan, the tradition of bunraku has been practiced since the Edo period, from 1608 to 1868. The practice involves puppets manipulated by skilled puppeteers in full view of the audience to tell a dramatic story. The puppets dance and move like living, breathing people. These performances are usually accompanied by narrative singing or strumming of the traditional shamisen. This three stringed instrument, built akin to a guitar or sitar, invokes a sharp, yet melancholic tone, similar to a banjo. The performances served to not only evoke strong emotions in the audience but to make them reflect on the motifs and profound themes shown in the narratives, such as conflict between social obligations and human feelings or finding beauty in the mundane– both still topical matters in the world today (Cherry 44-46).

The bunraku performance Meiji Tenno, performed in the late 20th century, touches on historical themes of war and morality. Set during the Russo-Japanese war, the play details a simplistic plot about the war and how the emperor and his subjects navigated a complicated political situation, desperately trying to both survive and keep their emotional integrity. Narrative, poetic singing enhances the experience and conveys crucial plot elements. (Jones 115-117). Before this performance, it was unheard of to cast a well known historical sovereign such as the Meiji emperor as a main character in a play. This groundbreaking concept crossed the boundary between fantasy and reality. It not only drew in a larger audience, but also allowed the ideas of the play to resonate on a much deeper level than a simple spoken or written story by relating the message to real world events and utilizing narrative singing.

In Mongolia, musical storytelling is explored through many traditions, for example, the tradition of tuuli. Tuuli refers to epic poetry accompanied by musical instruments like the tovshuur, a traditional stringed instrument reminiscent of a ukulele, and the choor, a wind instrument similar to an ocarina or flute. The practice spans centuries. Similar to bunraku, tuuli involves narrative singing and rhythmic speaking to convey a plot. Unlike bunraku, tuuli is told without the use of outside props such as puppets. These epic tales, describing the belief, tradition, and language of the Mongolians through poetry are passed down through generations,

preserving the cultural identity behind them (Cherry 4-7). Because music requires one to perform for others, it is inherently more social than written storytelling. This allows for a greater sense of community and a stronger bond to be built amongst societies. Austrian Mongolist, Walther Heissig, states in his paper "The Present State of the Mongolian Epic and Some Topics for Future Research" that due to the oral nature of these stories, "every performance of the same epic by the same singer has to be regarded as a new creation, because no singer will ever repeat his epic verbatim" (qtd. in Cherry 6). Due to the ever-changing and fluid qualities of the Mongolian tuuli, as these stories are passed down, new perspectives expressed through performance are added to the catalog of cultural preservation. While written stories are rigid and depict a snapshot view of one perspective at one point in history, oral stories such as musical performances are constantly evolving and adapt over time to incorporate many storytellers and changes to the narrative. This altering nature of musical stories renders written adaptations of musical and oral storytelling to be inherently flawed. Not only is the element of rhythm and the action of performance itself lost, but the many viewpoints and nuanced variations in each recital are condensed into a single narrative that is set firm and can no longer be changed. When Russian and Chinese scholars tried to translate Mongolian epics such as the performances of Jangaar and The Tale of King Geser, the translations were at best incomplete (Cherry 5-6). It was impossible to capture the shifting motifs and ideas of each and every performance, resulting in the full meaning of both epics being misrepresented.

Nepal's Gandharva musicians also practiced musical storytelling. As a group of traveling musicians deeply rooted in Nepal's history and culture, they traveled across the country, exchanging stories and music for food. These exchanges symbolize the intrinsic value held by these musical stories and exemplify the wisdom and thematic merit that the intersection between music and stories can hold. Nepali communities relied on Gandharvas to bring them news and tales across borders rather than adopting the nomadic lifestyle (Cherry 18-19). The practice of traveling musicians singing the stories of Nepal allowed communities and cultures across borders to interact and not only stay informed, but also find a sense of comradery in shared music. Beyond creating a stronger community, this made information far more accessible for illiterate people living in the countryside. Performances can be understood by anybody, while written works render themselves inaccessible to people who can't read them.

Furthermore, music has an observable impact not only from a societal and tangible perspective but also quantifiable effects on the human brain itself. Mark Reybrouck, emeritus professor of Ku Leuven University's department of Musicology, states in his paper "Neural Correlates of Music Listening: Does the Music Matter?" that there are two pathways from which sound enters the brain: the classical pathway, which carries sound directly from the inner ear directly to the auditory cortex, and a pathway that connects to the reticular activating system, which is linked to parts of the brain involved in emotional and automatic responses (Reybrouck et al 4). In his research, Reybrouck found that music travels through the latter pathway- listening to music is not a straightforward process, but rather a mix of emotional and physical responses that contribute to what Reybrouck calls an "aesthetic experience." By utilizing Music

Information Retrieval (MIR) and Functional Magnetic Response Imagery (fMRI), both methods used in tandem to observe the brain and its response to music, Reybrouck found that music connects networks in the brain involved with interpreting sound, motion imagery, and emotion (Reybrouck et al 4). Instead of simply responding predictably as one would to common audio stimuli, music develops the brain and creates new neural connections. The implications of this effect combined with the telling of cultural stories is immeasurable– while oral storytelling allows themes and ideas to be heard and interpreted by listeners, musical storytelling creates new connections in the brain on a neurological level, allowing for a far deeper understanding of the subject matter. A concept explored by oral storytelling simply does not have the same psychological effect as musical storytelling. This is the power of musical storytelling–by touching the emotions of the audience through something as ancient and engraved in human nature as music, the audience not only understands, but feels the meaning behind the story and the themes conveyed, creating a greater impact on the listener.

Today, musical stories of the past are at risk of being forgotten. Urza Acharya, writer at the Kathmandu Post, explains the state of Nepali cultural music today in her article "Folk Music is the Soul of Nepal's Agrarian History." In the hills of Nepal, Kamali Kanta Bhetuwal is fighting to protect his culture. He recreates melodies from older generations and composes his own original songs in a traditional style. In doing so, he has woven the essence of Nepal's agrarian spirit into his melodies, shown through his song "Jhamke Guleli." This song, with its roots in the Purbeli bhaka tradition (which refers to the musical tunes or styles originating from Eastern Nepal), is an original piece which captures the soulful and sometimes solemn aspects of life in Nepal (Acharya). Through its mellow tones and reflective lyrics, "Jhamke Guleli" encapsulates the intimate relationship between nature, love, and the divine, echoing the lived experiences of those connected to the land. Bhetuwal's journey from a young boy, moved by his grandfather's field songs, to a preserver of these melodies, underscores a profound commitment to safeguarding this cultural heritage for posterity. His recordings, starting with "Jhamke Guleli" in 2009 and extending to other folk classics, have celebrated the depth and diversity of Nepali folk music, ensuring its resonance across generations. Despite this, the fight to safeguard culture is still an uphill battle against commercialization and the fast pace at which society progresses. Music Nepal, a large organization dedicated to distributing Nepali music on various platforms, has been accused of depriving artists of their royalties. Bhetuwal claims he has not received any since the early years of the song's release. The same organization also approached Bhetuwal to re-record the song in order to make it more appealing to a modern audience by changing some of the older words or phrases that were deemed vulgar, to which he declined, wanting to maintain the authenticity of the piece (Acharya).

This modernization is not specific to Nepali music. As described in "Preserving Musical Cultures- Contemplations and Confessions" by musicologist Bruno Nettl, Persian music, specifically melodies derived from the radif (a collection of ancient songs passed down many generations), began to evolve stylistically to incorporate many different cultures of music such as Western or Arabic music around the 1930's. Some were opposed to this– for example, Dr.

Boroumand, a professor studying the radif at the time. After working with the few remaining masters of the radif, he memorized all ten hours of the melodies in the collection and began to believe that it was one of the world's greatest artistic achievements. Insisting on its uniqueness, he adopted a very conservative viewpoint, resistant to all forms of change to the art. In the 1960s, Iranian educators approached Dr. Boroumand and asked him to teach the radif. At first, he was reluctant, arguing that students would want to learn the melodies quickly when they were meant to be learned slowly, or that they would write them down instead of improvising, violating the principles of the tradition. However, after some thought, he taught his class at the University of Tehran. Today, in Iran, the custom has lived on and is being practiced vigorously. Dr. Boroumand single-handedly revived the tradition, allowing the radif to continue to be practiced and built upon (Nettl). Younger generations can listen to the songs and watch them continue to evolve, allowing them to stay in touch with their culture.

In the broader context of storytelling, the fusion of oral tradition and digital technology can help greatly in preserving the art. In the book "Time, Oral Tradition, and Technology," authors Andrew Martindale, Sara Shneiderman, and Mark Turin explore the significant role that the merging of oral tradition with digital technology plays in preserving cultural narratives. This blend of ancient oral stories with modern digital platforms is particularly evident in the preservation of Asia's musical heritage, highlighting the crucial role of memory in maintaining and shaping cultural identities. Digital media not only ensures the survival of these traditions in today's world but also showcases the adaptability and resilience of cultural memory. For example, traditional melodies and stories, like those performed by Jhamke Guleli on Music Nepal, are rejuvenated, fostering community and identity and bridging historical divides. These platforms' accessibility broadens the audience, sparking new ideas on a global scale and allowing younger generations to engage with their cultural heritage. This interaction ensures the continuity of profound wisdom and themes, such as those found in bunraku about love or the heroic tales in tuuli, resonating deeply with those connected to the culture. This evolution underscores the timeless importance of oral storytelling in Asia. While opinions on the themes of these musical stories may vary, they offer diverse global perspectives and historical insights, helping listeners worldwide to either resonate with or gain a better understanding of different viewpoints. These narratives connect generations and safeguard the rich cultural legacy of their regions. In the words of Rijan Maharjan, a member of the cultural music organization attempting to teach locals about indigenous instruments called the Manka Band, "The death of music is the death of culture."

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Genetic Pathways: Melanogenesis and its Link to Melanoma by Rounak Bodas

Abstract

As the largest organ in the human body, the system of the skin is known to encounter various forms of skin cancers, including melanoma. Although it only accounts for 1% of skin cancer cases, its proclivity to metastasize accounts for more than 90% of skin cancer-related deaths. In 2023 it was estimated by the American Cancer Society that about 97,600 cases of melanoma would be diagnosed and about 8,000 would die of the cancer by the end of the year. Melanoma starts in the pigment-producing melanocytes (located in the epidermis), and develops when these cells grow out of control. In melanoma, aberrant extrinsic and intrinsic cell signaling pathways contribute to an upregulation of melanogenesis. The significance of melanogenesis in melanoma cells is unclear as melanin is known to protect the skin from harmful rays yet increased melanin is associated with tumor progression. Although eumelanin is known to protect melanocytes from UV rays, in melanoma cells, I suspect eumelanin and pheomelanin synthesis contributes to melanoma progression by contributing to proliferation. The result of this study aims to clarify whether melanogenesis is helpful or harmful to melanoma patients, contributing to the understanding of risk factors and possible treatment modalities.

Keywords: melanoma, melanin, melanogenesis, eumelanin, pheomelanin, melanocyte

Melanogenesis and Tumorigenesis

Melanogenesis refers to the process by which melanin pigments are produced. Melanin synthesis begins in the melanosome, a lysosome-like organelle, located in melanocyte cells. Along with numerous other subcellular organs, melanin is synthesized through four maturation stages, and various enzymes are acquired such as tyrosinase. Once fully synthesized, melanosomes are transported towards melanocyte dendrites where they interact with keratinocytes to transfer matured melanosomes. Mutations in these genes and those responsible for constructing essential proteins cause irregularities in melanogenesis, and can often lead to tumorigenesis (the formation of tumors). Although the biology of the skin has been extensively studied, the nature of melanin synthesis in the context of cell proliferation of melanoma is still uncertain. The following study aims to clarify the role of melanogenesis by exploring transcriptomic data from melanoma patients and cell lines.

Gene Roles in Standard Melanogenesis

To further explore melanogenesis and melanoma, I first needed to identify a set of diverse genes of interest. Since the process of melanogenesis and tumorigenesis required an interplay of hundreds and thousands of genes, I identified three key types of proteins needed as melanosome transporters, transcription factors, and biosynthesis enzymes to diversify the study. The genes selected were TYR, TYRP1, MITF, SLC24A5, and MFSD12 as well as the oncogene BRAF (Table 1). Acquisition of TYR during melanogenesis acts as a rate - limiting factor. TYR

catalyzes the oxidation of its substrate L - DOPA into eumelanin and pheomelanin, through various processes (Ohbayashi & Fukuda, 2020). MITF has been known to upregulate expression of important pigmentation enzymes such as TYR and cell cycle progression such as CDK2 (Ostrowski & Fisher, 2020). SLC24A5 and MFSD12 both manage the homeostasis of melanosomes by transporting protons and amino acids respectively. TYRP1 and BRAF are associated with various melanogenic disorders and melanoma. However, both are also essential to melanogenesis if expression is regulated properly.

Name	Abbreviation	Role in Melanogenesis
Tyrosinase	TYR	Raper-Mason Enzyme. Rate limiting factor. Determines mammalian skin color.
Tyrosinase Related Protein 1	TYRP1	Raper-Mason Enzyme. Marker of melanocyte differentiation. Promotes pigment formation.
Microphthalmia - Associated Transcription Factor	MITF	Transcriptional activator. Regulates expression of pigmentation genes. Promotes melanocyte differentiation.
Solute Carrier Family 24 Member 5	SLC24A5	Membrane transporter. Maintains ionic homeostasis. Lightens basal skin pigmentation. Manages pH in melanocyte cells.
Major Facilitator Superfamily Domain Containing 12	MFSD12	Membrane transporter. Maintains normal levels of cysteine and oxidized dimers in melanosomes. Produces cysteinyl dopa.
V - Raf Murine Sarcoma Viral Oncogene Homolog B1	BRAF	Oncogene and kinase. Mutations lead to malignant melanogenesis and melanoma. Requires additional genetic alterations to induce melanoma progression alone.

Table 1: List and abbreviations of genes included in this study

I was also mindful of the two distinct pathways of melanin synthesis: eumelanin and pheomelanin. TYRP1 is significant and indispensable in eumelanin but not pheomelanin synthesis and MFSD12 provides building blocks to form only pheomelanin (Ohbayashi & Fukuda, 2020). Proteins in the MEK pathway, such as BRAF, are known for their clinically significant roles in melanogenesis and melanomagenesis. These proteins, however, are not tissue-specific and are meant to add diversity and a known melanoma oncogene to the list.

To first determine and analyze the roles of these genes, I evaluated the gene expression information of publicly available multi-omic databases including ProteinAtlas. I wished to determine whether the genes were differentially expressed throughout the physiological tissues of the body. The initial analysis focused on the tissue and organ specificity of each of the genes. The results demonstrated the genes chosen were highly localized to the skin (Figure 1). The tissue specificity was high as seen by the prominent salmon bar, providing further evidence that the selected genes are specific to their skin-related functions. Subcellular localization of these proteins was either specified to vesicles or soluble in the cytoplasm, consistent with their studied role in melanosomes (Figure 2). The results from ProteinAtlas showing high localization indicates the evaluation is of relevant and melanogenesis-specific proteins.
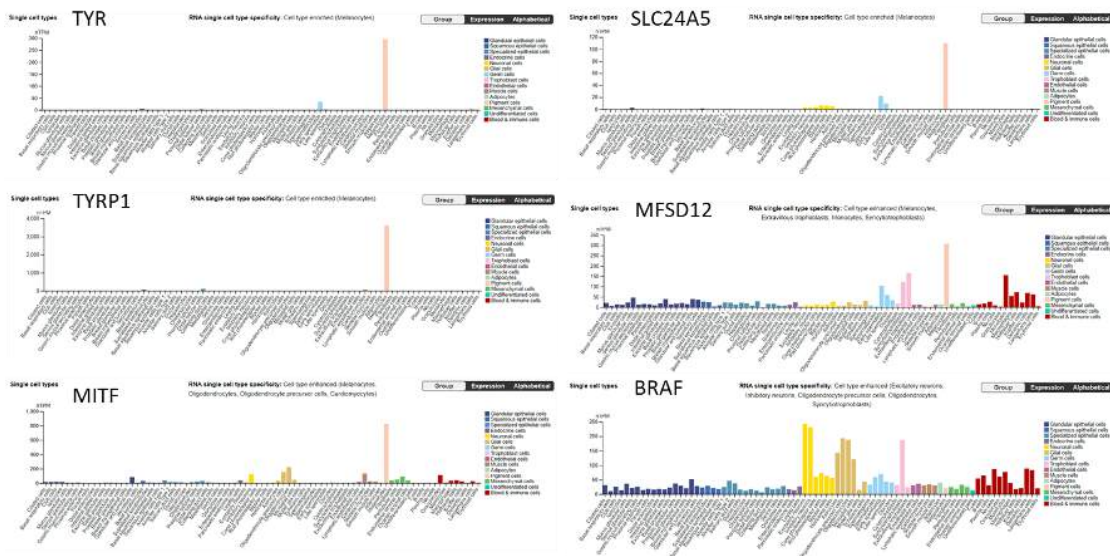
Figure 1: A collection of consensus data of gene expression levels throughout the body from ProteinAtlas. Each bar represents a type of tissue and is color-coded by organ. In these graphs, the outlying salmon-colored bar represents the skin. Data is based on RNAi expression studies.
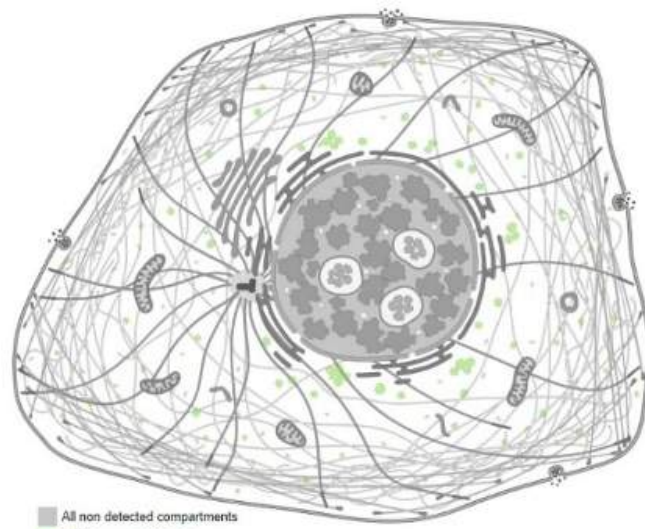
Figure 2: Schematic depicting subcellular localization of TYR and TYRP1 as representative illustrations. The green round structures represent unspecified vesicles, including melanosomes.

Gene Significance in the Context of Melanoma

Once established, most of the genes of interest were localized to the skin. I next wanted to explore the chosen genes in the context of cancer progression. Similarly, to the previous results, I evaluated publicly available databases for patient expression data. However, instead of focusing on expression in healthy tissues, the examination centered around their expression in cancer tumor samples.

Consistent with the outcome in Figure 1, the selected genes were also highly specified to cancer samples from the skin. TYR, SLC24A5, and TYRP1 were highly expressed in melanoma only, whereas MFSD12 and BRAF were highly expressed in nearly all the cancers explored (Figure 3). MITF, although highly expressive in melanoma, was also expressed in a few other tumor samples. The results in Figure 2 demonstrated that the chosen set of genes were highly significant in melanoma but less so in other types of cancers. The increased gene expression in melanoma samples could be a consequence of tissue specificity and this data says little about the relationship of gene expression within the skin and melanoma. I next needed to compare the level of gene expression in cancerous and non-cancerous samples.

The next exploration into the scale of genetic overexpression was conducted with the selected genes focusing on clinical data. I examined publicly available databases including OncoDB, to compare the expression of the genes in melanoma cells relative to normal melanocytes in melanoma patients. The results aligned with those in Figures 1 and 2, as most genes were overexpressed in melanoma cells, unlike melanocytes. The increased expression of these genes in cancer implies a functional role in cancer cells either through increased proliferation, drug resistance, metastatic activity, or some other cellular function. TYR, TYRP1, SLC24A5, and MFSD12 demonstrated high expression in melanoma patients, with the

interquartile range of the data being significantly higher than that in normal patients (Figure 4). MITF, though dominantly overexpressed in melanoma patients, was slightly more expressive in normal patients.

Contradictorily, BRAF was overexpressed more in normal patients relative to those with melanoma (Figure 4). This is explained by the fact that melanoma is driven by an activating mutation in BRAF, not an increased genetic or proteomic expression level of BRAF. MITF and BRAF are not lineage-specific genes and generally are more expressive in normal tissues than the rest. However, studies show that both MITF and BRAF have significant roles in melanogenesis. Many reported cases of melanoma have been driven by the V600 BRAF oncogenic activating mutation and targeted therapy approaches have targeted either BRAF function or the activating mutation (Arozarena & Wellbrock, 2017). With the high rate of mutation in the BRAF gene in melanoma cells, I wanted to explore whether there is any relationship between BRAF and other genes in the study.
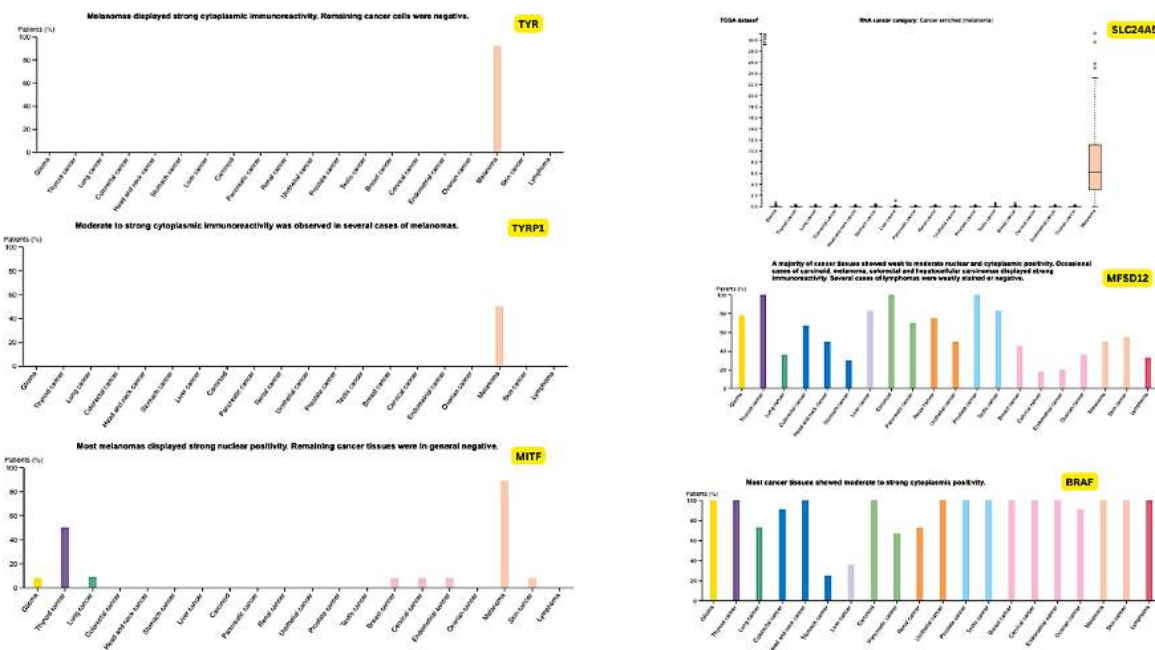
Figure 3: A collection of consensus data from ProteinAtlas on gene expression levels relative to various cancers located in the body. Each bar represents a tumor tissue sample of cancer and is color-coded by organ. In these graphs, the outlying salmon-colored bar represents melanoma.
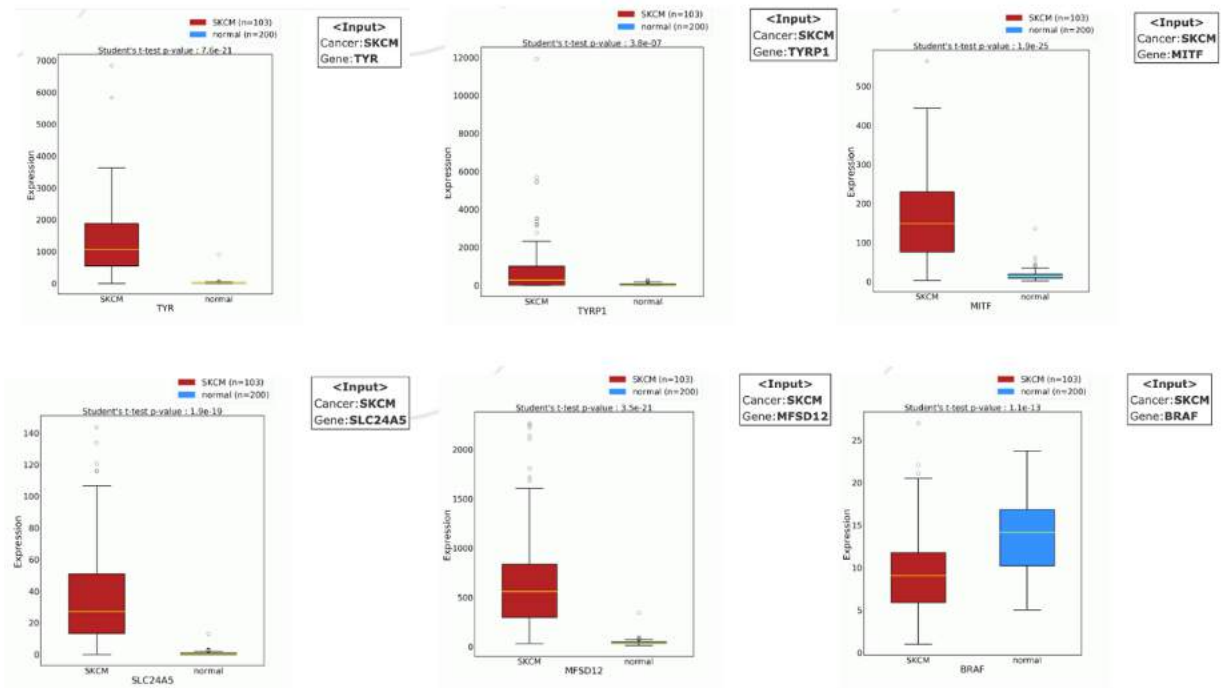
Figure 4: Box plots comparing the gene expression of select genes in normal and cancer tissue samples. The data is derived from RNA-seq data and is normalized to TPM (transcripts per million). Gene expression correlates with whole tumor samples and represents a heterogeneous population, thus may vary in patient populations. The red bar on the left represents melanoma samples and the blue on the right represents normal, non-cancerous skin tissue.

Signifying Melanomatous Gene Function Beyond Melanogenesis

Following the comparison of the selected genes' expression in various cancers and relative to normal patients, I wanted to analyze the relationship, if any, between the oncogene BRAF. The common standard of care practices in melanoma therapeutics includes pharmacological inhibitors of BRAF vemurafenib, dabrafenib, and/or encorafenib in addition to chemotherapy (Sullivan, LoRusso, Boerner & Drummer, 2015). A high correlation between the genes of interest and BRAF would highlight patient susceptibility and compatibility to BRAF targeted therapy. A high correlation could also provide evidence of interactions, co-overexpression, or intersecting signaling pathways, deepening understanding of melanogenesis in melanoma on a cellular level.

I analyzed public databases, including DepMap to examine cell dependence on the selected genes. I was interested in how the expression of each gene correlated to BRAF dependence. Determining the relationship between gene expression and BRAF reliance can provide insights into how gene expression may affect BRAF inhibitor treatment. I explored the CRISPR(DepMap Public 23Q2+Score, Chronos) dataset, which plots the cellular dependence on genes in various cancer cell lines where a negative number indicates a higher reliance on the gene for survival. Cell dependence on BRAF was plotted on the X-Axis and the individual gene

expressions on the Y-Axis. The final graph, comparing BRAF dependence on itself, provided a reference point and positive control for all the other results.

MFSD12 expression strongly correlated negatively to BRAF reliance, demonstrating that patients with high expression have a higher reliance on BRAF (Figure 5). TYR, MITF, and SLC24A5 had a strong correlation and an even steeper, negative slope relative to the control showing a high reliance. TYRP1 did not have a negative slope, meaning cells were not necessarily more dependent on BRAF when TYRP1 was expressed (Figure 5). Thus, there was no evidence correlating the expression of TYRP1 with cell reliance on BRAF. Highlighting these correlations demonstrates the clinical importance of studying the expression levels of the genes of interest.
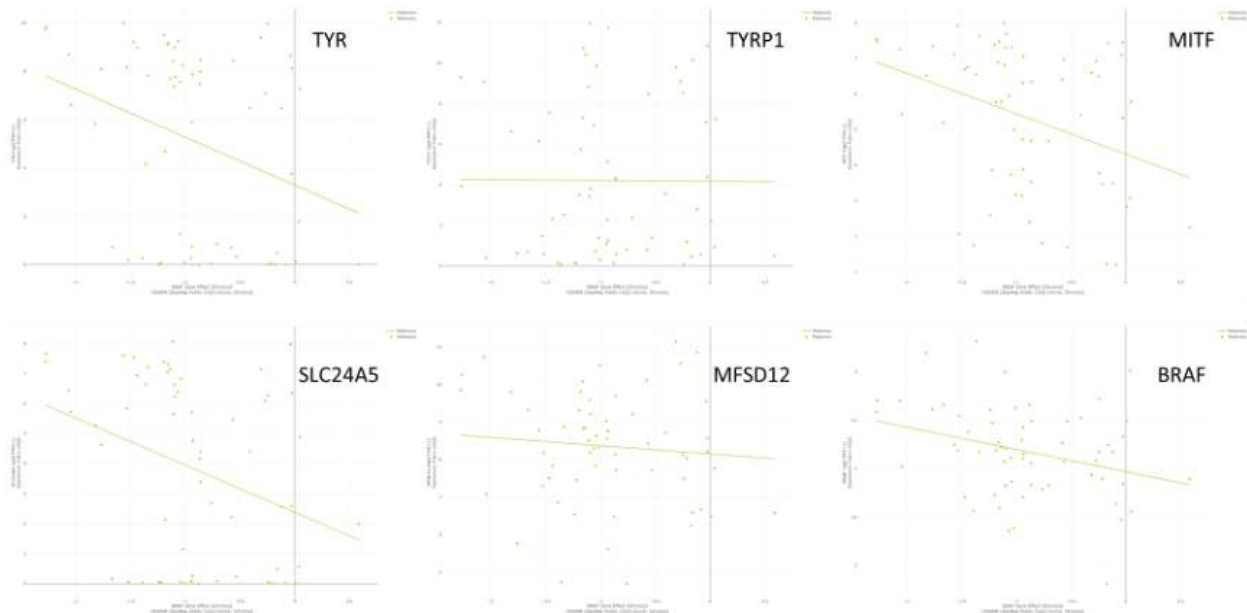
Figure 5: Scatter plots of selected gene expressions in cells, versus cell dependence on BRAF for survival. Data was collected from the CRISPR(DepMap Public 23Q2+Score, Chronos) dataset, through genome-wide screenings in over 1,000 cancer cell lines. The X-Axis represents cellular reliance on BRAF, while the Y-Axis represents individual gene expressions. The graph comparing BRAF to itself provided a positive control with a negative slope as a reference.

Discussion

In the following report, it was investigated whether the expression of certain genes is significant in melanoma progression. The genes were selected based on their diverse and significant roles in melanogenesis and were first found to be highly localized to the skin under both physiological and cancerous conditions. Their expression levels were then compared between various cancers and between patients and non-patients. Once their expression was proven to be higher in those with melanoma, their expressions in cancer cells were correlated to cell dependence on the BRAF oncogene. The findings of this exploration further clarified the

relevance of these genes in clinical studies regarding melanogenesis, and their significance in cell proliferation.

Data from the in-silico investigation was collected entirely from publicly available online databases. Though no wet lab and genetic experiments were conducted, these databases provided a large scope of multi-omic information from previous studies, all from real patients, which was just as valuable to analyze. Following this study, future research integrating the reinforced relevance of these genes in clinical studies regarding melanomagenesis would be needed. Genetic manipulation, such as CRISPR-mediated genetic knock-out of the selected genes, would be needed to establish stronger causative connections and provide deeper, more direct evidence of the correlations seen in this study. Exploring both genomic responses to targeted therapeutics and therapeutic responses to genomic alterations allows for advancements in drug development.

Moreover, analyzing genes related to those in this study enables researchers to gain clearer insight into the processes of melanogenesis and its relation to melanoma. This can further assist the clinic with classification in its battle against skin cancer. These forthcoming studies, along with the information reaffirmed in this paper, can contribute to the creation and refinement of treatment techniques, and aid in saving more lives.

Acknowledgments

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The Potential Role of Knees Over Toes Training in Patellar Tendinopathy Rehabilitation

By Pranav Rajan[1]

Abstract

Patellar Tendinopathy (PTN) is a debilitating chronic, recurring lower extremity injury that has plagued athletes in high-impact sports ranging from basketball to distance running. Its prognosis has been shown to be improved with PTN-specific physical therapy centering on isometric exercises, though injury relapses are common. Recently, knees over toes (KOT) training has gained popularity through social media outlets, prompting further research into its scientific basis and potential to reduce pain and prevent relapses of PTN in young and middle aged athletes. This systematic review aims to analyze the effectiveness of augmenting the current PTN standard of care with KOT training and propose a novel 3-step protocol in accordance with these findings.

Introduction

Patellar tendinitis (PTN), clinically known as patellar tendinopathy, is characterized by load-dependent infrapatellar pain. PTN is most common in athletes who participate in sports that involve intensive bouts of jumping, such as volleyball and basketball (Hutchison et al.) but can also manifest in those who exert repetitive loads on their knees such as long distance runners (Malliaras et al.). In 1978, a seminal study at Duke University found that deeper squats, where the knees move more freely over the toes, put greater pressure on the knees (McLaughlin et al.). These results fueled a persistent myth that knees over toes (KOT) exercises are unhealthy for the knee joint. However, a subsequent study at Memphis University (Fry et al.) disproved this theory, demonstrating that preventing movement of the knees over the toes transfers more force through the hips to the lower back rather than the knees. Despite these findings, the role of KOT training within a structured rehabilitation program designed to prevent or cure PTN is unclear. The aim of this review is to examine the role and effectiveness of KOT training in achieving pain reduction, particularly that localized to the patellar tendon. Such assessment of systematic KOT programming may offer new insight into novel protocols in PTN rehabilitation.

Diagnosis of PTN

The first step in treating PTN is determining whether the pain is localized to the patellar tendon, as management will logically differ depending on the type of injury to the knee joint. PTN pain is located directly under the knee at the patellar tendon (Malliaras et al.). It is also load related, meaning the pain is exacerbated by increased weight bearing on the patellar tendon, and resolves when the joint is unloaded; thus, the pain should linearly increase with an increase in training volume (Aicale et al.; Malliaras et al.). Once this pain pattern has been assessed, one then assesses surrounding areas of weakness, restriction, and instability that may manifest in the patellar tendon. This can be accomplished by a series of standardized tests, which are described

below.
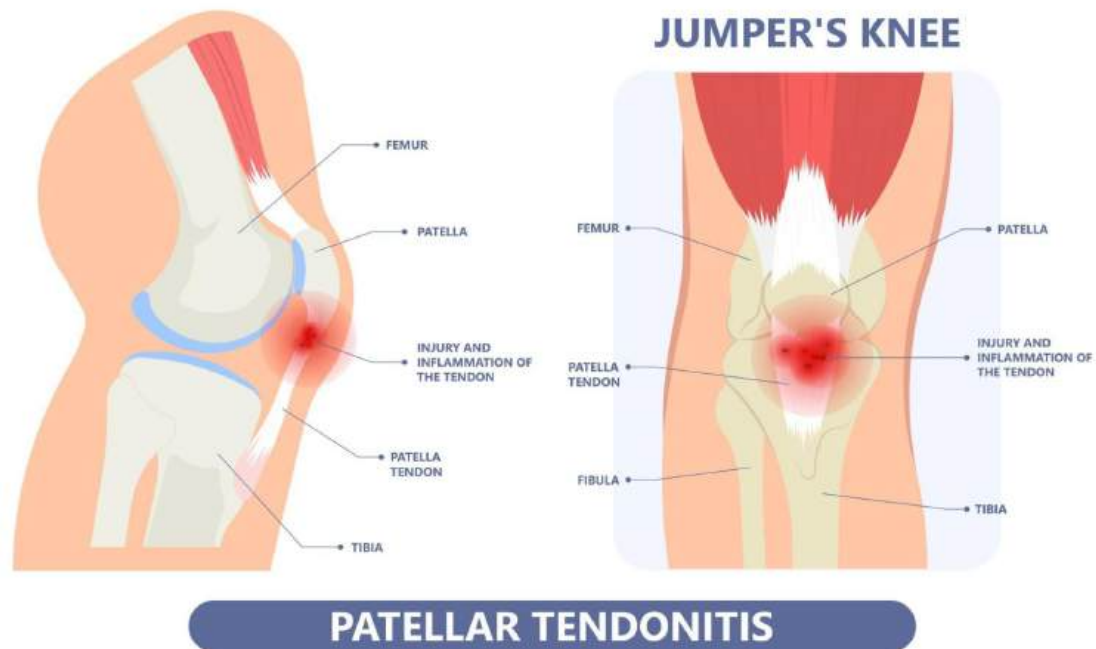
Figure 1. Patellar tendinopathy diagnosis. Adapted from Complete Physio.

The first exam that should be performed is the single leg squat (SLS) test (Ugalde et al.). This test serves as the basis for subsequent screenings in the hip, knee, or ankle. The SLS test is accomplished by having an athlete stand on the injured leg with their hand on their hips and opposite leg bent at 90 degrees, then squatting down to 30 degrees of knee flexion before returning back up, all while keeping their upper body neutral and relaxed. This test offers a more comprehensive measure of restriction and instability compared to a standard two-legged squat, as the athlete is unable to compensate for weakness while isolating one leg. If the athlete experiences pain, cannot complete the squat, the knee caves in, or the movement appears unstable or tense, an issue likely exists along the hip to ankle axis. This would need to be addressed prior to engaging in a formal PTN rehabilitation protocol.

Following the SLS test, additional clinical exams are necessary to localize lower instability. A study presented by (Stephenson) concluded that impaired hip mobility may present as pain in the patellar tendon, thus necessitating a discriminatory evaluation for the specific origin of the symptoms. One such exam that screens for specific restrictions in hip mobility is the Thomas test (Harvey). The Thomas test begins with an individual lying flat on their back on a table or bench with both legs hanging off (see Figure 1). The patient is instructed to bring one leg up as far as they can towards their chest while relaxing the opposite leg that is still hanging off the bench. They then switch sides and perform the test on the other leg. If they were unable to pull either knee all the way to their chest, fail to keep their resting leg relaxed and unstraightened on the bench, or their resting leg angles outwards, a restriction likely exists. The hips need to be

addressed by hip mobility and strengthening exercises before entering into the next PTN diagnostic protocol.

<table>
<tr><th colspan="2">Pass</th><th colspan="2">Fail</th></tr>
</table>

Pass		Fail	
	Able to pull knee fully to chest (adequate hip flexion)		Unable to pull knee fully to chest (inadequate hip flexion)
	Able to keep opposite leg flat on the bed		Unable to keep opposite leg flat on the bed
	Opposite leg lies in a straight position on the bed		Opposite leg is turned out to the side of the body
	Opposite knee is flexed and relaxed		Opposite knee is relatively straight and tight

Figure 2. Thomas Test Criteria. Adapted from Squat University.

Ankle Mobility Test

The Dorsiflexion Lunge (DF) (Bennell et al.) test provides a reliable way to assess ankle mobility. It begins with having the athlete kneel in a staggered stance and place their forward foot greater toe at a 5-inch distance from the wall, followed by pushing the same knee towards the wall while keeping their heel in contact with the floor. If they're unable to touch the wall with their knee, their heel comes off the ground, the knee collapses, or they experience any pain,

then restriction in the ankle and/or calf exists that needs to be addressed before formally entering the following protocol.

Materials and Methods

Comprehensive literature searches were conducted through PubMed, Google Scholar, and other academic databases to identify studies related to KOT training and PTN. Keywords included "patellar tendinopathy," "Patellar Tendinitis," "treatments," "Eccentric exercises," and "decline squat." Studies from the last 27 years were included to be fully comprehensive. Given the paucity of studies on older adults, only those younger than 50 years old were included.

Strength Protocol including KOT training:

The forthcoming section describes a novel 3-step protocol I have developed in accordance with current findings in PTN treatment and KOT training literature.

Step 1: Self Myofascial Release (SMR) Pre-Mobilization of Lower Extremity

Self myofascial release (SMR) utilizes tools such as foam rollers and lacrosse balls to allow the athlete to apply targeted pressure to different muscles, thereby allowing those muscles to relax. As a remedy for PTN, SMR can be used to relieve restrictions in surrounding areas, such as the calves and hips, that could manifest from injury to the patellar tendon. A systematic review by Schroeder and Best found SMR to be effective in reducing pain when used in both pre-exercises (warmup) and post-exercise recovery sessions. Though some of the individual studies investigating whether SMR improved athletic performance were inconclusive (Healey et al.; Macdonald et al.), SMR was shown to increase upper and lower body range of motion and decrease delayed onset muscle soreness (DOMS) for up to thirty minutes, allowing athletes to be more productive in their workouts (Schroeder and Best), and showing that SMR could be added before performing rehabilitation exercises in the later steps of the protocol. Together, these conclusions support SMR as an effective pre-exercise "warm up" tool. Furthermore, multiple SMR repetitions spread evenly throughout the day have been shown to reduce chronic pain (Schroeder and Best). Compared to a massage therapist, SMR is more accessible and cost-effective, as it can be done anywhere with tools such as foam rollers that can easily be substituted for everyday items such as PVC pipes (DeBruyne et al.).

Step 2: Isometric Loading

One of the main issues faced when addressing PTN is collagen shielding (Baar). As repetitive loading breaks down patellar tendon collagen, surrounding stronger collagen fibers will begin to shield the weaker ones. This process also leads to a buildup of proteoglycans and water, which manifests as painful local swelling. To address this issue directly, the stronger collagen fibers must relax, which can be accomplished through isometric loading. Isometric loading also aids in strengthening Vastus Medius Oblique (VMO) muscle weakness. Diminished strength in the VMO muscle can lead to PTN, and stimulation and strengthening of this muscle

through isometric exercises can thus lessen pain. Of the various isometric loading exercises and protocols, the most studied is the Spanish Squat.

Spanish Squat

The Spanish Squat is performed (insert brief overview). One study examined the use of "stress relaxation" (isometric loading) in reducing chronic PTN pain in an NBA player (Baar). His stress relaxation program included Spanish Squats alongside two other isometric exercises while continuing to perform at games and practices. Over an 18 month period, the holds were progressively increased from 5 repetitions of 10 seconds up to 30 second holds. In addition to being pain-free after 18 months, a follow-up MRI interpreted by a blinded orthopedic surgeon declared his patellar tendon as normal.

Another study (Basas et al.) involving 6 Spanish national team male jumpers (3 high jumpers and 3 long jumpers) showed further evidence regarding the effectiveness of the Spanish Squat in PTN rehabilitation. Their program included isometric electrical stimulation of the quadriceps along with three variations of the Spanish Squat. Their pain was tracked through a self-reported visual analogue scale (VAS) of pain over a 48-month period, with a protocol interruption from months 24-30 and program reapplication at month 30. The VAS score decreased significantly from months 0-24, then slightly increased during the protocol interruption before decreasing again after protocol reimplementation, thus supporting the effectiveness of Spanish Squats in a PTN rehab program. A final study (Rio et al.) employed the Spanish Squat in 5 patients, 3 of whom were elite athletes (national Australian football, national level squash, and world ranked tennis) and 2 of whom were sub-elite athletes (recreational dance and recreational volleyball). Their baseline pain was measured through the SLS test and the VISA-P questionnaire, a self-report clinical tool used to assess the severity of patellar tendinopathies in athletes. They were then prescribed 5 repetitions of 30 seconds of a Spanish Squat hold for a 4-week interventional period. Post-intervention SLS tests and questionnaires revealed an average baseline pain reduction of 49% with a mean 18.8 % improvement in VISA-P scores.

Step 3: KOT training

Upon releasing the tension of collagen shielding, it is necessary to re-strengthen the weaker fibers to achieve pain free long term return to play. This objective can be achieved with eccentric, or KOT, training, as it increases the mechanical and load-bearing capacities of the tendon and aids in collagen synthesis (Čobec and Kozinc). Furthermore, KOT training addresses strength deficiencies in the VMO muscle, which, as established previously, are correlated with PTN (Burkholder). The most researched KOT exercise to date is the Single leg decline squat (SLDS).

Single leg decline squat (SLDS)

A recent pilot study from the HAN University of Applied Sciences (HAN university of applied sciences) examined VMO activation in 3 exercises both with and without heel elevation: the 2-legged squat, the lunge, and the single leg squat. Athletes were instructed to perform 10 repetitions of each exercise, maintaining 2 second eccentric and concentric tempos. The results showed significant increases in VMO activation for all three exercises, but there was comparatively more activation in the SLDS when compared with the standard single leg squat.

These findings were validated by another study, which further compared SLDS to traditional single leg squats within a PTN rehabilitation program (Young et al.). The SLDS group performed SLS on a 25 degree slant board and the step group performed step downs on a 10 cm block, with both groups progressing their assigned exercise with speed then load increases. Their VISA scores were evaluated at 12 weeks and 12 months, and while both groups reported significantly reduced pain pain, further analysis revealed a greater likelihood of improvement in the SLDS group as opposed to the regular stepdown group. To compare KOT training to the current PTN interventional standard of care, a cohort of 35 athletes were split into two groups, with one group being exposed to KOT training and one subject to surgical treatment. The KOT training group performed SLDS on a 25 degrees decline board with three sets of 15 repetitions twice daily for a twelve-week interventional period. In the surgical treatment group, abnormal tissue was removed and the athletes followed up with a structured rehabilitation program with gradual progression to KOT training. The athletes were evaluated after three, six, and twelve months of rehabilitation, and while both groups improved, there were no significant differences in outcomes found between the surgical group and the KOT training group. (Bahr et al.)

Discussion

Overall, this review highlights the integral role KOT exercises have in a systematic program to reduce PTN symptoms and improve return to play metrics. While traditional eccentric training has been evaluated in previous studies, new research shows a comparative increase in both VMO activation and athlete satisfaction when incorporating KOT exercises.

Despite these promising findings, progressing too quickly into KOT training without first addressing lower extremity restrictions in mobility or strength can lead to a lack of progression and less effective pain reduction. Moreover, since the pain may stem from the hip or ankle, the aforementioned diagnostic tests are important to include in a PTN rehabilitation program to determine if the symptoms are actually from PTN. In other words, athletes may experience similar pain , but that doesn't necessarily mean it stems from the same problem area. The steps are presented in this particular order because it is the best studied method to achieve progress without putting undue stress on the patellar tendon. In summary, the isometric phase serves to get an athlete out of pain, while the KOT phase allows them to stay out of pain. Thus, the act of progressing directly into KOT training without the isometric phase may lead to excessive load on the patellar tendon, which may explain past findings of low satisfaction with KOT exercises, especially if these are performed while an athlete is in season for their sport.

Before implementing this protocol, It is important for the athlete to assess their goals. Most of the literature supports this program for athletes with high activity levels due to their regular participation in sports. For older cohorts with relatively lower activity levels, there remains a dearth of literature supporting the use of this program. Another important program consideration centers on acceptance of the lengthy time requirements inherent to rehabilitation processes such as this. Depending on the person, programs can range from 6 weeks to 6 months (Nuhmani and Muaidi), thereby necessitating consistency and patience throughout the process. Limitations of this review include the small sample sizes of the majority of the included studies as well as the relative lack of standardization across the entire field of PTN and KOT training research, the latter of which may be attributed to the novelty of the proposed methods as they continue to be adopted into formal practice. Future studies should aim to include larger cohorts with rigorous methodologies.

Conclusion

Upon comprehensively reviewing the literature regarding PTN management, the current standard of care was discussed within a novel 3-step protocol designed to include KOT training given recent studies indicating promising results when such training is implemented in the rehabilitation of young to middle aged athletes. We argue these findings support the use of KOT training in conjunction with mobility and isometric exercises to augment return to activity programs after ensuring PTN is properly diagnosed. Furthermore, these results constitute evidence that additional research including randomized controlled trials to assess the efficacy of KOT training in PTN and other similar pathologies should be conducted.

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The Economic Impact of Renewable Energy Transitions on Wages: A Study of the Effects of Solar and Wind Energy in the United States From 2013-2022 By Tavas Phogat

Abstract

The transition to renewable energy sources from traditional fuel sources, specifically wind and solar, effects on the labor sector will be studied in this paper. This will be measured using wage data, to see how the increasing shift to renewable energy has changed wages over a 10 year span, from 2013 to 2022. To do this, an indirect causation chain was used, with each state's renewable energy potential affecting the states renewable energy production capacity, which affects the wages in each state, where the energy potential remains unaffected by the other two factors. Then, using 2 stage linear regression, a positive causation was found for solar capacity and wages, and a negative causation for wind capacity and wages . These insights can help policymakers make decisions in promoting or restricting the shift to renewable energy.
Introduction and Literature Review.

The transition to renewable energy is one of the most significant global challenges and opportunities of this time. As countries strive to meet climate goals and reduce their carbon

footprints, the shift from fossil fuels to renewable energy sources such as wind and solar is accelerating. This transition not only promises environmental benefits but also has profound implications for the labor market, particularly in the energy sector. Understanding these implications is crucial for policymakers, businesses, and workers to navigate and leverage the economic transformations that accompany this energy shift.

The research question of this study is to examine how the transitions of states' power grids away from fossil fuels affect the wages in each state. As the world shifts from fossil fuels to renewable energy, significant changes occur in the job market. Moving away from coal, for example, can lead to job losses in some areas, but renewable energy sources like solar and wind power can create new jobs and boost local economies (Gholipour et al., 2022). Young workers with skills in renewable energy technology, such as solar panel installation and maintenance, may find better job opportunities and potentially higher wages. Understanding who benefits and who loses in this transition is essential for developing fair and effective energy policies. The transition also stimulates regional economic growth, providing a new avenue for job creation and industrial development.

Recent studies provide valuable insights into this shift. Research shows that renewable energy policies can create jobs in the green energy sector, even as employment in fossil fuel industries declines (Chan and Zhou, 2024). The International Monetary Fund's report highlights that while green energy boosts overall employment, there needs to be strong policy support to help workers transition from traditional to renewable energy jobs (Kim and Mohommad, 2022). These policies are crucial for mitigating the adverse effects on workers displaced from the fossil fuel sector and ensuring that the benefits of the green transition are widely shared.

Additionally, research shows that investing in renewable energy leads to job growth, especially in areas like construction, maintenance, and manufacturing sectors related to renewable energy technologies (Kammen et al., 2010). Such investments not only help in reducing carbon emissions but also contribute significantly to the local economies by creating a range of job opportunities from high-skilled engineering positions to lower-skilled maintenance jobs. However, the transition also poses challenges. Policies must balance environmental goals with economic growth, ensuring support for workers moving from fossil fuel industries to emerging green sectors (Pestel, 2019). Comprehensive training programs and supportive measures are necessary to equip the workforce with the required skills for new green jobs.

The study by Chan and Zhou shares several methodological similarities with this study, particularly in the use of regression models and instrument variables. Both studies employ regression techniques and use natural resource potentials and capacities as instrument variables to address endogeneity issues. However, there are notable differences in the scope and findings of these studies. Their study focuses on smaller, more localized groups, whereas this research encompasses a broader geographical range, examining the impact across various states. This broader focus could account for the differences observed in these results. Their study highlights a positive employment effect of renewable energy policies, whereas this study finds a positive

correlation between solar energy capacity and wages, but a weaker, sometimes negative correlation with wind energy capacity.

My analysis uses a comprehensive dataset that includes labor wage data from the Occupational Employment Statistic program by the Bureau of Labor Statistics. Additionally, data on renewable energy production capacities are gathered from the U.S. Energy Information Administration. Population data is sourced from the U.S. Census Bureau. These datasets provide detailed cross-sectional and time-series information on individual and household labor market outcomes, renewable energy capacities, and population demographics across different states. Preliminary findings suggest that the transition to renewable energy has varied effects on wages in the energy sector depending on the type of renewable energy and the state's natural resource availability. Specifically, a 1% increase in solar capacity is associated with a 0.04% increase in wages, significant to the 0.1% level, while a 1% increase in wind capacity is associated with a 0.02% decrease in wages, significant to the 10% level. These insights can inform policymakers in supporting job growth and economic planning within the renewable energy sector, ensuring that the economic benefits of the energy transition are maximized and equitably distributed.

Data

The primary data sources for this study include the Bureau of Labor Statistics (BLS), the U.S. Energy Information Administration (EIA), and the U.S. Census Bureau, covering the period from 2013 to 2022. The BLS provides detailed wage data for the energy sector, while the EIA supplies data on renewable energy production capacities, including solar and wind nameplate capacities, and natural resource availability for renewable energy. Additionally, population data is obtained from the U.S. Census Bureau.

	Solar Potential (MW)	Wind Potential (MW)	Solar Capacity (MW)	Wind Capacity (MW)	Wages	Population (1000s of people)
count	308	308	308	308	308	308
mean	4276927.88	317778.48	920.46	2706.48	3475.50	7736.07
std	5485348.26	430856.33	2323.53	4887.56	3543.21	8183.02
min	11537.15	309.30	0.50	2.00	286.91	624.05
25%	410549.67	17318.68	36.60	151.00	1296.41	2910.85
50%	3094779.62	171858.45	170.55	985.80	2758.68	5974.30
75%	6542717.26	492083.50	676.58	3282.63	4133.12	9262.91
max	28368971.93	2172973.35	17691.60	39334.80	17693.58	39503.20

Table 1: Summary statistics for key variables

The summary statistics for the key variables in the study, such as log-transformed solar capacity, wind capacity, wages, solar potential, wind potential, and population, are presented in Table 1.
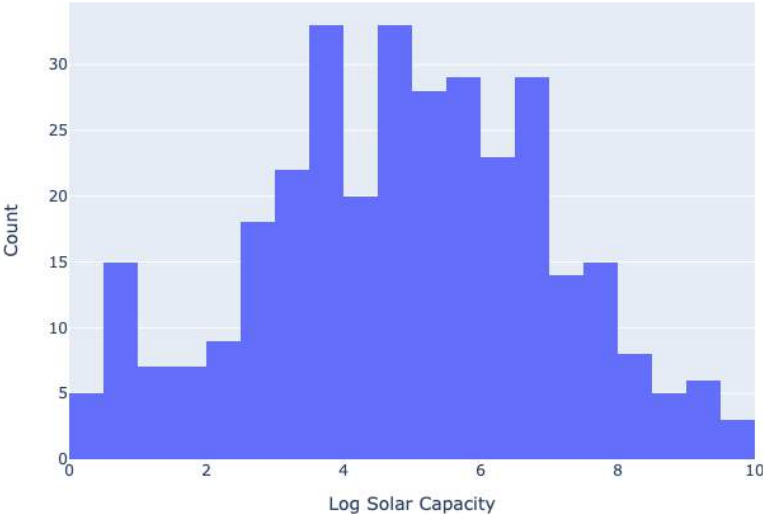
Figure 1: Count of different log solar capacity values

The distribution of the count of log-transformed solar capacity across different states is illustrated in Figure 1. This graph shows how solar capacity is distributed among the states and highlights the variability in solar energy production capacity.
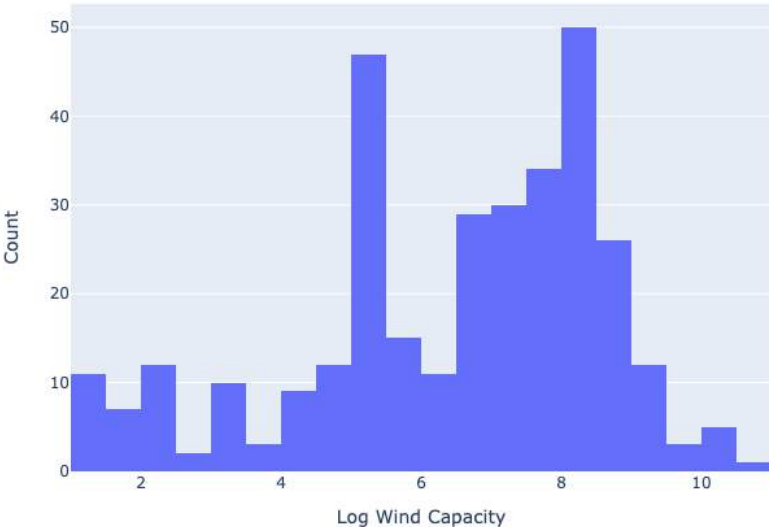
Figure 2: Count of different log wind capacity values

Similarly, Figure 2 of log-transformed wind capacity shows the count of wind capacity across different states.
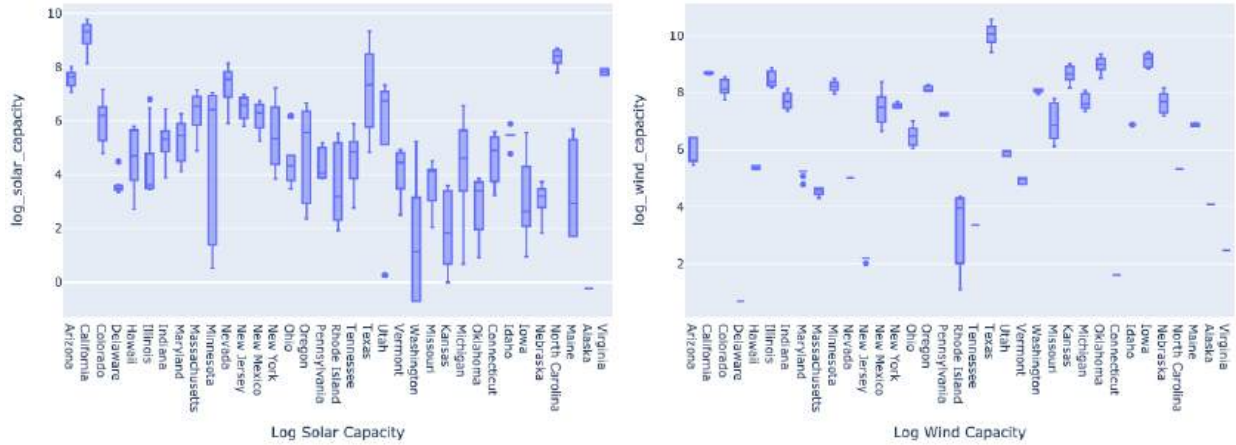
Figure 3 (left) and Figure 4 (right): Box and whisker plot of log solar and wind capacities in each state

Figures 3 and 4 compare the distributions of log-transformed solar and wind capacity across different states. This graph highlights the variations in solar capacity among states and identifies any outliers or extreme values. States missing either solar or wind data over a multitude of years, or lacking variation, were dropped from the data set as well.

Methodology

This study uses a two-stage least squares (2SLS) regression approach to analyze the impact of renewable energy transitions on wages in the energy sector across U.S. states.

The logarithms of solar potential and wind potential were employed as instrument variables to address potential endogeneity. Endogeneity could come up because solar capacity and wages can influence each if higher wages could attract more investment in solar capacity, and increased solar capacity could lead to higher wages in the energy sector. By using the potential for solar and wind energy, which are natural and exogenous to the economic outcomes, this isolates the variation in solar and wind capacities that is not correlated with employment outcomes.

In the first stage, log-transformed solar and wind capacities were predicted using Ordinary Least Squares (OLS) regression. In the second stage, log-transformed wages were regressed on these predicted values, along with control variables such as the population variable. In the first stage, the regression equation for log capacity predicts the renewable energy capacity using the instruments. The equation is:

$$\log capacity_r \; = \; \alpha_s \; + \; \alpha_t \; + \sum_{r=wind,\,solar} \beta_r \, \log potential_r \; + \; \beta_1 \, population$$

Here, $\log capacity_r$ represents the logarithm of renewable energy capacity for wind or solar in a state, α_s and α_t are the state and year fixed effects, $potential_r$ is the logarithm of the renewable energy potential for wind or solar, β_r are the coefficients for the log potential variables (different for wind and solar), and β_1 is the coefficient for the population variable. In the second stage, the predicted values of log capacity are used to estimate the effect on wages. The equation for log wages is: $\log wages \ = \ \alpha_s + \alpha_t + \beta_1 \log \widehat{capacity} + \beta_2 population$

In this equation, α_s and α_t are again the state and year fixed effects, $\log \widehat{capacity}$ represents the predicted log capacity from the first stage, $\log wages$ represents the logarithm of wages, β_1 is the coefficient for the predicted log capacity, and β_2 is the coefficient for the population variable.

Results

The results section presents the findings from the two-stage least squares (2SLS) regression analysis. This section incorporates detailed explanations for the relationships between key variables and the implications of these findings.

The regression indicates significant relationships between renewable energy capacities and wages in the energy sector. Specifically, a 1% increase in solar capacity is associated with a 0.04% increase in wages, suggesting that investments in solar energy contribute to higher wages in the energy sector. In contrast, a 1% increase in wind capacity is associated with a 0.02% decrease in wages, indicating that investments in wind energy may have a different economic impact compared to solar energy.

	log(Wages)
Δ log(solar capacity)	0.0472****
Δ log(wind capacity)	-0.0179*

Table 2: Regression results
In Table 2, * represents significance at the 10% level, ** represents significance at the 5% level, *** represents significance at the 1% level, and **** represents significance at the 0.1% level.

In Table 2, the positive impact of solar capacity on wages can be attributed to the economic activities generated by solar energy projects. These projects often require significant investments in technology, manufacturing, and construction, which create high-paying jobs and boost local economies. For every 1% increase in solar capacity, there is a corresponding 0.04% increase in wages.

Conversely, the slight decrease in wages associated with increased wind capacity may be due to the lower marginal costs of wind energy compared to solar. As wind energy becomes more prevalent, it might lead to the retirement of higher-cost energy sources like coal-fired power plants, reducing the overall demand for labor in the energy sector. The 0.02% decrease in wages for every 1% increase in wind capacity suggests that the economic benefits of wind energy projects may not fully offset the job losses in traditional energy sectors.

The first-stage regressions for this analysis yielded high F-statistics, notably an F-statistic of 533 for wind capacity. This high F-statistic indicates that the instruments used in the regression, which are the solar and wind potentials, have significant predictive power for the endogenous variable, wind capacity. A high F-statistic suggests that the instruments are strong and reliable, meaning they effectively predict the changes in wind capacity. This strong predictive power supports the validity of the instruments used and reinforces the reliability of the subsequent findings on the relationship between renewable energy capacities and wages in the energy sector.

However, it is crucial to address potential concerns regarding the exclusion restriction assumption. The primary assumption in our instrument variable approach is that the instruments, solar and wind potential, affect wages only through their impact on solar and wind capacity. A potential violation of this assumption could arise if the amount of solar potential sunniness or windiness of a state directly influences wages. For instance, sunnier states might attract higher wages due to other economic factors such as tourism, improved living conditions, or increased productivity in other sectors unrelated to renewable energy production. These direct effects could confound the estimated impact of renewable energy capacity on wages.
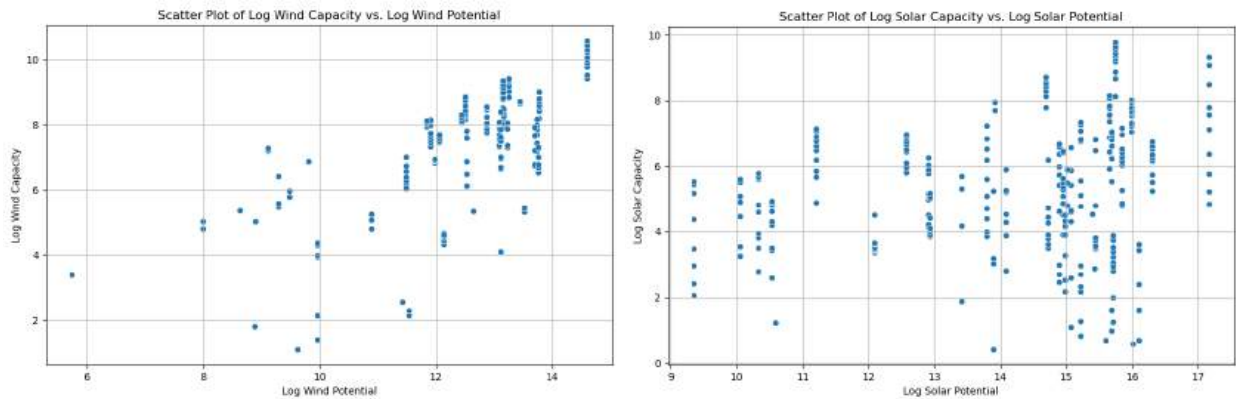
Figure 5 (left) and Figure 6 (right): Scatter plots of log solar potential versus log solar capacity and log wind potential versus log wind capacity

Figures 5 and 6 show positive correlations for both energy types. States with higher natural energy potential tend to have greater energy production capacities. However, variability exists in how effectively states utilize their resources, influenced by factors such as policy support and economic conditions.
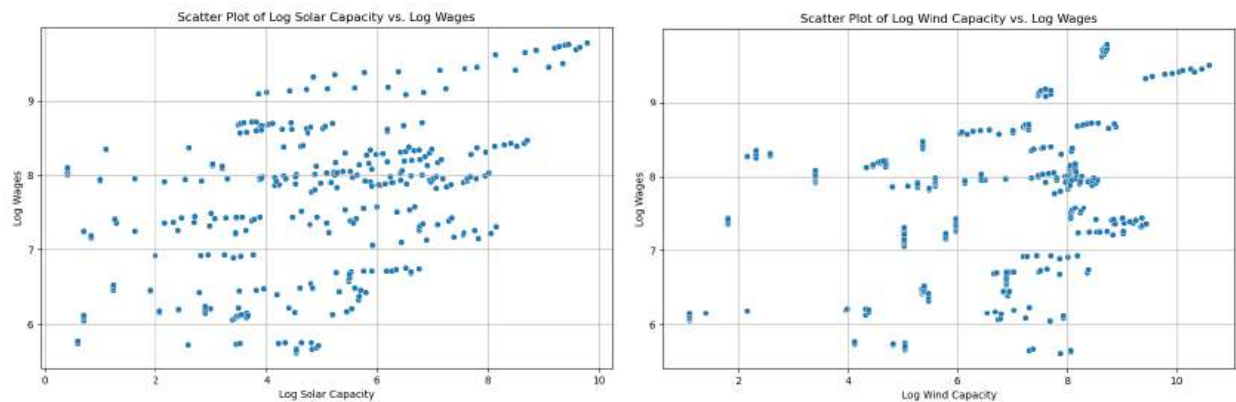
Figure 6 (left) and Figure 7 (right): Scatter plots of log solar capacity versus log wages and log wind capacity versus log wages

Figures 6 and 7 reveal differing impacts on wages from solar and wind capacity. Solar capacity shows a strong positive correlation with wages, indicating that increased solar capacity is associated with higher wages in the energy sector. In contrast, wind capacity has a weak negative correlation with wages, suggesting that increased wind capacity does not significantly boost wages and may even have a slight negative impact.

The results of this study highlight the complex relationship between renewable energy transitions and wages in the energy sector. While solar energy investments generally lead to higher wages, the impact of wind energy is more nuanced and may require further investigation to fully understand the underlying factors. The findings underscore the importance of considering the unique economic characteristics of different renewable energy sources when designing policies to promote job growth and economic development. These insights can inform policymakers and stakeholders as they navigate the complex landscape of renewable energy transitions and their economic implications.

Conclusion

This study examined the impact of renewable energy transitions on wages in the energy sector across U.S. states from 2013 to 2022. Using a two-stage regression approach, it found that increased solar capacity is linked to higher wages, while increased wind capacity shows a slight decrease in wages. Specifically, a 1% increase in solar capacity leads to a 0.04% increase in wages, while a 1% increase in wind capacity results in a 0.02% decrease. The strong F-statistics in this study confirm the relevancy of it.

However, there are concerns about the assumptions underlying this approach. The primary assumption is that the instruments, solar and wind potential, affect wages only through their impact on solar and wind capacity. A potential violation could occur if sunniness or windiness directly influences wages through other economic factors such as tourism or improved living conditions. These concerns highlight the need for careful consideration when interpreting the results.

These insights are important for policymakers as they work to support the shift to renewable energy while considering its impact on jobs and wages. This research highlights the need for thoughtful policies to ensure the economic benefits of renewable energy are widely shared.

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Analyzing the Social and Economic Implications of Menstrual Equity in South Asia By Shreya Nadagowda and Sathvega Somasundaram

Abstract:

Menstrual hygiene is a crucial yet often overlooked aspect of public health and gender equality. This paper explores the social and economic implications of menstrual product access, focusing on education, gender equality, cultural stigmas, and economic challenges. Through analytical data interpretation on tax and social inequalities surrounding menstruation, this paper aims to highlight the impact on individuals and communities, along with emphasizing the nature of period inequity, the lack of access to menstrual hygiene products, adequate sanitation facilities, and education about menstruation due to economic constraints. We investigate the role of menstrual hygiene in educational attainment and gender empowerment, showcasing the importance of access to resources and initiatives promoting open dialogue. Additionally, we examine the influence of cultural traditions and economic barriers on menstrual hygiene practices, underscoring the need for affordable, culturally relevant, accessible solutions and community-based initiatives to support the use of menstrual products. By presenting a comprehensive overview of these issues, we provide insights and recommendations for policy interventions and efforts to promote open menstrual discussions where girls and women can request products that match their needs.

Introduction

Menstruation is a natural bodily process experienced by billions of menstruators worldwide, yet it remains shrouded in social stigmas, economic barriers, as well as environmental issues. Differing access to menstrual products such as pads, tampons, menstrual cups, and cloth, is not only a matter of hygiene but also carries significant social implications, spanning various domains including health, education, and gender equality. Addressing these social issues is crucial for promoting the well-being and empowerment of individuals worldwide. This study examines the prevalence of menstrual hygiene practices, exploring socio-cultural attitudes towards menstruation in this region of South Asia, and assessing the accessibility and affordability of menstrual products. South Asia is typically much largely affected by period inequity, but researchers often solely emphasize India. Our focus is on Sri Lanka in respect to South Asia as a whole. Further, this study proposes a contemporary way of promoting one's voice in their menstrual journey.

Background on Sri Lanka and Menstrual Equity

People in Southeast Asia view menstrual hygiene practices and societal attitudes towards menstruation through the lenses of socio-economic, cultural, and religious beliefs [1] . Sri Lankan traditional practices often include seclusion and restrictions on daily activities for

menstruating women, influenced by notions of power and cleanliness [2]. Although modernization and urbanization have brought about changes in perceptions, there is no one specific characterization of Sri Lankan views, especially given different ideologies based on religious, familial, and cultural positions in society. The prolonged civil war, lasting for three decades (years), has significant repercussions on the lives of Sri Lankans, and disruption of infrastructure in the country has led to the lack of access to sanitation and necessities, specifically those used for menstruation [3] [4].

Period poverty refers to the inability to afford or access menstrual products and adequate sanitation facilities, leading to adverse consequences for individuals' health, education, and well-being [5] In Sri Lanka, and many other global regions , period poverty disproportionately affects women and girls, exacerbating existing gender disparities in education and perpetuating cycles of inequality. **Figure 1** depicts the correlations between women empowerment and social inequalities in five South Asian countries.
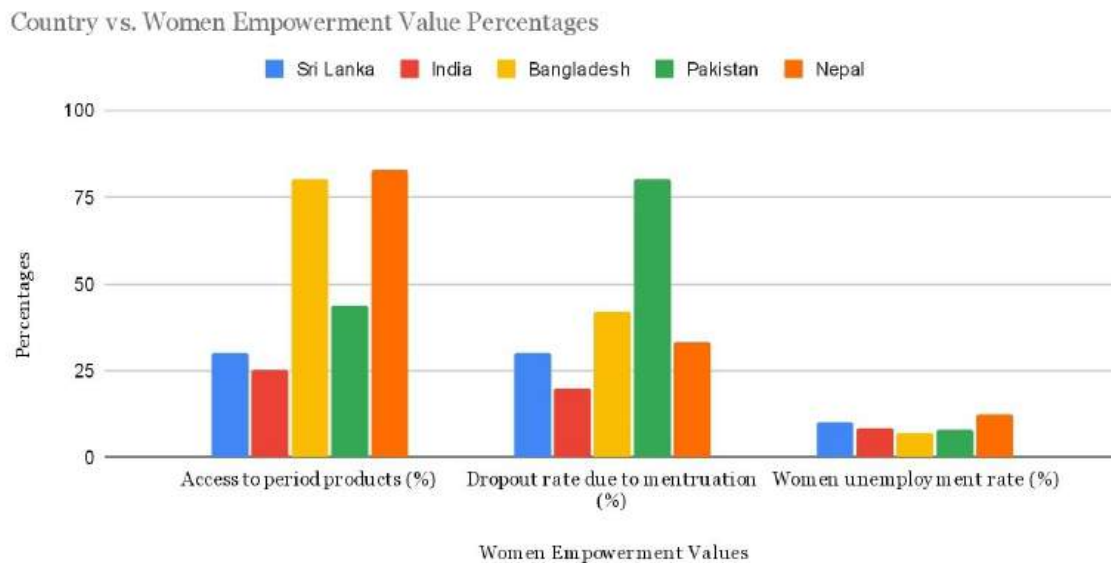
Figure 1: Different assessment of economic and social factors affecting women's empowerment [3] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17]

The graph above depicts how the different values of women empowerment are scattered across the South Asian countries India, Sri Lanka, Nepal, Bangladesh, and Pakistan. When looking into data specific to Sri Lanka, despite having relatively low access to period products, Sri Lanka experiences moderate school dropout rates due to menstruation, indicating potential cultural or policy interventions that mitigate this issue. Persistent education initiatives, sanitation facilities, and dignity kits that include supplies like soap and underwear, by the UNFPA and WATER organizations have helped engage many in the urban community to support menstruators and provide accessible menstrual products for schools as well [18]. In contrast, countries like Bangladesh and Pakistan, with higher access to period products, still face severe

educational disruptions due to menstruation, suggesting that availability alone isn't sufficient without proper education and facilities.

Sri Lanka's lower unemployment rate for women compared to that in other South Asian countries results from more progressive gender policies and better economic conditions. Sri Lanka's female literacy rate is over 90%, contributing to better employment opportunities for women. However, the persistence of child marriage, although lower than other country's rates, underscores ongoing socio-cultural challenges.

Variables That Impact Menstrual Health

Education and Period Equity

Sri Lanka's education system has made significant strides in recent years, especially with introducing new teaching methodologies designed to reduce exam pressure, and integrating technology to create a more resilient and inclusive educational environment [19]. These reforms are supported by international partners like Finland to ensure alignment with global educational standards while retaining Sri Lankan cultural identity [20]. Yet, period equity continues to hinder educational access and outcomes, particularly in rural and marginalized communities. According to the United Nations Population Fund, around 30% of schoolgirls in Sri Lanka miss school during menstruation due to a lack of access to menstrual hygiene products [21]. Similarly, the Sri Lankan Ministry of Education reveals a concerning trend in increased dropout rates among menstruating individuals, particularly in rural areas where menstrual products are limited [22].

Girls from low-income families often face challenges in accessing menstrual products, resulting in school absenteeism and decreased educational attainment. More than 60% of Sri Lankan parents don't allow their children to go to school during their period [23]. This not only prevents academic progress, but also limits future opportunities. Girls who miss school due to their periods are more likely to fall behind in their schoolwork, leading to lower academic achievement compared to their peers. This counter-intuitively impacts mental health and productivity, as peer pressure and discrimination lead to feelings of shame and embarrassment [24].

In turn, this affects gender inequality, as period equity restricts access to educational and economic opportunities [25]. The International Center for Research on Women reported more than 65% of adolescent girls in Sri Lanka feel embarrassed about menstruation, often with the outcome of self-isolation and limited participation in school activities [22]. Due to this, girls are less likely to achieve economic independence and empowerment, reinforcing gender disparities in society [26].

Gender equity in period equity entails equal access to menstrual hygiene products, education, and resources for all individuals [27]. This could include taking initiatives to distribute free or subsidized menstrual products in schools, community centers, and public spaces. Menstrual education goes beyond addressing the biological aspects, as it includes discussions on gender norms, stereotypes, and the social and cultural aspects surrounding it, fostering a comfortable environment and providing safe spaces for open dialogue ensures

individuals can express themselves without fear of judgment [28]. A survey by the International Center for Research on Women states that menstrual hygiene education programs and community-based interventions have been implemented across Sri Lanka [22]. These programs aim to empower women by providing information about menstrual health, creating a positive environment, and ensuring access to such products is affordable [29].

Sri Lankan Cultural Perspectives on Menstruation

In many cultures worldwide, menstruation is often accompanied by societal values that constrain individual access to menstrual products and their health practices [30]. Societal attitudes surrounding menstruation in Sri Lanka greatly impact the issue of menstrual equity across generations. Menstruation holds varying significance across different communities in this region due its diverse practices in culture. While some celebrate this milestone as a symbol of fertility and womanhood–such as India–others view it with secrecy, shame, and misinformation. This shapes the perspectives around what is perceived as both positive and negative occurrences in a woman's life. One specific example in Sri Lanka is Kotahalu Magula is a ceremonious coming of age with Sri Lanka which signifies the transition between wearing shorter clothing when younger to longer garments when a girl reaches womanhood. Celebrated with a bath and new fresh white garments is a day for these girls to embrace a cultural celebration of menstruation. Of course, rituals include isolation in a specific room where girls are given time to rest and eat healthy. Contradictory beliefs stem from this practice for it can significantly impact a young girls education and school attendance [31].

Generational differences towards menstruation also exist in many cultures. Younger generations, particularly in urban areas, may be more open to discussing menstruation and challenging the views of other traditional beliefs. However, older generations, influenced by traditional beliefs and customs, may hold more conservative views regarding the topic [16]. This is prevalent in Sri Lanka, as much of its urban population located in cities and highly populated areas have drastically different views than those in rural, secluded communities.

Discussion

Meeting Women's Demands

Approaches to addressing menstrual health and period product access in low-resource communities have often been characterized by the Western savior outlook, where external organizations impose solutions without adequately considering local contexts and preferences. This is often seen as paternalistic and disempowering, failing to address the nuanced needs and realities of individuals in all communities [32].

It is crucial to shift trends and provide women living in communities lacking the access to menstrual products to make informed choices about their menstrual health. This ultimately creates a sense of ownership over one's health and needs [33]. Instead of prescribing specific products or interventions, organizations should provide women with the option to request the

products they feel most comfortable using. However, to do so, western organizations can provide resources and support, while local groups understand the cultural context and specific needs of women in their communities. Together, they can offer education on various menstrual products, ensuring women are informed about their choices. In rural towns and villages, women aren't always given the freedom of choice in terms of menstrual products, especially due to their expense and lack of diversity.

By involving women in decision-making processes and prioritizing their preferences, organizations can ensure that interventions are culturally sensitive, effective, and sustainable in the long term. Successful outcomes have been evident throughout, with Maharashtra, India allowing for women's participation in WASH programs, which improved access to clean water and hygiene practices [34]. In Nepal, the Maternal and Child Health Integrated Program (MCHIP) successfully addressed cultural barriers to maternal healthcare by engaging local women's groups [35], prompting for maternal benefits like paid 14 week maternal leaves [36]. Similarly, education programs in Afghanistan achieved drastically high enrollments and retention rates for girls, notably from the years 2001 to 2018, mainly by involving former women teachers and community leaders [37].

Central to this approach is meaningful community engagement, where local perspectives and experiences are valued and integrated into program design and implementation. By doing so, organizations can gain insights into the unique challenges and barriers faced by menstruating individuals and accordingly create solutions that are relevant and impactful.

Addressing Health Concerns Surrounding Current Menstrual Product Solutions

Promoting open dialogue and education on menstrual hygiene is essential for empowering individuals to manage their menstrual health with confidence. According to a survey by UNICEF, only 38% of adolescent girls in Sri Lanka have access to menstrual hygiene education [38]. Lack of education perpetuates misconceptions about menstruation, contributing to limiting individuals' ability to advocate for changes in access and costs of such products and also making informed decisions about their menstrual health [28]. Comprehensive menstrual health education should cover topics such as anatomy, hygiene practices, and social, cultural, and emotional aspects of menstrual cycles [39].

Various organizations and individuals worldwide that lead non-governmental organizations (NGOs), grassroots, government agencies, and advocacy groups have been revolutionary in breaking menstrual stigmas globally [40]. These efforts help leverage their resources and networks to develop educational materials, organize events, and advocate for policy changes to improve access to menstrual products and facilities [41]. Ideally, these initiatives should be led by those directly affected by menstrual stigma or yearning to advocate for the pressing issue to make changes such as providing menstrual education and period products in school settings, along with fostering an open and inclusive community accepting of change. Centering their voices and experiences ensures that resources are relevant, empowering, and inclusive of diverse perspectives [42].

Overcoming Economic Challenges and Financial Barriers

Around the globe, individuals, particularly those from low-income and rural households, face challenges and financial constraints that limit their ability to purchase menstrual products regularly. Women and girls are disproportionately affected by poverty, with limited access to education, employment opportunities, and financial resources. As a result, they tend to struggle to afford menstrual products, resorting to makeshift solutions or forgoing essential hygiene practices altogether [43].

The high cost of menstrual products due to the taxation, which exceeds 52%, also poses challenges among the Sri Lankan population, as they are mainly imported resources/items [44]. This is displayed in **Figure 2**, which shows the trend of taxation on menstrual products throughout the years across countries in South Asia. Sri Lanka's period poverty rate is 50%, which typically translates to 50% of households with women of menstruating age that cannot spend any amount of money on sanitary napkins [45]. Alternatives like tampons and menstrual cups, while available, may not be as widely accessible or known, further hindering their ability to access cost-effective options.

Similarly, cultural stigmas surrounding menstruation can also influence purchasing decisions and preferences, potentially leading individuals to opt for less expensive, albeit less hygienic, methods of managing menstruation [28]. Gendered economic disparities put Sri Lankan women at risk, thus this results in limited access to employment and opportunities for financial resources; ultimately affecting the cost expenditures on a basis.

Income inequality also intersects with other forms of marginalization, such as race, ethnicity, disability, and geographic location, further amplifying the economic barriers to menstrual hygiene for marginalized groups [46]. Sri Lanka is a relatively new country and its environments drastically vary, especially between rural and urban residential areas. Individuals from different communities are affected by the lack of local access to menstrual products and hygiene factories that make these products [3].

Taxation on Menstrual Products vs. Years
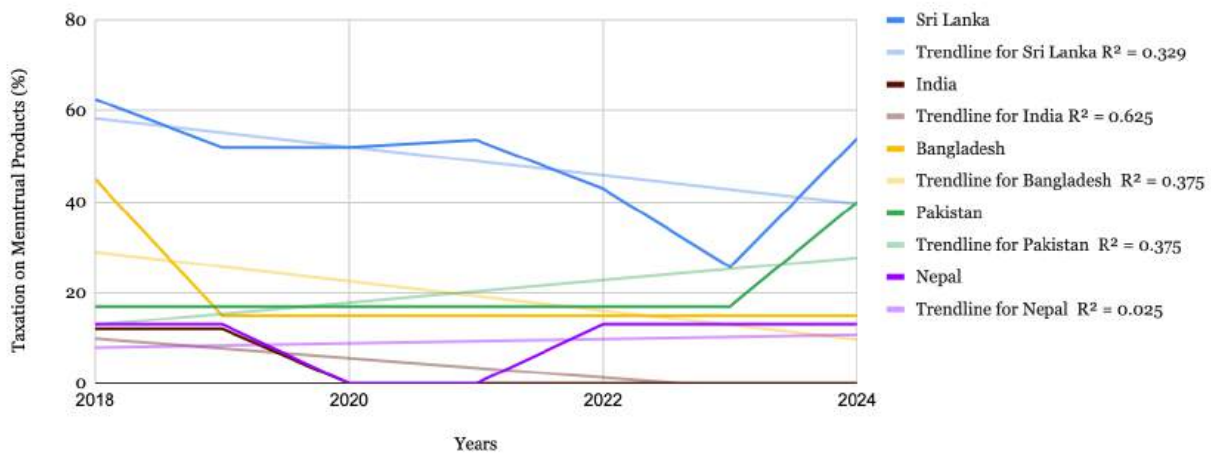
Figure 2: Taxation on Menstrual Products (%) 2018-2024 in five South Asian Countries

Year	Country				
	Sri Lanka	India	Bangladesh	Pakistan	Nepal
2018	62.6	12	45	17	13
2019	52	12	15	17	13
2020	52	0	15	17	0
2021	53.62	0	15	17	0
2022	42.9	0	15	17	13
2023	25.6	0	15	17	13
2024	54	0	15	40	13

[47] [48] [44] [49] [50] [51] [52] [53]

Figure 2 above provides data from the table shown, and it displays the trend of taxations on menstrual products across South Asian countries from years 2018 to 2024. From the graph, the R-squared values for Sri Lanka, Bangladesh, Pakistan, and Nepal all are relatively low, mainly around the ranges of 0.40. This suggests a weak correlation, implying that other factors not captured in this linear model significantly influence the changes in taxation among those countries, which will further be explained. India, on the other hand, has an R-squared value of 0.625, meaning about 62.5% of the variability in taxation can be explained by the trendline. This suggests a moderate correlation, indicating that as years progress, the taxation on menstrual products decrease.

In Nepal, the tax rate on menstrual products has varied as it was set at 13% until 2019. In 2020, due to the global Covid pandemic, Nepal exempted menstrual products from VAT, reducing the rate to 0%. However, the VAT rate was reintroduced at 13% in 2023 and has remained at that level since [54] [49].

In Pakistan, menstrual products have historically been subject to standard sales tax, known as a "luxury tax", which ranges from 17% to 20%. However in recent years, these taxes made period products affordable for many women and girls, especially in rural areas, and led to poor menstrual hygiene. In May 2024, UNICEF Pakistan reported that sanitary pads are taxed up to 40%, and that they are advocating for the reduction or removal of these taxes [52] [53].

India had eliminated its 12% goods and services tax on menstrual products, also commonly known as the "blood tax," the year after 2018 due to the outbreak of protests across the country and the lack of access to period products (more than 4 in 5 girls not having adequate access to them). In efforts to raise awareness for this long standing issue, Bollywood actor Akshay Kumar had taken a role in a Bollywood movie as Pad Man. Produced to address

menstrual equity, this piece caught the attention of the government which later abolished the blood taxThus, from year 2020 onwards, period product taxations ceased [48].

From the graph, the reduction in taxation on menstrual products in Bangladesh from 45% to 15% occurred as part of the government's efforts to make these essential items more affordable. Historically, menstrual products were heavily taxed, making them prohibitively expensive for many women and girls, particularly in rural areas. In fiscal year 2019-2021, the government temporarily removed value-added tax (VAT) on raw material imports for sanitary napkins, which significantly reduced the overall cost. This policy change aimed to support local manufacturers, stabilize prices, and improve accessibility to menstrual products. However, their retail prices have barely reduced, leading to women and girls hardly being able to afford them across the country [50] [51].

In Sri Lanka, the taxation on menstrual products was initially very high, with a combined tax burden of around 63%, including import duties, Cess tax, PAL tax, and VAT. This high taxation, especially compared to other South Asian countries, significantly increased the cost of these essential items contributing to menstrual inequity and making products inaccessible for many women and girls. In 2022, the tax rate was partially reduced to 42.9%, but it was not enough to make a substantial impact. Responding to advocacy efforts and recognizing the necessity of menstrual products, the government decided to eliminate VAT tax on these items in 2023, resulting in a 25.6% tax rate. This move aimed to improve menstrual health across the country, yet it has again drastically increased in 2024 due to additional revenue needs, political changes, and economic pressures [44].

Future Affordable Solutions and Community Initiatives

Addressing economic barriers to menstrual hygiene requires innovative taxation solutions and community-based initiatives prioritizing affordability and accessibility. Affordable menstrual product alternatives could be locally produced and distributed cloth pads and menstrual hygiene kits, offering cost-effective options for those with limited resources and clean water sources [28]. However, these products may not be affordable for some people. The collaboration of community organizations in rural areas to new alternatives while also distributing free or subsidized menstrual products for their income would reduce economic burden and contribute to environmental sustainability by minimizing waste generation [43].

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How AI Trained on the Confucian Analects Can Solve Ethical Dilemmas By Emma So

Abstract

The influence of AI has spread globally, intriguing both the East and the West. As a result, some Chinese scholars have explored how AI and Chinese philosophy can be examined together, and have offered some unique insights into AI from a Chinese philosophical perspective. Similarly, we investigate how the two fields can be developed in conjunction, focusing on the popular Confucian philosophy. In this work, we use Confucianism as a philosophical foundation to investigate human-technology relations closely, proposing that a Confucian-imbued AI would reduce prevalent AI ethical issues. Through this discussion, the strong substantivist stance that we will lose control over AI is refuted. We then discuss the practical elements of this project, explaining how passages from the Confucian text of the Analects can be incorporated into AI systems. As an example of a real-world context, psychology is used to demonstrate how the project could be practically applied. Potential criticisms surrounding the proposed project are also identified and challenged. By reducing the negative effects of common AI ethical issues and utilising Confucian principles from The Analects, AI systems can be more ethical, promoting peaceful relations between humans and technology.

1 Introduction

Artificial intelligence (AI) is without a doubt showing exponential growth every day. It is a field that explores the way in which machines can replicate humans' ability to perform different tasks, such as decision-making, translation, driving, and understanding people. Unlike traditional computational systems, AI systems can learn and improve based on historical data. They mainly involve algorithms, which are developed via the artificial neural network (ANN).

The ANN is specifically modelled to replicate the electrical activity within the human brain and nervous system. Neurodes, which are typically arranged in layers or vectors, are connected to other neurodes. Weighted data signals then enter a neurode to transfer the information within the network. Since AI systems contain the ANN, they are able to process information similar to how human brains can, thereby enabling them to self-learn (Walczak, 2003).

Seeing that AI is a complex recent technological advancement that functions in a way that is similar to humans, investigating its potential societal impacts, especially relating to its ethical nature, is of utmost importance. In light of this, the proposed project puts forward a novel idea of technological development within the field of AI and computer science: inserting passages from the Analects, the most well-known piece of literature by ancient Chinese philosopher Confucius into the algorithms of AI. The Analects, based on Confucius' teachings to his students, is a seminal work on virtue ethics that has been used for centuries to cultivate a holistic sense of virtue in individuals, and its moral principles are often considered the cornerstone of modern Chinese values.

There are a few main reasons as to why the Analects is chosen to be used in this proposed technological advancement. One of the main reasons is the fact that virtue ethics, a moral philosophy that stresses the importance of building a moral character through the cultivation of virtues, although researched by some, is not an area of philosophy that is as thoroughly developed in Western realms, such as deontology. Another reason is that there is a mounting number of concerns over the high level of eurocentric biases in the data of AI systems, so using an eastern philosophy would help reduce them. Given that Confucianism is the most well-known Chinese philosophy in modern-day society and had widespread influence in feudal China, there is a natural desire to investigate whether it could still be applicable to contemporary society. A third reason as to why the Analects is chosen is that the entirety of it is written in aphorisms, providing its readers with valuable insights into what it means to be virtuous, according to Confucianism. Aphorisms, unlike traditional full-picture stories, are not often examined closely, which is why this concept for a technological innovation seeks to investigate this area, as well as to defend their significance.

It is therefore with confidence that this proposal for a technological innovation is put forward in the field of AI along with high hopes that this postphenomenological investigation will contribute to the advancement of human society.

2. Confucianism and AI Ethical Concerns

Currently, there are many ethical concerns within the field of AI, with the most common ones being: (1) that AI will replace human jobs; (2) that AI will develop in ways that cannot be controlled by humans; (3) that there are biases in the data used to train the AI models; and (4) that AI systems are not private or secure enough.

Although the concept of combining Confucianism and AI systems is relatively new, there is still some existing research that supports the idea. This means that using a Confucian approach to alleviate AI ethical concerns can be seen as suitable. For example, philosopher and ethicist of technology Dr. Pak-Hang Wong demonstrates the importance of the Confucian virtue of li (禮, propriety) through his paper Why Confucianism Matters for the Ethics of Technology (2020), emphasising that li is important to the ethics of technology for primarily two reasons: (1) that it makes up the rules for social interaction, similar to how grammar makes up the rules for languages; and (2) that it fully embodies the virtues of the Confucian tradition and that it provides a set of moral or ethical principles that are considered binding within that tradition, which Wong refers to as the "normative standard". Ultimately, he argues that li can serve as the "normative standard" for ethical considerations, design, and use, or the ritualisation of technology to guide users and societal responses with reference to the virtue.

Additionally, in Intelligence and Wisdom (Song, 2020), contributor Chengyang Li also recommends AI to be included in the Confucian moral domain, which includes people and animals, which exhibit intelligent signs of morality. Some scholars believe that the intellect of AI systems means it should be included. Others cite the Confucian order, arguing that AI's status as a wu (inanimate object, 物) disqualifies it, as wu is the lowest category in the moral hierarchy.

However, Li reasons that despite this it should be "upgraded" within the Confucian order if it is able to make ethically relevant decisions, making it functionally similar to people and animals.

With the support of existing research within the Confucianism and AI discipline, there is promise that integrating passages from the Analects into AI systems would reduce AI ethical issues as Confucian ethical principles and values promote fairness, equity, and inclusivity.

2.1 The concern that AI systems will eliminate human jobs

The concern that AI systems will replace human jobs arises from a lack of understanding or misconceptions regarding the advancements, capabilities, and limitations of AI technology. The fear that AI systems will replace human jobs can be broken down into different "subtypes", each of which adds to the overall concern about the potential elimination of human jobs by AI systems. The first "subtype" is the fear that smart machines can outthink us, therefore having the ability to replace human judgement.

The question of whether or not AI could replace human jobs from a decision-making aspect was explored by a group of Harvard professionals. One of the professionals, Fuller, responds that it is highly unlikely for AI to eliminate entire job categories. He states that "what we're going to see is jobs that require human interaction, empathy, that require applying judgement to what the machine is creating [will] have robustness" (Pazzanese, 2020). Another professional, Mills, believes that AI could bring more benefits than harm to businesses because their owners could be provided with detailed insights into important financial information pertaining to them (Pazzanese, 2020). Therefore, as long as AI is used as a supporting device instead of a primary method for humans to make decisions, it will only enhance their ability to make informed ethical judgments and will not eliminate human jobs as a result.

This aligns with the Confucian belief that education and self-cultivation are necessary for moral development, which is elucidated in the Analects 2.15: "The Master said, "to study without thinking will cause bewilderment. To think without studying will cause danger" (「學而不思則罔, 思而不學則殆。」) (Lui, 2016). Contextualising Confucius' philosophy, it means that humans would be foolish not to think or study the implications involved in their ethical decisions before using AI to aid them in their decision making. This is also in agreement with Naik et al.'s paper, which argues that users or operators of AI systems should be aware of their limitations and how they are designed, even when bias within the systems are effectively managed (2022). Whilst AI can enhance human decision-making, humans should still remain educated about the capabilities and limitations of AI and use it responsibly.

2.2 The concern that humans will lose control over AI.

The second "subtype" of fear is the concern that the power of AI will progressively surpass human control. This can be addressed via the study of postphenomenology, which aims to explore the way in which technologies help to shape the relations between humans and the world. The proposed project, that passages from the Analects should be incorporated into AI systems, can contribute to postphenomenolological studies by providing a philosophical

foundation that explores the relationship between humans and technology. Through this, humans are invited to reflect on the role of technology and to consider whether technology is fundamentally an instrument that derives all its impact from human actions and intentions, or if it possesses the capacity to reshape society beyond, and potentially independent of, human intentions (Rosenberger and Verbeek, 2015, p.2). The former approach is known as instrumentalism, whereas the latter approach describes a strong substantivist stance. Not all substantivists view technology as pessimistically as described. In fact, only very few support such a strong stance. Milder substantivists simply acknowledge the non-neutrality of technology as a tool (Rosenberger and Verbeek, 2015, pp.2-3).

The belief that AI will surpass human control and replace human jobs is a thought that is driven by certain sectors of substantivists, which the proposed project seeks to address. The most prominent example of a strong substantivist is German philosopher Heidegger, who views technology as "the greatest danger". He believes that danger is in itself dangerous, and that humans have not unravelled its true form or essence. Hence, he reasons that humans should develop a mindset of "releasement", which involves recognising that technology is omnipotent and that it is impossible to escape from understanding the world under its influence. He explains that instead of succumbing to it, humans should instead stay open to new ways of understanding and existing in the world (Heidegger, 1977).

There are some problems with regards to his approach. The first problem, which is identified by political philosopher Feenberg (2000), is that it fails to provide scholars who want to engage with differing technologies and their societal implications with anything of merit, since it assumes that all technology is harmful to the same extent. A second limitation outlined by Verbeek (2005) states that Heidegger's approach is limited, as it does not consider the practical and real-world implications of technology. A third limitation is the overemphasis on the historical development of humans and the role that technology plays within it. Even though it is important to consider the historical nature of humans, the evolving nature of technology should not be undermined.

It can therefore be argued that the strong substantivist stance is highly limited, further reflecting the need for humans to view technology more open-mindedly. Humans should, for instance, be encouraged to reevaluate their fears pertaining to AI eliminating human jobs. The proposed project supports this, resonating with the broader idea of postphenomenology, promoting that humans can work alongside technology. It seeks to maximise the benefits of AI whilst ensuring that human control remains the dominant force behind the development of the systems. Additionally, it adopts an instrumentalist stance, acknowledging that AI is neutral in itself- the implications of technology depends on how it is designed by, and how it interacts with, humans. Ergo, the project seeks to address the concern that AI will surpass human control and replace jobs by directly contributing to the growing field of postphenomenology because it will examine the relationship between AI systems and their users closely.

2.3 The concern that there are biases in training data.

The concern that there are biases in the data used to train AI models can be alleviated with the proposed project. Training data is an essential and arguably the most important part of machine learning. It is a set of data that the machines use to correct their behaviour and is the foundation of the machine learning model, which corrects the behaviour of the machine through analysing the training data and understanding its features (Joby, 2021).

Different factors that contribute towards the existence of biases in training data include the underrepresentation or overrepresentation of certain demographic groups, sampling biases, data collection methods, and inherent biases in the data sources themselves (Chapman University, 2022).

The proposed project will target the factor of the underrepresentation of data due to the diverse perspectives offered by Confucius' teachings from the Analects regarding the various aspects of human life, focusing on the importance of virtues. By integrating the Analects' passages into AI systems, the models are exposed to a wider range of ethical viewpoints, challenging the limitations of Western-centric biases that may be present in the data. This infusion of diverse perspectives allows AI models to develop a more inclusive understanding of human values and behaviours. A way of approaching this is through the study of virtue ethics. This is better understood as behaviours of high moral standards, so that the right decision can be made in any given circumstance (Angle and Slote, 2013).

Namely, some important virtues of Confucian philosophy are ren (仁), the concept of humaneness; xiao (孝), which is filial piety; li (禮), meaning propriety; and yi (義), which refers to righteousness.

The core of Confucian philosophy, however, is the virtue of ren (仁). It describes that people should behave in a loving, selfless, and moral way. Confucius believed that through building a moral character, it enables one to affect the world around them positively through "cosmic harmony", which refers to the maintenance and regulation of various properties in the world. It makes sense, then, that the golden rule of Confucianism is "do not do unto others what you would not want others to do unto you" (Angle and Slote, 2013).

It is through ren (仁) that the other virtues are introduced: xiao (孝) describes the way in which people should interact with each other based on their relationship status, li (禮) concentrates on the fixed set of rites and rituals that people should adhere to according to the role system, and yi (義) is the willingness to behave in a positive way that is beneficial to oneself and the community around them. Xiao (孝), for instance, would be for one to treat their parents with respect; li (禮)would be for a funeral guest to wear black to the funeral; and yi (義) would be for one to volunteer for military service.

By taking advantage of the emphasis on virtue ethics that is evident through the Analects, the biases in training data of AI systems will be challenged through a more holistic and morally grounded approach to artificial intelligence development and implementation.

2.4 The concern that there are privacy and security issues

The virtue of xiao (孝) can serve as a guiding principle for the development of AI systems, addressing concerns about privacy and security. By inserting the relevant passages related to xiao (孝) from the Analects into the AI systems, the privacy and security of users can be prioritised.

This is because if AI systems are imbued with xiao (孝), they will be programmed to act with respect towards humans, meaning that they will ensure that user data is handled with care and not misused or accessed without consent.

The belief that all relationships must fall under a strict social hierarchy is closely related to xiao (孝), as it emphasises the importance of respecting and fulfilling one's obligations to family members and other individuals based on their social roles and positions. This can be seen through the five cardinal relations (五倫), which refer to: (1) the relationship between sovereign and subject; (2) the relationship between father and son; (3) the relationship between elder and younger brother; (4) the relationship between husband and wife; and (5) the relationship between a friend and friend (He and Li, 2015).

According to Confucian philosophy, family lies at the centre of society and should be prioritised before the individual (Stanford Medicine, 2019). A passage from the Analects that illustrates this is 4.18, in which "The Master says, "in serving our parents, if we discover some fault in them, we should advise them tactfully by expressing our own view. If they do not take any heed, we should still respect them rather than rebel against them. While we worry about them, we should not blame them" (子曰:「事父母幾諫。見志不從, 又敬不違, 勞而不怨。」) (Lui, 2016).

This can be used to address privacy issues surrounding AI because it mentions the necessity of respect and empathy within a parent-child relationship. This means that if it were to be incorporated within AI systems, a sense of ethical behaviour and responsibility could be instilled by the developers, ensuring that user data is handled with care and respect. As a result, the users will feel more safe and secure in handling AI systems.

3. The Method of Integration of the Analects

Machine consciousness, as a hot topic in contemporary society, will inevitably arise as a discussion point when considering this project. Would the project require machines to be conscious?

The idea of machine consciousness has also been discussed amongst Confucian scholars. Contributor Chunsong Gan of Intelligence and Wisdom (Song, 2020) is pessimistic about this, fearing the impacts that it might have on traditional reproductive practices and the Confucian ideal of "kinship society".

Despite the instrumentalist stance of the proposed project, it will still not support the idea of machine consciousness, as the repercussions and consequences of such an approach could be tremendous. In order for machine consciousness to be considered, more research with regards to it is required.

Also, machine consciousness is not needed for this proposed project in particular, as it could integrate Confucian ethics into AI by incorporating explicit ethical maxims into the machine's code, enabling precise ethical judgments based on Confucian principles in different ethical situations. This is explored through James H. Moor's paper on The Nature, Importance, and Difficulty of Machine Ethics (2006), in which he describes two ways of incorporating ethics into machines: the first way is to create software that implicitly supports ethical behaviour (which is what implicit ethical agents entail), and the second way is the aforementioned one, which is to write code containing explicit ethical maxims.

Through the first way, Moor explains that the machine's actions will be constrained and so unethical outcomes will be avoided, and that it will also act ethically because the machine's internal functions will promote ethical behaviour. Moor also argues that in order for machines to achieve ethical outcomes, it is more feasible for them to act as implicit ethical agents. He uses the implicit ethical agents of automated teller machines and Web banking software to illustrate his point- they are meticulously constructed, and argues that using a line of code to tell the machines to be honest will not produce the desired outcome.

AI systems are implicit ethical agents and therefore the proposed project would adopt this approach. In the context of this project, the AI would be trained to act according to Confucian principles in numerous situations. Over time, it would learn to internalise the behaviour and act accordingly in unseen situations. For example, if someone were to ask the AI if they should hire someone who has flattered them during an interview by referring to them as "top of the field" despite the candidate lacking experience and showing no signs of a strong work ethic, the AI could be taught to respond according to the passages from the first chapter of the Analects, which is about learning. In this situation, for instance, it could respond: "The Master says, "Those who are glib in their speech and wear an ingratiating expression have little benevolence about them" (「巧言令色, 鮮矣仁」) (Lui, 2016). The response could also include a contemporary explanation of the saying in the context of the situation. Below the saying, it could state: "be careful with flattery. Flattery is not always the truth."

If this project were not AI-based and instead adopted an explicit agents approach, the number of rules required to be inserted into the system would be inexhaustible. Due to the contingent nature of virtues found in the Analects, there are many possibilities for each virtue, meaning that it would take immense periods of time and effort to ensure that each possibility is inserted into the system. In addition, the system would be limited to only a few situations, as it would only know how to respond in situations that it has been taught. In comparison, an implicit ethical agent approach would provide us with more benefits.

Machine consciousness exists in theory, whereas an explicit ethical agent approach is not feasible for the purpose of this project. An implicit ethical agent approach, on the other hand, would be an efficient and energy-saving way of achieving the goal of having a Confucian-imbued AI that is trained on the Analects.

4. The Practical Application of The Project Explored Through Psychology

Inserting passages from the Analects into AI systems could benefit various industries in a number of ways, as it promotes ethical behaviour that should be taken into consideration no matter which industry one may work in.

The Analects contains values that align with the moral beliefs of a wide variety of people from differing backgrounds, emphasising the concepts of trust and kindness, meaning that an AI that is embedded with Confucian principles could benefit an unprecedented number of people.

The field of psychology witnesses expansion on a daily basis, especially within the area of psychotherapy, following a societal paradigm shift that places a strong emphasis on mental health in recent years. Since it is a discipline that explores interpersonal relations closely, it is reasonable to evaluate how the proposed technological advancement could be implemented within this industry.

The concept of AI chatbots functioning as therapists, although new, is rapidly advancing, where an increasing number of experts in both the fields of psychology and computer science are exploring ways to use AI as a tool for counselling or therapy. Examples of this include Woebot (Evers, et al., 2024), talk2us.ai (talk2us.ai, 2024), and Ellipsis Health (Verma, et al., 2016), which are all AI chatbots that use cognitive behavioural therapy (CBT) principles to provide users with guidance and emotional support pertaining to each of their respective situations. Out of the three, Ellipsis Health can even detect in advance warning signs of mental disorders, such as anxiety and depression, before they fully manifest (Verma, et al., 2016). As a result, users are able to more proactively change their daily lives before their issues develop chronically.

Even though these chatbots are relatively safe to use, the topic of mental health issues is a sensitive topic and can even lead to health and safety concerns. Before the user interacts with the chatbot, therefore, these platforms usually offer a disclaimer stating that the company does not guarantee the full accuracy of information provided by the chatbot, and recommends one in crisis to seek help from a nearby emergency room or online hotlines. With this emerges the issue of ethics: to what extent are AI chatbots ethical?

The American Psychological Association (APA) keenly distinguishes between the Ethical Standards of psychology and its General Principles (American Psychological Association, 2017). The Ethical Standards of psychology include guidelines on resolving ethical issues, competence, human relations, privacy and confidentiality, and more.

General Principles, on the other hand, suggest ethical ideals that are only "aspirational in nature" (American Psychological Association, 2017) to encourage the highest order of ethical standards. They include ethical recommendations such as beneficence and nonmaleficence, fidelity and responsibility, integrity, justice, and respect for human rights and dignity.

These principles align with the Confucian principles that are illustrated in the Analects. For example, regarding beneficence, a passage from the Analects that depicts this is Chapter 4.2, where The Master says, "Only those who are wise and benevolent can seek humanity" (「仁者安仁，知者利仁」。) (Lui, 2016). Another example is Chapter 4.19, where The Master says, "When your parents are around, do not take a long journey. And if you must do so, you should let them know where you are heading." (「父母在，不遠遊。游必有方」。) (Lui, 2016). This aligns with

the ethical recommendation of responsibility in the General Principles of Psychologists and Code of Conduct, as it promotes responsible behaviour by advising us to inform our parents of our location to prevent them from getting worried. This means that the proposed project can not only enhance the Ethical Standards set by the APA within psychology AI chatbots, but also substantialise the General Principles, promoting them from aspirational principles to compulsory ones.

Between the APA's Ethical Standards and the Analects, an overlapping feature that they share is the concept of benevolence, which is referred to as ren (仁) in the Analects, and Beneficence and Nonmalevolence in the APA Ethical Principles of Psychologists and Code of Conduct (2017). According to APA's definition of Beneficence and Nonmalevolence, it is when psychologists do no harm to their clients and instead strive to benefit them.

This aligns with what is elucidated in the Analects, as Confucius states that it is important to "be loyal, honest and reliable when dealing with people " when Fan Chi asks about benevolence in 13.19 of the Analects. This means that treating others well is a recurring theme in both Confucian philosophy and ethical guidelines for psychologists. Hence, if the passages from the Analects related to benevolence were to be incorporated into the algorithm of psychology AI chatbots, they would be able to respond in a manner that is in line with the Ethical Standards whilst emphasising Confucian teachings at the same time. For example, in a hypothetical situation, if the user of the Confucian-imbued chatbot were to ask the AI if they should continue living with their toxic partner or to move out and live with their kind sister instead, it could then respond: "according to Confucius, "living in an environment of benevolence is beneficial" ("里仁为美，则不处仁").

Another overlapping principle between the APA's Ethical Standards and the Analects is the concept of trust. This is of paramount importance regarding AI chatbots and user interactions, as users wish to disclose sensitive information to the chatbots, which can only be done under the condition that the users trust the chatbots. According to Confucius, "if a person cannot keep his word, he will not be able to achieve anything" ("人而無信，不知其可也"). In a hypothetical situation, if a user of a Confucian-imbued AI chatbot were to inquire about their partners' infidelity, the chatbots would be able to give advice to them according to Confucius' sayings. It could then also offer a contemporary analysis of the situation and contextualise it to fit the user's needs. In this circumstance, the AI could, for instance, respond: "According to Confucius, "人而无信，不知其可也。" This translates to "if a person cannot keep his word, he will not be able to achieve anything." Therefore, you should believe that he is keeping his word in saying that he will be bound to you forever- for if it is trust that he lacks, he may not be able to achieve anything of significance in your relationship."

5. Counterarguments to the Proposed Project

However, despite the many benefits of the proposed project, some factors may bring into question its validity. These counter arguments will be addressed and discussed at length, including the aphoristic nature of the Analects and critiques from Daoists. It will be explained

that using the aphorisms from the Analects do not limit the data that the AI receives and instead opens the system to new possibilities. It will also be explained that this approach would not lead us astray from nature and will instead bring us closer to The Way, otherwise known as dao (道).

5.1 The aphoristic nature of The Analects

        The proposed technological advancement, that passages from the Analects should be inserted into AI algorithms, is centred around the usage of the Analects. Although some may criticise the use of an aphoristic piece instead of a traditional extended argument or essay, aphorisms can be perceived as more preferable because they are subject to contingency in a way that is within reason. This is supported by philosopher Wong (2020), as he explains in his paper that the Confucian ideal of "naturalness" (自然) enables humans to reflect on not only what we do in a situation, but also how we do it. It is a pattern, as it is consistent throughout the Analects, no matter which virtue is emphasised. For example, 13.23 of the Analects states that "The noble man is in harmony but does not follow the crowd. The inferior man follows the crowd, but is not in harmony" ("君子和而不同。小人同而不和") (Muller, 2021). This accentuates the underlying importance of naturalness because it is implied that if one were to actively change their behaviour to fit in with others, their behaviour would not be authentic as it is forced. Everyone has a different "naturalness" which should be accepted. Philosopher Kupperman (2002) further elaborates on this idea, as he explains in his paper that the Confucian ideal of "naturalness" is when "the agent is reasonably comfortable with his or her behaviour, and there is no conflict between the behaviour and what the agent normally is like", which is in alignment with what Wong illustrates.

        The contingent nature of the virtues can also be found throughout other parts of the Analects. For example, both 12.22 and 12.1 of The Analects state the word "ren" (仁), but their definitions in each situation differ due to them being used in different contexts. For example, in 12.22, when Fan Chi, one of Confucius' disciples, asks Confucius for the meaning of ren (仁), he responds with "love your fellow men" ("爱人"). However, when Yan Yuan poses the same question in 12.1, Confucius responds "benevolence is to discipline yourself to complete tasks according to the protocol... You should see no evil, hear no evil, say no evil, and do no evil." It is therefore evident that the virtues are purposely subject to contingency, and that this is an essential element that should not be carelessly misplaced or overlooked when extracting Confucius' ideas from the Analects to use for another project.

5.2 A Daoist critique

        Another possible piece of criticism regarding the project might come from the Daoists, who are philosophers that believe in embracing dao, otherwise known as "The Way" (道), and maintaining "Oneness" (守一). They might criticise the proposed project for disrupting nature through promoting the use of technology. They believe that it would interrupt "The Way", which is the universal operating mechanism of the world. As Song (2020) comments in Intelligence and

Wisdom, "they are unlikely to embrace disruptive technologies that result in any displacement of the natural flow of things."

However, it can be argued that technologies can bring humans closer to dao (道), especially since postphenomenological investigations place a particular emphasis on how humans and technology can interact with each other in a mutually beneficial way. As Verbeek (2021) illustrates in his paper, these studies shed light on the relations between humans as they are interacting with different types of technology, so that these technologies serve as a mediation tool instead of a disruptive one. Examples of this include using a MRI scanner, or an EEG scanner to plan a patient's treatment plan, where humans are directly interacting with the technology and develop new types of behaviour as a result of their interactions. Furthermore, instead of viewing technology as a foreign entity that disrupts the flow of nature, it is also worth considering that it is now seamlessly embedded into our daily lives, with its presence now feeling as natural as any other element of our environment. Hence, it might be worth considering the possibility that technology might be now essential to maintaining the natural flow of life in contemporary society. By viewing technology through a postphenomenological lens and considering the positive impacts of technologies, the Daoist critique can be refuted.

6. Conclusion

The development of AI has a variety of ethical implications, pervading both interpersonal interactions and the mechanisms of our societies. An over-reliance on AI raises many concerns regarding the possibility of AI replacing human jobs, biases in the data that is used to train AI models, and that the AI systems that we use in our daily lives are not secure enough. This project therefore proposes a technological advancement in the field of AI- or, more specifically, AI ethics. Namely, the proposal is to insert passages from the Analects, an important piece of literature in Ancient Chinese history created by philosopher Confucius' disciples, into AI algorithms to promote more ethical AI-powered systems.

Not only does the proposed technological advancement acknowledge ethical issues within the field of AI and offer ways to reduce them, but it also introduces postphenomenology as a recent field that is being investigated by computer scientists and philosophers alike. It defends the advancement of technology in the sense that it can be used as a source of comfort when considering the instrumentalist stance within the field of postphenomenology. Moreover, since it is proven that AI developers and philosophers are investigating relations between humans and technology, meaning that there is a growing awareness of AI ethical issues, and increasing attempts to alleviate them. The idea of a Confucian-infused AI, then, seeks to contribute to postphenomenological studies.

Additionally, to illustrate that technology can ethically play a role in humans' lives through the proposed technological advancement, this dissertation uses the field of psychology as an example of an industry that could benefit from it. Since it is a discipline that deals with personal and sensitive issues, it is then believed that the Confucian-imbued AI could be applied to a wide range of industries.

Lastly, this project addresses the potential criticisms that it may receive due to its bold, original, and modern approach. It understands the complexities involved pertaining to the interpretational aspect of the proposed development, and also argues for the nature of aphorisms as a strength instead of a weakness.

As AI inevitably continues to evolve, humanity must continue to develop it with rigour and careful consideration of ethics, involving ethical philosophers and professionals in its field of application at every step to navigate its benefits and limitations.

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Understanding the Impact of Respiratory Viral Infections on Immunocompromised Populations By Siqi Julia Lai

Abstract

Respiratory viral infections like COVID-19, influenza, and respiratory syncytial viruses impact human health tremendously, especially that of immunocompromised people. These individuals have a weakened immune system and, thus, are more vulnerable to catching and developing worse infections. This report contrasts the normal immune response to respiratory infections with the response and impact of viral disease on the immunocompromised. Specifically, it will focus on individuals with autoimmune diseases (systemic lupus erythematosus), chronic diseases that affect the immune system (lymphoma and persistent Epstein-Barr virus infection), and people who fall into high-risk age categories (adults greater than age 65 and infants from 0 to 6 months). The goal is to explore the effects of respiratory viral disease on groups with weakened immunity to identify protective strategies for them in our communities. We propose vaccination and healthcare accessibility as well as strict adherence to public health guidelines and personal preventative measures, as important ways to safeguard our vulnerable population.

Introduction

Respiratory viruses burden the global healthcare system and significantly impact immunocompromised people, who comprise a substantial subset of the population. Respiratory viruses such as influenza virus, SARS-CoV-2 virus (COVID-19), and respiratory syncytial virus (RSV) infect our breathing passages (nose, mouth, lungs) and spread through direct contact with respiratory droplets. These viruses can cause infections ranging in severity from mild to severe and, in some cases, result in hospitalization and death. Immunocompromised individuals experience more severe effects from infections because their immune systems are weaker and likely dysregulated, reducing viral clearance. Vaccines do not work as effectively for an immunocompromised individual as a healthy individual because they do not trigger a strong enough response from their immune system. Additionally, the immunocompromised population is heterogeneous, including individuals with autoimmune disease, chronic disease, and even high-risk age groups like infants and the elderly. Understanding how respiratory viruses affect the immunocompromised will allow us to shed light on this vulnerable group and identify strategies to better protect their health.

Viruses are incredibly complex microbes that can infect and kill millions of people. Our immune system has evolved mechanisms to combat viruses and prevent prolonged, severe illness. However, in immunocompromised people, the immune system is incapable of robust responses, leading to long recovery times and more critical symptoms. For example, the respiratory syncytial virus (RSV) is a common virus that hospitalizes more than 100,000 older adults per year and causes around 10,000 deaths. Most healthy individuals who get infected with RSV develop mild cold-like symptoms and recover within two weeks, whereas high-risk age

groups like infants and the elderly are disproportionately affected due to their weaker immune systems, ending up with RSV bronchitis or pneumonia. According to the Administration of Aging, there are over 70 million people over 60 years old in the United States, which means over fifteen percent of our population is in a high-risk age category. When factoring in the percentage of infants, this percentage surpasses fifteen percent. It is essential to spread awareness about the effects of viruses on immunocompromised as there is a substantial population of people in the US who are more vulnerable to disease and require more attention from the public.

Overall, this paper will investigate the normal immune response to viral respiratory infections and the response and impact of viral disease on the immunocompromised. Specifically, it will focus on individuals with autoimmune diseases, chronic immune diseases, and people who fall into high-risk age categories. The goal is to explore the effects of respiratory viral disease on groups with weakened immunity to identify protective strategies for them.

Normal Immune Response to Viral Infections

To gain a deeper understanding and more holistic view of respiratory viral diseases and their impact on immunocompromised populations, we must investigate the distinct characteristics of a virus. Viruses are considered non-living, infectious agents that depend on infected host cells for replication. Though viruses cause similar symptoms as bacteria, a distinct difference between viruses and bacteria is that bacteria are single-celled and can survive independently.

Coughing and sneezing are not the only ways a virus can travel; touching a contaminated area or surface and then rubbing your eyes, nose, or mouth can also lead to infection. Symptoms of an infection include runny nose, sore throat, headache, and fatigue. Additionally, we can classify a respiratory infection into two categories: upper and lower infection. Upper respiratory infections affect our sinuses and throats, while lower respiratory infections affect our airways and lungs. The latter is generally more severe and lasts longer because it impacts our lungs and chests, which can result in bronchitis, chest infection, or pneumonia.

There are many steps involved in the viral infectious cycle. The process can be divided into three stages: entry, genome replication, and exit. In the entry stage, the virus attaches to the host cell's plasma membrane and interacts with two proteins: the attachment factor and the viral receptor. These proteins help the virus particle penetrate the membrane and enter the cell's cytoplasm. After penetration, the virus particles move to a specific site in the cell with cellular machinery that allows them to replicate in the nucleus. Following replication, the virus exits the cell either through cell lysis or budding through the plasma membrane. The stages of entry, genome replication, and exit are complex but essential to understand for a thorough comparison of this process in a healthy immune system with a weakened one.

The immune system is our primary defense mechanism against viruses and bacteria. It is one of the most complex biological systems known to us. When a virus or bacteria enters our body, it triggers immune responses from both the innate and adaptive immune systems. The innate immune system acts quickly to clear pathogens (minutes to hours) while the adaptive

immune system forms a long-term response (days to weeks) that can provide long-term protection (lasting years) against pathogens. The innate immune system, the more ancient immune system, comprises cell types such as neutrophils, macrophages, and dendritic cells. It has evolved to respond quickly in minutes to hours against toxins and infectious agents. Their components include physical and anatomical barriers like skin and mucous and epithelial cells which serve to separate the organism from the external environment. On the contrary, the adaptive immune system takes days to weeks to respond, but it possesses T-cells and B-cells that effectively get rid of the virus. Although the adaptive immune system takes longer to initiate a response, it is the body's strongest immune response. Immune system cells can recognize the viruses with protein receptors at the outer plasma membrane. Because the adaptive system has billions of pattern-recognition receptors capable of recognizing various viruses, it is challenging for pathogens to bypass the system without detection and destruction. After an infection, our immune system gains memory of the specific virus and is able to kill the virus if the body is infected again. Because we can develop immunity to viruses, symptoms are mild to none in our second infection of the same virus.

The adaptive immune system is capable of defending our body from pathogens. However, because of the myriad of protein receptors in the immune system, there is a chance the immune system recognizes the body's own beneficial cells as foreign and attacks them, sometimes resulting in autoimmune disease. Infections can be deadly for immunocompromised or immunosuppressed people with dysregulated immune systems. Because of their reduced ability to fight infections, the immunocompromised are at a higher risk in our community. Causes of a weakened immune system include AIDS, diabetes, genetic disorders, etc. Moreover, treatments like radiation therapy or medications following organ transplants can also weaken the immune system. A person with a weakened immune system might always have a cold, a slow wound healing process, frequent diarrhea or constipation, infections, or low energy levels. While a healthy individual can fight off an infection in a week or two, an immunocompromised individual might experience a prolonged infection that lasts for several weeks. According to the Centers for Disease Control and Prevention, the risk of death in hospitalized people with COVID-19 is 1.44 times greater for immunocompromised people than for others. Another main risk factor for the immunocompromised is the inefficacy of vaccines to protect them from serious infection. For example, during the COVID-19 pandemic, immunocompromised patients were advised to get additional doses of the mRNA vaccine because a single dose may not mount a sufficient immune response.

Table 1

Specific Immunodeficiencies Mentioned

Autoimmune disease	Systemic lupus erythematosus
Chronic diseases that affect the immune system	Lymphoma and persistent Epstein-Barr virus infection
People who fall into high-risk age categories	Adults greater than age 65 and infants from 0 to 6 months

Response and Impact of Viral Disease on People With an Autoimmune Disease

Autoimmune disease occurs when the immune system can not distinguish between foreign pathogens and host cells, triggering immune responses to host tissues, and causing significant damage to the body. People with autoimmune diseases like systemic lupus erythematosus (lupus) or type 1 diabetes are especially susceptible to and more affected by viral infections as their overactive immune system targets host cells. Consequently, autoimmune disease patients experience more severe symptoms during infection.

Viral infection induces a robust immune response in the body. Still, when the immune system is dysregulated and can not control its response, it can target and harm beneficial host cells. A mechanism called molecular mimicry plays a role in autoimmunity. In this process, viral proteins that share structural similarities with self-peptides activate autoreactive T or B cells, which can shift the immune response to attack itself. Although there are technological limitations and a lack of statistical power in the study of T-cells and B-cells, the concept of molecular mimicry may still help prevent and treat autoimmune diseases.

Lupus, a common autoimmune disease, can be characterized by a facial rash shaped like a butterfly's wings. Usually, individuals are predisposed to developing the disease; however, external factors like infections, drugs, or sunlight can trigger its onset. Those with lupus can have episodes or flares, which is when symptoms temporarily worsen and then improve or even disappear rapidly. Additional signs of lupus include fatigue, joint pain, swelling, and fever.

As mentioned before, external environments combined with genetics can cause one to develop lupus. Respiratory viruses like COVID-19 and influenza/flu have been reported to trigger systemic lupus erythematosus (SLE) flares. Disease flares are dangerous and can result in organ damage, which can lead to hospitalization and death. According to a report published in 2021 analyzing the relationship between influenza infection and SLE flares, influenza infection positively correlates with SLE flares, resulting in hospitalization. In other words, a flu infection can cause a higher risk of SLE flares. Therefore, we must consider the possibility of SLE flares in patients during the first 7 days of influenza infection. A case report published in 2022, on the contrary, researched the relationship between COVID-19 and systemic lupus erythematosus. According to the report, there have been cases where COVID-19 infection caused autoimmune disease development. In one case, a 53-year-old male patient developed SLE one month after COVID-19 infection. At first, the patient complained about fatigue, wrist pain, and vomiting, but after examination, it was revealed that they were in acute renal failure due to SLE. Overall, developing autoimmune diseases like SLE after a COVID-19 infection is rare but possible.

Generally, respiratory infections significantly impact immunocompromised people with autoimmune diseases, as infections are external factors that can trigger the onset of lupus and other diseases. Specifically, in lupus, infections can increase the risk of flare-ups, which can be severe and require hospitalization.

Response and Impact of Viral Disease on People With Chronic Diseases That Affect the Immune System

Some diseases last a prolonged period and can be classified as chronic immune diseases. They are especially dangerous because they persist for an extended amount of time and often cannot be cured.

Hodgkin's lymphoma, or Hodgekin's disease, is a type of chronic immune disease that affects the lymphatic system, which plays a big role in the body's immune system. The disease is a kind of cancer where infection-fighting white blood cells called lymphocytes multiply rapidly and uncontrollably, resulting in swollen lymph nodes and various tumor growths in the body. There are two types of Hodgekin's lymphoma: classical Hodgkin's lymphoma and nodular lymphocyte-predominant Hodgkin's lymphoma. Classical Hodgkin's lymphoma is more common, while the nodular lymphocyte-predominant Hodgkin's lymphoma is much rarer and requires less intensive treatment. Several disease symptoms include lymphadenopathy (painless swelling of lymph nodes) in the neck, armpit, or groin, fever, and severe itching. Though doctors are still unable to pinpoint the exact cause of lymphoma, they believe it involves DNA mutation in the lymphocytes that signals its own continual division and growth. Besides DNA changes, the lymphoma cells attract healthy immune cells to protect their growth. People with a family history of lymphoma, people who are infected with HIV, and people with a past Epstein-Barr infection have an increased risk of developing this disease.

Hematological malignancies (HMs) are cancers of blood-forming cells or tissues. Researchers have determined that patients with Hodgkin's lymphoma, which falls under the category of HMs, have a high susceptibility to RSV, influenza virus, parainfluenza virus (PIV), and human metapneumovirus (hMPV). During the winter months, when RSV and flu infections are most prevalent, immunosuppressed patients are at a higher risk of an upper respiratory tract infection (URTI). In more severe incidences, these respiratory viruses can cause lower respiratory tract infection (LRTI) in patients with HMs, which is more severe and dangerous than an upper infection. Increased mortality rates and progression into LRTI are associated with respiratory infection of RSV, influenza, PIV, and hMPV in patients with HMs. Therefore, preventive strategies and measures should be used to prevent community outbreaks.

The Ebstein-Barr virus (EBV), a type of herpes virus, can increase the risk of contracting Hodgkin's lymphoma. According to the CDC, EBV is one of the most common human viruses in the world. It is a ubiquitous disease related to the chronic infection of memory B cells and airway cells. Typically, the virus spreads through bodily fluids like saliva, blood, and semen and has fatigue, fever, and inflamed throat symptoms. Furthermore, while EBV primarily causes infectious mononucleosis, also called mono or the kissing disease, it can also induce other illnesses such as Hodgkin's lymphoma. After infection, the EBV virus becomes latent or inactive in the body but can reactivate in certain circumstances. Because of their weakened immune system, immunocompromised people are more likely to develop symptoms if the EBV reactivates. Epstein-Barr virus, in rare incidents, has triggered lymphoma as it is a potent agent with an oncogenic (cancer-causing) mechanism that promotes B-cell growth and possibly

lymphomagenesis. In immunosuppressed settings, patients who have recently received stem cell or organ transplants and thus have a weakened T-cell function can develop a higher risk of developing lymphoma from EBV. Persistent infection of EBV weakens the immune system and makes one more vulnerable to respiratory viral diseases. result in Like EBV-induced lymphoma, other respiratory viruses can also have devastating long-term effects, particularly for immunocompromised individuals. Analyzing and studying these abnormal cases will push for more effective and safer treatments for the immunosuppressed and raise awareness of the dangerous possibilities the immunocompromised population faces daily.

Response and Impact of Viral Disease on People Who Fall into High-Risk Age Categories

Elders aged 65 years and older, as well as young children under 6 months, have relatively high hospitalization rates from respiratory viral infections. Elders have a deteriorating immune system and likely have underlying health conditions, while infants have a developing immune system that has incomplete antiviral abilities. Over the past few years, infants under 12 months and adults over 65 have been reported to have the highest rate of COVID-19-related emergency department visits. Additionally, the highest number of visits to the department due to RSV is highest among infants under 12 months. Evidently, older adults and infants both fall into high-risk categories for developing severe cases of illness.

Young children with an underdeveloped immune system may encounter dangerous viruses early on and have difficulty combating them. Children comprise 18% of all reported COVID-19 cases since the start of the pandemic. Contrary to popular belief, older children do not get critically ill from COVID-19 and sometimes do not display symptoms. The ones at risk are babies under age 1.29 Many infants can get COVID-19 during childbirth or after delivery, both highly vulnerable times. In some incidents, multisystem inflammatory syndrome in Children (MIS-C), a post-COVID condition, can occur 2-6 weeks after a young child is infected with COVID-19.29 MIS-C causes inflammation in different body parts like the heart, lungs, and kidney. A child might have the illness if they show symptoms of ongoing fever accompanied by stomach pain, diarrhea, bloodshot eyes, etc. The condition is deadly but can get better through treatment and medical care. In a study published in 2017, researchers investigated the long-term effects of RSV on young children. The results concluded that contracting RSV in early childhood is associated with long-term wheezing, asthma, and impaired lung function. Overall, babies under six months are more susceptible to severe respiratory viral infection, face more significant challenges and complications during infection, and may suffer the long-lasting aftermath of a virus.

Similarly, adults over 65 years old experience serious consequences from respiratory diseases. They have immune systems that do not function as well as others. In an aging immune system, there is a decreased ability to activate T cells, which are vital to eliminating virus particles and cancerous cells and generating sufficient immune memory responses. Most deaths from respiratory viruses occur in the elderly as they have an increased risk of hospitalization. Particularly, U.S. adults over 65 accounted for 62.9% of COVID-19-related cases from January

to February 2023. And, people who are 75 years and older are nine times more likely to die from COVID-19 compared to people who are 18-39 years old. In the case of the influenza virus, those 65+ are 3-5 times more likely to get a heart attack and 2-3 times more likely to get a stroke in the first two weeks of infection. On the other hand, long COVID worsens preexisting health disorders like heart failure, lung disease, or dementia in older people. As a result, during the COVID-19 pandemic, state health departments identified key protective strategies for high-risk age groups and other immunocompromised people to safeguard them from hospitalization and death.

Current Issues and Protective Strategies

Identifying high-risk groups in our community is our first step towards improving current protective and preventive strategies against respiratory viruses and infectious outbreaks. The immunosuppressed and immunocompromised population can include those with autoimmune diseases, chronic immune diseases, and infants under six months or elders over 65. Through extensive research, immunocompromised individuals with weakened immune systems were found to experience more significant and longer effects from respiratory infections.

Immunization is one way to protect immunocompromised patients from infectious diseases. However, because of concerns about adverse effects from vaccines, more attention on active clinical issues rather than prevention, and doubts about whether vaccines are worthwhile for the immunocompromised, many individuals susceptible to infections may not receive the vaccines they need to protect themselves. In reality, although vaccines may only mount a partial response in people with weakened immune systems, they are still beneficial for protection. Inactivated or killed vaccines with particles or strains of a dead virus are safe, moderately effective, and recommended for those with compromised immunity. If the compromised individual does not receive the vaccine, their family members and healthcare workers should be immunized to decrease the risk of transmission. Still, the lack of effective vaccines and the high cost of antiviral therapy for the immunocompromised underscore the need to increase awareness among our community about the effects of respiratory viral diseases on vulnerable groups. During outbreaks and flu season, wearing masks and gloves, quarantining, adhering to contact isolation, and paying attention to overall hygiene are fundamental ways to protect oneself and others.

During the COVID-19 pandemic, the CDC issued guidelines for people with weakened immune systems and cohabitants, listing preventative measures like obtaining the updated COVID-19 vaccine, washing hands, and spending time outside for better ventilation. Although the immunocompromised gained access to vaccines earlier than the rest of the population due to their susceptibility to infection, vaccine inequality amongst populations of color can be especially detrimental for high-risk individuals. If a group or a community has limited access to vaccines because of the lack of interpretation services, communication challenges, and reduced internet access that allows one to schedule vaccine appointments, it becomes perilous for the immunosuppressed in those populations as there may be higher viral transmission rates due to

the lack of immunization. As a result, combatting inequities in healthcare and vaccine distribution remains vital for overall health and safety, especially for those more vulnerable to disease.

Conclusion

Respiratory viral infections like COVID-19, influenza, and respiratory syncytial viruses tremendously impact human health, especially for immunocompromised people. These individuals have a weakened immune system and, thus, are more vulnerable to infections. Respiratory infections can induce or worsen pre-existing health conditions and lead to long-lasting problems in the airway in individuals with autoimmune diseases, chronic immune diseases, and people who fall into high-risk age categories. However, through immunization and preventive measures like wearing masks, quarantining, and strictly adhering to health guidelines, risk factors can be significantly reduced in compromised populations. Education and awareness of the impact of respiratory viral disease are imperative in improving community engagement in the matter and helping strengthen protective strategies during a pandemic. Specifically, ensuring access to vaccines and healthcare for populations of color should be a priority, as inequities and historical challenges to acquiring necessities impose dangers on vulnerable people in those communities.

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Qualitative Analysis Of Superconductivity By Robin Singh

1. Introduction

1.1. Background (Abstract)

Kamerlingh Onnes, in 1911, discovered a strange phenomenon while cooling mercury to extremely low temperatures. He observed that its internal resistance seemed to suddenly vanish as its temperature got close to 4.2K(or -268.95°C or -452.11°F). You can imagine how strange this must have been, in fact, it was so strange that many scientists proposed various theories and failed to explain this strange phenomenon for nearly a century!

The discovery of superconductivity can be traced back to at least the early 19th century and the discovery of the procedure to make liquid chlorine by Michael Faraday. Briefly explaining, one winter day, he took crystals of chlorine hydrate ($CL_2 \cdot H_2O$) and placed them in a sealed glass tube the upper end of which was hermetically closed. Then he heated the tube and noted the formation of a coloured oily liquid on subsequent cooling of the tube. On further analysis, he found out that this was liquid chlorine. But wait! We know today that we need to cool down chlorine to -34°C for it to become a liquid (which is well below what he could have gotten on that winter day). Well, it turns out that the increase in pressure in the sealed tube when it was heated was enough to bring the boiling point or the liquefying point up to the room temperature of Faraday's lab.

After this followed a series of events that led to the development of methods to achieve very low temperatures which is a crucial development on the path which led to the discovery of superconductivity.

1.2. Scope

Before we delve deeper into the mysteries of superconductivity, I think it is important to define the scope of this paper, and what it will and will not cover. Superconductivity is an advanced topic of solid-state physics and understanding the mathematics and quantitative aspects of the topic requires deep knowledge of quantum mechanics, calculus, linear algebra, and tensor calculus (although vector calculus should also suffice but tensor calculus is recommended), basics of solid-state mechanics, etc. Due to these reasons, I will keep the main focus of this paper on providing a qualitative explanation of various phenomena and building up to superconductivity, involving equations only when it helps to understand the topic at hand. After we cover the basics, we shall also explore various applications of this amazing phenomenon both current and future. We will also discuss its newest findings and think about how they can be used to further improve the world.

2. Theoretical Background 1 (QUANTUM MECHANICS)

In order for us to understand superconductivity, it is essential to have some foundation in quantum mechanics. In fact, the most modern theory Bardeen-Cooper-Schrieffer or BCS theory,

and the formation of cooper pairs cannot be explained by classical mechanics at all.

2.1. Wave functions and Quantum States

First of all, I need to explain what exactly is a "**state**". It is simple business really, a set of physical quantities that describe the current 'situation' the particle is in, represent the **state** of that particle. For instance, let us consider a neutral particle going through empty space affected by no force with some velocity, the only things I need to describe the entire 'situation' of the particle are its momentum and mass, or its momentum and velocity, or its mass and velocity. Only 2 physical parameters are enough for us to know all that we can know about that particle. As I have shown, there may be multiple feasible ways or combinations of physical quantities to define the state of a certain particle or there may be only one feasible way, it depends on the situation.

Now that you know what a state is, let us consider what a **quantum state** is. This part is a bit awkward to introduce since I will need to just tell you about it without explaining it or deriving it mathematically (which is, as I have said earlier, not in the scope of this paper). According to the basic theory of quantum mechanics, we cannot know precisely, the state of any quantum particle or quanta, we can only know a part of its state. This is known as the general uncertainty principle and is mathematically derivable.

$$\sigma_A^{\,2}\sigma_B^{\,2} \geq \left(\tfrac{1}{2i}\langle[A, B]\rangle\right)^2 \text{(both A and B are operators)} \qquad \dots (1)$$

Where σ_A is the standard deviation of A;

$\langle[A, B]\rangle$ represents the expectation value
(which is just a fancy way of saying "average value");
And, $[A, B] \equiv AB - BA$

(this value is often called the commutator and describes how well A and B fail to commutate). This equation is the **General Uncertainty Principle.** This is proved in <mark>Appendix A</mark> in detail if you are interested. You may notice the i in the denominator on the right side of the equation, this i cancels out with the i from $\langle[A, B]\rangle$ (the commutators' expectation value). You have probably seen the **Heisenberg's Uncertainty Principle:**

$$\sigma_x^{\,2}\sigma_p^{\,2} \geq \left(\tfrac{1}{2i}\langle[x, p]\rangle\right)^2 \qquad \dots (2)$$

Well, the $\langle[x, p]\rangle$ works out to be $i\hbar$, so

$$\sigma_x^{\,2}\sigma_p^{\,2} \geq \left(\tfrac{\hbar}{2}\right)^2 \qquad \dots (3)$$

Since the standard deviations are positive by nature:

$$\sigma_x \sigma_p \geq \tfrac{\hbar}{2} \qquad \dots (4)$$

This is not just because we have a hard time measuring these physical quantities (even though we do), it is something more fundamental than that. Some physical quantities can be measured simultaneously and some cannot. Specifically, those that can commute with each other

can be measured simultaneously (also known as compatible observables) and the ones that don't commute cannot be measured simultaneously (also known as incompatible observables).

At this point you might ask 'If we can't know about the state of a particle, how then does quantum mechanics go about describing the particle?', this leads us to our next topic of discussion, **wave functions**. According to the statistical interpretation, we can talk about the state of the particle by considering the probability of that particle being in a specific state. This probabilistic interpretation of quantum mechanics troubled many scientists. This can be understood better if we take an example of a particle in empty space. We define a function that gives us the probability (more accurately probability amplitude) of that particle being in that specific position for all the positions in space. This function is known as the wave function.

2.2. Schrödinger Equation

$$i\hbar \frac{\partial \Psi}{\partial t} = \frac{-\hbar^2}{2m} \frac{\partial^2 \Psi}{\partial t^2} + V\Psi \qquad \qquad \dots (5)$$

The above equation is the Schrödinger Equation where Ψ (Greek letter 'psi') represents a complex function that is our wave function. I will not derive this as it will get quite complicated. There is a simpler derivation where we can derive this equation from classical mechanics but that is unnecessary and will only create misconceptions in the reader's intuition. Strictly speaking, it is classical mechanics which should be derived from quantum mechanics, not the other way around. All you need to understand from this equation is that it is a deferential relation which is really useful for calculating the wave function.

To solve this equation, we split it into 2 parts one purely time-dependent and one purely position-dependent.

$$\Psi(x, t) = \psi(x)\varphi(t) \qquad \qquad \dots (6)$$

Some of you might object that this won't give us all the solutions to the Schrödinger Equation and some will be excluded, but for practical purposes, they never occur in the real world so physicists tend to ignore them.

After some mathematical manipulation, $\psi(x)$'s relation comes out to be:

$$\frac{-\hbar^2}{2m} \frac{\partial^2 \psi}{\partial t^2} + V\psi = E\psi \qquad \qquad \dots (7)$$

It can also be written as:

$$\hat{H}\psi = E\psi \qquad \qquad \dots (8)$$

Where Ĥ is the Hamiltonian and is acting as a Hermitian operator. Here ψ is acting as an **Eigenfunction** and E is the **Eigenvalue** of this equation. It is important to note carefully that Ĥ is an operator and E is a scalar, a simple number. The Hamiltonian operator acts or "operates" on the wave function and returns a scaled version of the wave function. On taking out the scalar quantity from the wave function, we get E, the energy of the system.

'All right, but what is this good for?' you might ask. The Schrödinger Equation is one of

the most important equations in all of quantum mechanics. As an example, let us consider a simple case of the hydrogen atom. We want to know the wave function for the position of the single electron that 'revolves' around the nucleus. We can do that by solving the Schrödinger Equation for that specific case. The equation is usually solved in polar coordinates and gets quite lengthy.

Hydrogen Wave Function
Probability density plots.

$$\psi_{nlm}(r,\vartheta,\varphi) = \sqrt{\left(\frac{2}{na_0}\right)^3 \frac{(n-l-1)!}{2n[(n+l)!]}} e^{-\rho/2} \rho^l L_{n-l-1}^{2l+1}(\rho) \cdot Y_{lm}(\vartheta,\varphi)$$
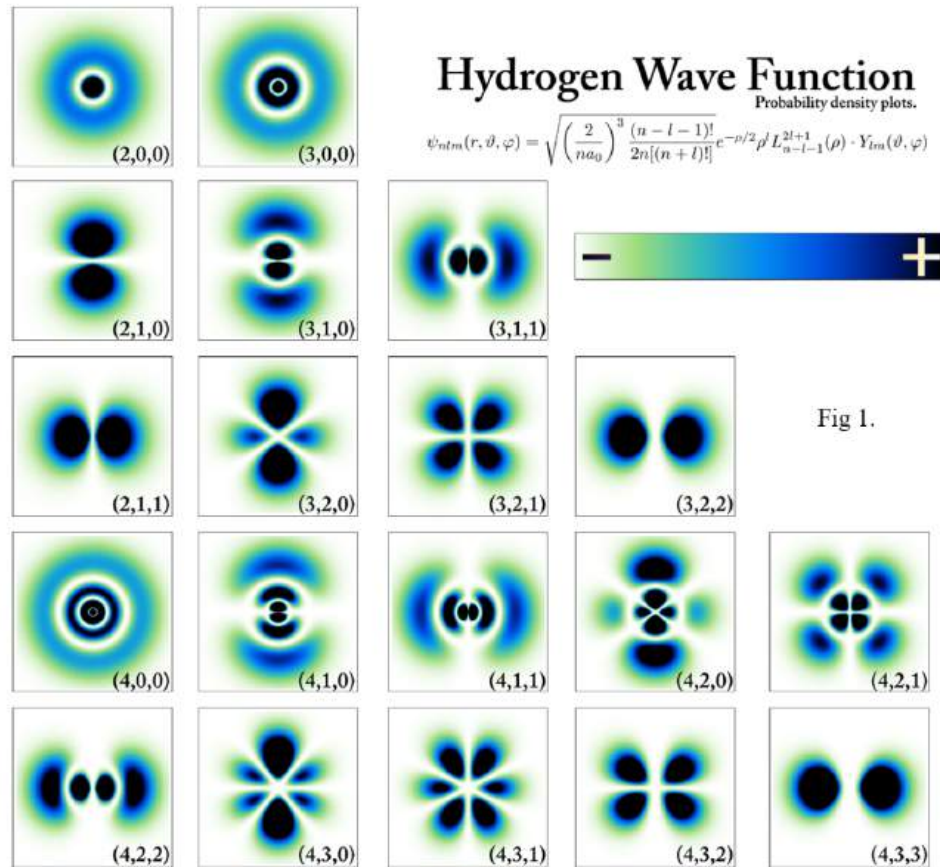
Fig 1.

Fig 1. Shows a plot of the probability of finding the electron at various points in space. Notice the 3 numbers in the bottom right corner of each graph, they represent quantum numbers that are used to define the state of the electron. They are ordered (**n**, **l**, **m**) where **n** is the principal quantum number, **l** is the Azimuthal Quantum number, and **m** is the magnetic quantum number. **n** represents the energy associated with the electron, both **l** and **m** are responsible for representing the angular momentum of the electron and they also determine the shape of the probability plot you just saw. Also, n and l only take on integer values and m can take on pseudo-integer values (±1, ±1.5, ± 2…).

There are a few restrictions on the values of l and m quantum numbers as per the set value of the principal quantum number. I shall explain them briefly here. The azimuthal quantum number, l, is restricted to exist between 0 to n-1 (both included), and for every value of l, the magnetic quantum number, m, can exist from -l to +l (both included). These restrictions may seem random and you may be puzzled as to why this is the case, but when we go through the

formalism of quantum mechanics, these seemingly unnecessary restrictions come out as natural results.

2.3. Quantum Tunneling

Quantum Tunneling is another phenomenon that is really important for superconductivity. It is something that only exists in quantum mechanics. Let us consider a situation classically then convert that situation and look at it from a quantum mechanics point of view.

Let us consider a ball rolling up and down a valley between 2 hills, but there is a further even deeper valley across the mountain. When it is at the bottom-most point of the higher valley, all of its energy is in the form of kinetic energy. This kinetic energy is converted into potential energy as the ball moves up the mountain. Any sort of frictional loss is assumed to be negligible. In this case, in which the ball's energy is insufficient to cross the mountain, the ball will continue to oscillate back and forth forever.
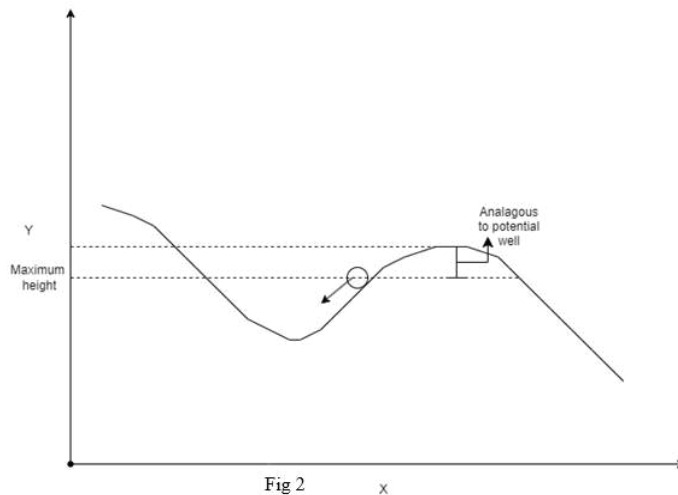
Fig 2

In Fig 2. The ball can't gain energy from anywhere and use it to cross the hill and get to the deeper valley.Now let us convert this problem into something that we can look at from a quantum mechanical point of view. The ball represents a particle and the valley represents a potential 'well'. The particle is stopped from getting to an even deeper potential well i.e. to lower its energy even further, by the potential 'wall' that is represented in the above situation by the hill.

Fig 3   X
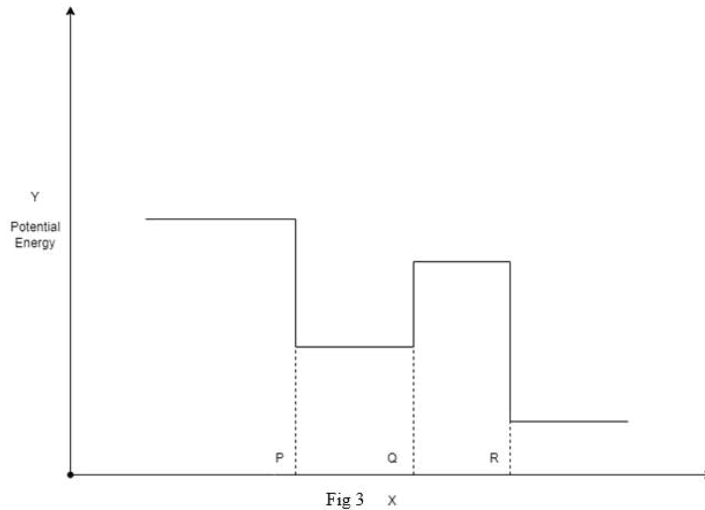
In Fig 3, our particle is present in the region present between P and Q. The potential wall is represented by the region Q to R, and after R is a low potential 'valley'. The particle doesn't have enough energy to 'climb' the potential wall so, classically speaking, it should never be able to get to the lower potential region after R. But this is where the weird properties of quantum mechanics come in. It turns out that when we compute the wave function, there is some probability of the particle ending up on the other side of the energy barrier! Interesting right? This phenomenon is known as **Quantum Tunneling**. Of course, this effect has its limitations too. Practically speaking this can only take place when the barrier is extremely thin and the particle in question is 'small'. Theoretically speaking, there is always some probability, regardless of the size of the particle and the barrier, that quantum tunneling will occur (Though I wouldn't recommend running towards a wall hoping that quantum tunneling will save your nose from getting flattened), but the odds of such an event taking place are astronomically low (and yes, we can calculate the odds given the right information).

Also, don't misunderstand and think that this phenomenon can only be created in extremely controlled environments like a lab, it is something everyone has seen without knowing it! For a short example, take a beaker made of glass and place your dry hand on the outer surface of the beaker (the beaker must be dry from the outside), and try to see your fingers from the outside. You will probably not see anything (if you do see a little of your finger, this means that the humidity in your area is high). Now pour some water on your hands to make them wet and repeat the above experiment. You will be able to see the part of your hand in contact with the beaker easily now. This is due to quantum tunneling (if you find this interesting, I encourage you to search for more details about it on the internet)

2.4. Pauli's exclusion principle

Well, now it is time to introduce you to the concept of '**spin**' of quantum particles. This topic is really famous on the internet, but because of the large amount of misinformation or incomplete information, it is widely misunderstood. The name "spin" is in itself a bit misleading; we don't know that an electron is itself spinning, it is just that its magnetic properties can be

explained if we assume the electron to be spinning in a direction corresponding to the magnetic field.

It is not a good practice to take this analogy any further than this. It is also important to note that, unlike the spin of any classical object, say a ball, which is just the sum of the total angular momentum of all the molecules that make up that ball concerning the spin axis, the 'spin' in quantum mechanics is something more **intrinsic** than what can be classically derived. Also, the spin in the 3 coordinate axes does not commute. That is to say, it is fundamentally impossible to know, with absolute certainty, the S_x and S_y (or any other pair of x, y, and z) of an electron.

$$[S_x, S_y] = i\hbar S_z \qquad \qquad \dots (9)$$
Where $[A, B] \equiv AB - BA$ (A and B are both operators)

In an atom, an electron's spin is denoted by a 4th quantum number **s**. In general, this number can be an integer or a fraction like $\pm\frac{1}{2}, \pm1, \pm1\frac{1}{2}, \pm2\dots$ and so on, and its range is the same as **m** but when talking about the electrons in an atom, we only need to concern ourselves with the $\pm\frac{1}{2}$ value of s and the integral values of m.

Paulie's exclusion principle states that no electron bound to an atom will have all 4 quantum numbers the same. To exemplify, this means that no two electrons can have n=2, l=1, m=1, and s=+½. The closest they can get is one having configuration n=2, l=1, m=1, and s=+½, and the other having configuration n=2, l=1, m=1, and s=-½ (this is a specific case for atoms, its general case will be discussed roughly in the next topic).

2.5. Fermions and Bosons

All elementary particles are classified into **fermions** and **bosons**, based on their spin quantum number. **Fermions** are particles that have half-integer spins ($\pm\frac{1}{2}, \pm1\frac{1}{2}\dots$), like the electron, proton and neutron. These follow Pauli's exclusion principle that no 2 fermions can have all 4 quantum states the same. On the contrary, **bosons** are particles that have integer spins ($\pm1, \pm2, \pm3\dots$) and don't follow Pauli's exclusion principle, for example, the photons, Higgs-bosons, gluons, and phonons. Also, Bosons can be created or destroyed singly, whereas fermions can only be destroyed in matter-antimatter pairs. As to why this is, there is no conceptual explanation that I know of that can easily explain Paulie's principle. We can 'derive' it in relativistic quantum mechanics but in non-relativistic quantum mechanics, it is simply taken as an axiom.

Electrons only take on +1/2 or -1/2 and are classified as fermions and sure enough, they obey Paulie's principle. This is an important fact upon which all particle physics and chemistry is based.

3. Theoretical Background 2 (SOLID STATE PHYSICS)

3.1. Crystal Structures

Solids are made up of atoms and molecules tightly bound to one another via molecular

bonding. These solids are categorized based on the arrangement of atoms and molecules. If the arrangement of molecules is periodic and neat, it is called a **crystalline solid** and if there is a seemingly random and messy arrangement of molecules, the solid is called an **amorphous solid**. Of course, there are those who can't be classified into just these 2 categories, and some are a mix of both.

We shall discuss crystals in detail to gain some qualitative intuition that will help us understand superconductivity. This gives rise to the question 'But why crystals, why not non-crystalline solids?'. Well, that is because the electronic properties of solids and their interaction with the ion nucleus are best understood by looking at crystals rather than non-crystals. Their regular arrangement makes it easier for us to see what is going on at the molecular level.

Before we study the interactions of electrons and ion centers, it is important to first familiarize ourselves with some basic concepts and terminologies.

"An **ideal crystal** is constructed by the infinite repetition of identical groups. A group is called the **basis**. The set of mathematical points to which the basis is attached is called the **lattice.** $\mathbf{r'} = \mathbf{r} + u_1\mathbf{a_1} + u_2\mathbf{a_2} + u_3\mathbf{a_3}$ Here, u_1, u_2, u_3 are arbitrary integers. The set of points $\mathbf{r'}$ defined by the above equation for all u_1, u_2, u_3 defines the lattice.

The lattice is said to be **primitive** if any 2 points from which the atomic arrangement looks the same satisfy the above equation with a suitable choice of the integers u_i" (this has been quoted from the textbook 'Introduction to Solid State Physics' by Charles Kittel)

The above text is important to understand as it forms the foundation of all solid-state physics. Every basis in a given crystal is identical to every other in composition, arrangement, and orientation.

Fig 4

a) Lattice b) Basis c) Structure Of Crystal
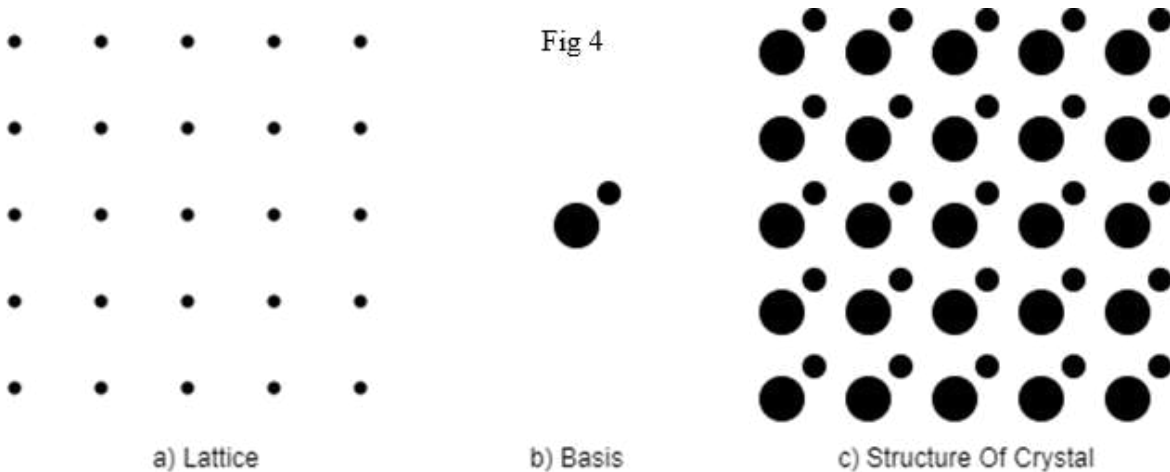
A **primitive cell** is a parallelepiped defined by the **primitive axes a_1, a_2, a_3**. A primitive cell is a minimum-volume cell and the basis corresponding to the primitive cell is called the primitive basis. No other basis has fewer atoms than the primitive basis. There is always one lattice point per primitive cell. If the lattice points lie at the corners of a primitive cell, then the total number of points in the cell is still one as $8*(1/8) = 1$.

There is a neat and sort of mechanical way of choosing a primitive basis called the

Wigner-Seitz cell.

"The cell may be chosen by first picking a lattice point.

Fig 5

After a point is chosen, lines are drawn to all nearby lattice points. At the midpoint of each line, another line is drawn normal to each of the first set of lines. The smallest area enclosed in this way is called the **Wigner–Seitz primitive cell**" (the above text and Fig 5 are courtesy of Wikipedia.com).

Now, we shall take a look at some fundamental types of lattices. Namely the simple cubic lattice (sc) Fig 6.1, the body-centered cubic lattice (bcc) Fig 6.2, and the face-centered cubic lattice (fcc) Fig 6.3. (courtesy of Wikipedia.com)
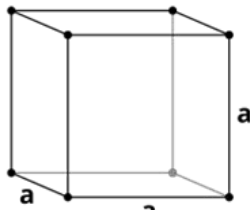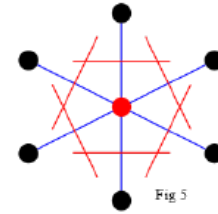
Fig 6.1
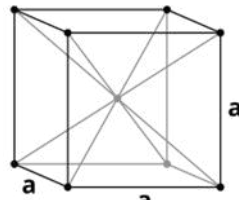
Fig 6.2
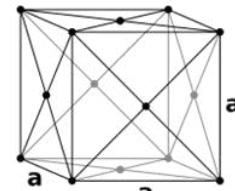
Fig 6.3

These images depict the 3 most important types of lattices in solid-state physics. Note that 'a' is the primitive axis in the case of sc but not in the case of bcc or fcc lattice; we have used 'a' to simply compare the three.

3.2. The Reciprocal Lattice and Brillouin Zones

We shall now discuss a concept that can prove to be a little hard to wrap your head around, the reciprocal lattice. In short, **the reciprocal lattice** is the Fourier transform of the real lattice. Unfortunately, the mathematics can get a little complicated, so we will just look at the derived expressions. Let's first look at the relation that is derived between the reciprocal lattice vectors and the real lattice vectors.

$$b_1 = 2\pi \frac{a_2 \times a_3}{a_1 \cdot (a_2 \times a_3)} \;;\; b_2 = 2\pi \frac{a_3 \times a_1}{a_1 \cdot (a_2 \times a_3)} \;;\; b_3 = 2\pi \frac{a_1 \times a_2}{a_1 \cdot (a_2 \times a_3)} \qquad \dots (10)$$

The factors of 2π are not necessary but are convenient in solid-state physics. One good way to visualize this relation is to imagine a cube in real space and tinker with it and calculate and observe how it changes the shape in the reciprocal lattice; by doing so we can see the naming sense of 'reciprocal' lattice.

Let us, for now, look at the reciprocal lattice as a normal lattice and perform the process of drawing the Wigner–Seitz primitive cell in the reciprocal lattice. The area enclosed in the primitive Wigner-Seitz cell is called the first **Brillouin Zone**. This has significant applications in solid-state physics. That's all well and good, but what is the significance of these concepts? Well,

Brillouin Zones represent specific regions in a reciprocal lattice that define the allowed **wavevectors** (**k**-vector) for electrons in the crystal lattice. **Bloch's theorem** states that the wavefunctions of electrons in a crystal lattice can be written as a product of a periodic function and a plane wave. The k-vector specifies the electron's state within the Brillouin zone. We can analyze the connection between k-vectors and electronic properties. But what is most appreciable about this concept is that we only need to study the electron's behavior for one Brillouin zone as the k-vectors repeat (for a crystal lattice of course) further.

3.3. Basic Band Theory

This is the most important part of the theoretical background section, and it is the most interesting and relatively easy to understand as well (that is, according to me at least).
To understand this concept easily, we will look at the state of the electronic configuration of a single isolated atom first, then a 2-atom system (in which the atoms are bonded together). And then we shall discuss the case most relevant to us, the crystal lattice.

A single, isolated atom is the easiest to discuss as we already know the shape of its electron cloud, as we have discussed in section 2.2 and even showed the electron cloud density plot-diagram for the hydrogen atom. Things begin to change, however, when we move on to 2 bonded atom structures. The orbitals of each individual atom are disturbed as they face electrical repulsion from the neighboring atom's electron cloud. However, since they are bonded together, this leads to extra complexity. It is important to realize that the 2 atoms are 'bonded together' is just another way of saying that they are sharing their election cloud density with each other in order to expel excess energy and have as little energy as possible (i.e. reach a stable state). Due to these effects, it isn't accurate to think of electrons as being present in 'atomic orbitals', but it is more accurate to think of them as forming 'molecular orbitals' (mo's), that is, orbitals for electrons of the molecule as a whole. This is known as the molecular orbital theory MOT and it is one of the best theories that has been successful at explaining the properties of various compounds.

This has many consequences and many other details like the role of bonding and anti-bonding mo's in the stability of the molecule and the number of unpaired electrons leading to various magnetic properties. But for now, we are only interested in the 'energy aspect' of mo's.

Now we shall look into the electrons in a crystal lattice. A crystal, in practice, is a very long array of atoms arranged in a similar manner. The electrons of many atoms are brought close together and there are so many orbitals that this causes overlapping between the orbitals leading to not a discrete spectra of energy levels or orbitals but an almost continuous 'band' of different energy levels. These are known as **energy bands**. There are gaps in the energies of these bands which are not allowed by the quantum mechanical model, these are known as **band gaps**. Loosely speaking, there are 2 types of energy bands; the **valence band** which is the band of energy levels that is filled up first at 0k following Pauli's principle; it is a derivative of the highest occupied atomic orbitals; then there is the **conduction band** which is just above (above,

as in having more energy) the valence band and is empty at 0k, and the electrons can 'jump' to it when they are given energy. It is derived from the atomic orbitals just above the filled orbitals.

Having different band gaps between the valence and the conducting bands can greatly influence the properties of the said material.

Fig 7
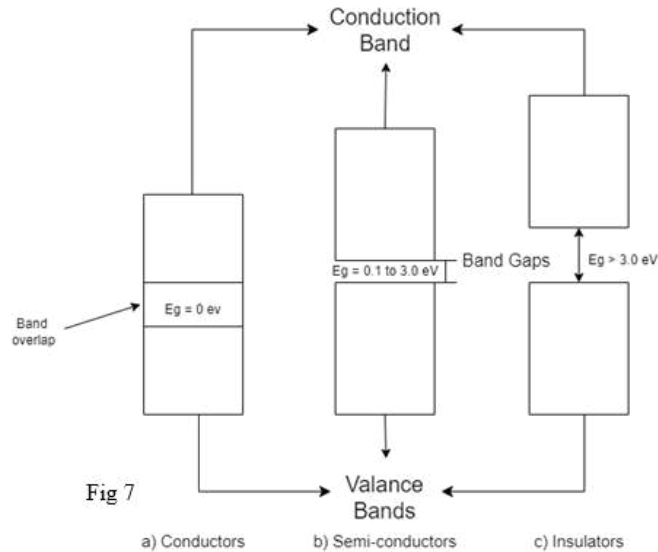
If the band gap is non-existent i.e. the valence and conduction bands are overlapping or touching then the material is called a conductor, this is because the electrons can jump into the conduction band without much energy.

If the band gap is small, that is, in between 0.1 to 3.0 eV, then the electron can jump up to the conduction band with some energy. These materials are known as semiconductors. The electrons won't have this energy when sitting idle, but when given some external energy via sunlight or via applying potential difference, they are able to move to the conduction band. They have a lot of applications in the modern world, in fact, it wouldn't be an exaggeration to say that most of today's modern technologies rely on semiconductors.

If, however, the band gap is more than 3.0 eV, then the electrons need so much energy to move to the conduction band, that they are not able to jump even when they are given a source of energy. These materials are used to protect electronics and used as insulation. They have a lot of applications in safety and other electronic components like capacitors, transformers, inductors, etc.

4. Fundamentals of Superconductivity

4.1. Main Properties

We shall now look at the various properties of superconductors.

First of all, we should know exactly what a superconductor is. When a certain metal is cooled down to a certain temperature, its electrical resistivity suddenly drops to zero or so close to zero that currents can continue to flow within these conductors without external potential

difference. This is, however, only half of the story.

Along with the drop of internal resistance, the magnetic fields if present inside the conductor are expelled. This phenomenon is really interesting as it leads to properties that enable the levitation of superconductors on magnets. This is a loose description of the **Meissner Effect**.

Fig 10

The temperature at which the 'transition' takes place between normal to superconductor is called the **critical temperature** (T_c). This T_c can vary with many other conditions like pressure.

But it is not all sunshine and rainbows. The effect of expelling the magnetic field can also '**break**' the superconductivity if the magnetic field is strong enough. Unfortunately, this value isn't much for pure metal superconductors like mercury. Many scientists of the time were frustrated by this. Fortunately, there have been immense developments in the field of superconductivity which has enabled us to create 'high-temperature' superconductors that can also withstand much stronger magnetic fields, which is necessary for them to be useful. The term high temperature is a relative term of course; even the highest-temperature superconductors are way below room temperature.

You may have heard the term 'Type 1' or 'Type 2' superconductors before, I shall explain briefly what is the difference between them. Type 1 superconductors are a more traditional type of superconductor, they have a fixed line where they transition from a normal conductor to a superconductor. They have a low tolerance to magnetic fields and break easily.
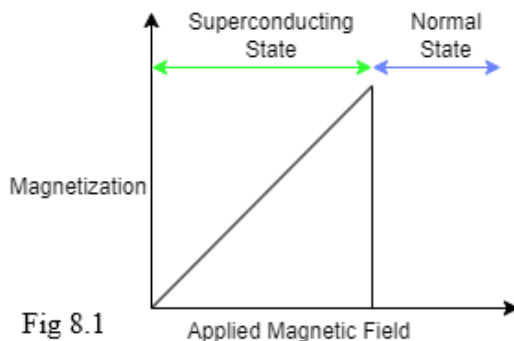
Fig 8.1

In Fig 8.1, we can see how a type 1 superconductor behaves in an applied magnetic field. The range of magnetic fields in which the superconducting state persists is relatively small.

Fig 8.2 depicts a type 2 superconductor. The material remains in a pure superconductive state for a lesser value of magnetic field but then enters a semi-superconductive state called the **vortex state**. In this state, the magnetic fields are sort of threaded in the material. This vortex state is also responsible for the levitation of superconductors on magnets.
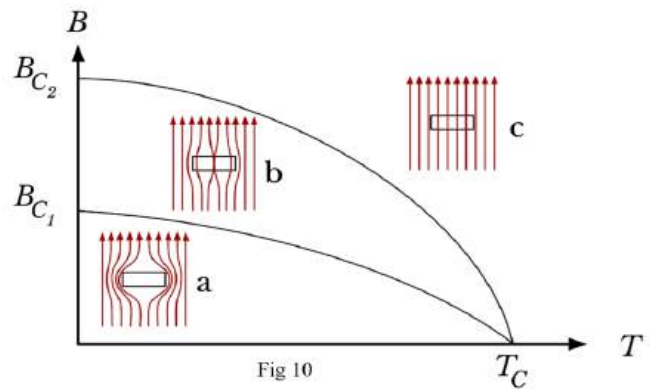
Fig 9
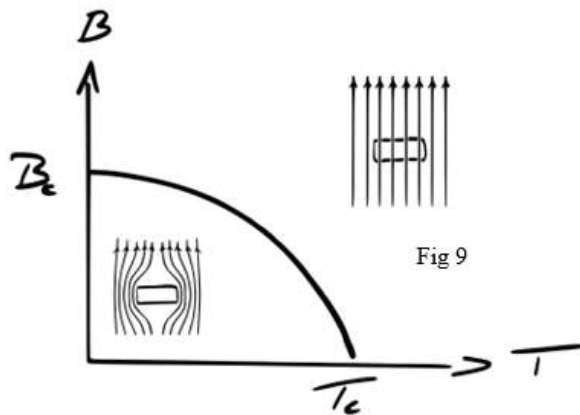
Fig 9 shows the Meissner effect on a type 1 superconductor as it is cooled. The material sort of forms a binary system, where either it is superconducting or not; either it is repelling the magnetic field or letting it pass through.

Fig 10 shows the transitions of a type 2 superconductor, where it goes from a normal conductor (letting all the magnetic fields pass through), to a vortex state superconductor (letting the magnetic field pass through from a few spots), and then finally to a pure superconducting state.

Also, as a side note, the term 'vortex' was chosen to describe this phenomenon as this occurs due to the formation of a stable current vortex inside the superconductor.

Note: It can be seen from the above graphs that even if the temperature is absolute zero, the superconductivity can still be broken if the magnetic field is strong enough.

4.2. Qualitative Analysis of BCS Theory and London Equations

Ever since superconductivity was discovered, there have been many attempts at formulating a theory that can explain this phenomenon. The most successful theory to date is the **Bardeen-Cooper-Schrieffer (BCS) theory**. This theory was formulated by John Barden, Leon Cooper, and Robert Schieffer in the year 1957. Now it acts as a foundation that helps us develop the field of superconductivity and apply it to solve problems in the real world. It explains the formation of **Cooper pairs**, and how they lead to the formation of a superconducting state.

It is common knowledge that the electrons in a normal environment repel each other and, when subjected to an external electric field, travel in the direction opposite to that of conventional current, all while bumping into each other and the kernels (+ve ion core). Their drift velocity is around the order of 1mm/s (or 10^{-3}m/s) but the actual speed at which they travel is of the order of 10^6m/s. All this wastage of energy is avoided in superconductors because of the formation of cooper pairs.
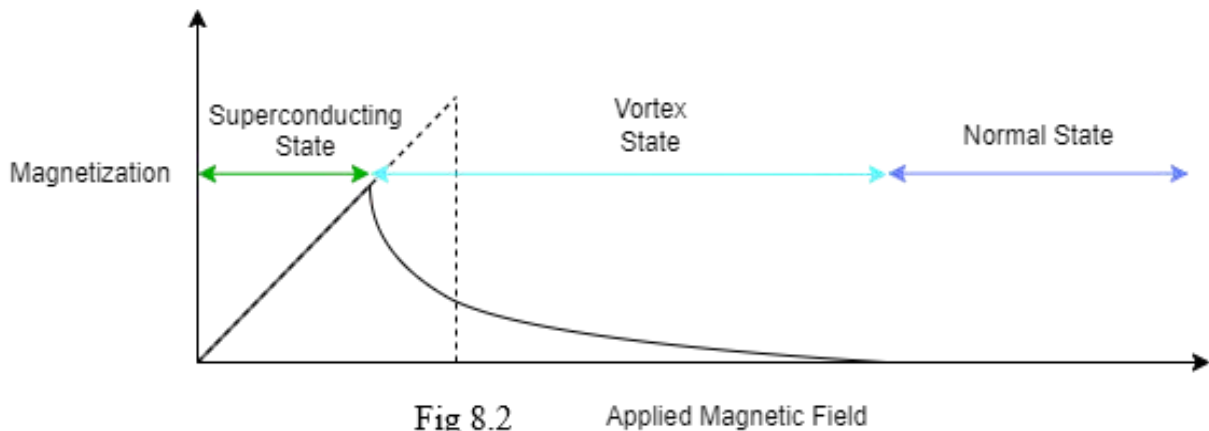
Fig 8.2   Applied Magnetic Field

Let's consider an electron traveling in a straight line, passing between the positive kernels (see Fig 11.1). As the electron travels, it attracts the positive kernels and creates a sort of temporary positive charge in the area it just left. The kernels relax back to their normal positions as the electron moves forward.

Temporary area of positive charge

Fig 11.1

Pair of electrons bound together
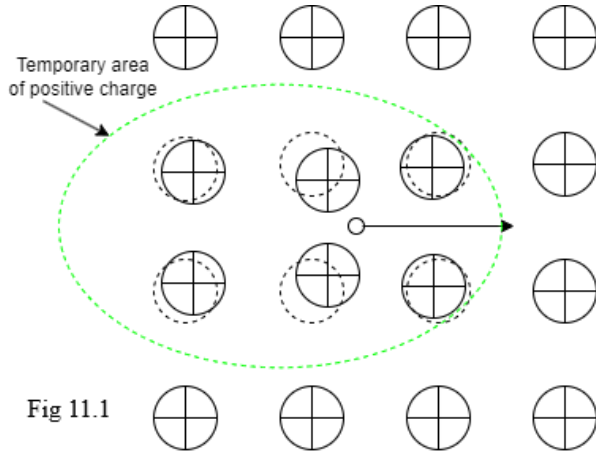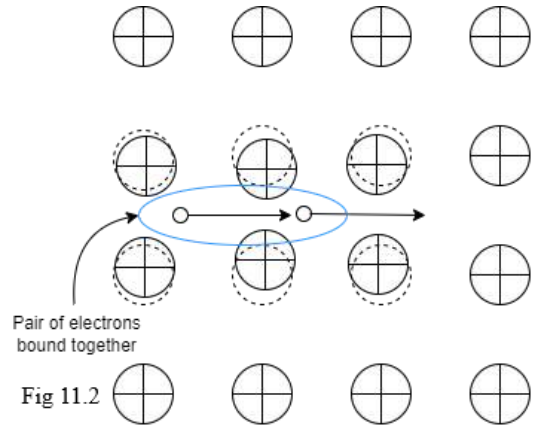
Fig 11.2

During that time there is a window where if an electron comes from behind, the attraction by the kernels is more than the repulsion by the first electron at that distance, which leads to lower energy. This leads to the formation of a pair of electrons stuck together due to a stable configuration.

This pair of electrons travels straight without bumping into any obstacle. This pair of electrons is called the **Cooper pair** (see Fig 11.2). These Cooper pairs can only be formed at low temperatures when the electrons and the kernels don't vibrate as much. These pairs have a lower energy state than individual electrons which leads to the formation of an energy gap. They are also the reason for some of the macroscopic properties of superconductors.

The energy gap of the Cooper pairs is also the energy required to break the pair. The higher the value of this band gap is, the more stable the cooper pair formation and the better the superconductor. Mathematically, the band gap is represented by delta and is a function of temperature.

$$\Delta(T) = \Delta(0)\left[1 - (\frac{T}{T_c})^4\right]^{\frac{1}{2}}$$

... (11)

This gap increases as the temperature is lowered and becomes zero at the critical temperature (T_c), breaking the superconducting state of the material. The Cooper pairs move without electrical resistance as the energy gap prevents the electrons from scattering.

The BCS theory can explain the electromagnetic response in superconductors. The Cooper pairs condense into a coherent quantum state that can be described by a macroscopic wavefunction. The density of superconducting electrons is given by the square of that wave function.

The **London Equations** were developed by brothers Fritz and Heinz London in 1935. They describe the electromagnetic properties of superconductors. The key equations are:

Superconductor

λ_L Magnetic Field
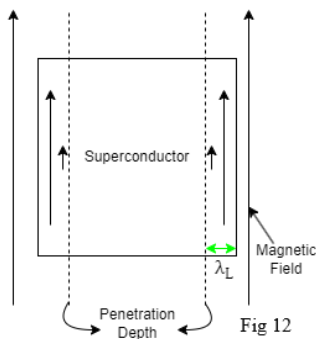
Penetration Depth   Fig 12

$$\nabla \times J_s = \frac{-1}{\lambda_L} B \; ; \; \nabla \cdot J_s = 0 \qquad \ldots (12)$$

Where J_s is the current density, B is the magnetic field, and λ_L is the **Penetration Depth**. The penetration depth describes how deep inside the surface of the superconductor, the magnetic field can penetrate. Typically, this depth is not much and is negligible unless the superconductor is extremely thin.

In Fig 12, a type 1 superconductor has been placed in an external magnetic field. The magnetic field penetrates the surface of the superconductor and decays exponentially inside the material. The penetration depth λ_L is really small, around the order of 10^{-8}m. In the diagram, λ_L has been exaggerated for ease of viewing.

4.3. Basic Ginzburg-Landau Theory

The Ginzburg-Landau theory, named after Vitaly Ginzburg and Lev Landau, is a theory used to explain the macroscopic aspects of superconductivity. It can explain the YBCO (very famous superconductor) and all cuprates.

GL theory represents the density of Cooper pairs and their phase in terms of a complex order parameter field $\psi(r) = |\psi(r)|e^{i\theta(r)}$. The magnitude of $\psi(r)$ is related to the local density of Cooper pairs, and its phase is associated with the quantum mechanical phase of the superconducting wavefunction. GN theory relates this with the free energy density:

$$f_s = f_n + \alpha|\psi(r)|^2 + \frac{1}{2}\beta|\psi(r)|^4 + \frac{1}{2m^*}|(-i\hbar\nabla - \frac{e^*}{c}A)\,\psi(r)|^2 + \frac{B^2}{8\pi}, \qquad \ldots (13)$$

Where,

f_n is the free energy density of the normal phase.

α and β are phenomenological parameters and are a function of 'T'.

m^* is the effective mass of the Cooper pair.

$\mathbf{B} = \mathbf{A} \times \nabla$ is the Magnetic field.

$\mathbf{A}$ is the magnetic vector potential.

e^* is the effective charge of the Cooper Pair.

The 2 GL equations are:

1
$$\nabla \times B = \frac{4\pi}{C}J \; ; J = \frac{e^*}{m^*}\left\{\psi^*(-i\hbar\nabla - \frac{e^*}{c}A)\psi\right\} \qquad \ldots (14)$$

2
$$\alpha\psi + \beta|\psi|^2\psi + \frac{1}{2m^*}(-i\hbar\nabla - \frac{e^*}{c}A)^2\psi = 0 \qquad \ldots (15)$$

These equations describe the behavior of the superconducting order parameter and the current density **J** in the presence of an electromagnetic field.

The GL theory also introduces 2 fundamental lengths: the **Coherence length** and the

Penetration depth. We already know penetration depth from the previous section, as for the coherence length, it characterizes spatial variation of the order parameter.

In GL theory, the electrons in a material in the superconducting phase form a **Superfluid**. In this interpretation, $|\psi|^2$ indicates the proportion of electrons that have condensed into a superfluid.

4.4. Some Effects of Tunneling of Superconductive Electrons

The tunneling of particles under suitable conditions has been discussed in section 2.3 of this paper. This effect has amazing applications in superconductivity. Under suitable conditions, we observe Cooper pairs tunneling through a layer of insulator into another superconductor. This junction is called a weak link. The effects of this phenomenon include:

DC Josephson effect (DC is for direct current): A direct current flows across the junction in the absence of any electric or magnetic fields

AC Josephson effect (AC stands for alternate current): a DC voltage applied across the junction causes the current to oscillate across the junction with a frequency in the range of around 3 kHz to 300 GHz, which corresponds to the frequency of radio waves (often called RF current). This effect has been employed in determining a precise value of ħ/e. Further, if a voltage with a frequency in the RF range (commonly known as RF voltage) is applied with the DC voltage, can cause a direct current flow across the junction.

Macroscopic long-range quantum interference: A DC magnetic field applied through a superconducting circuit containing two junctions causes the maximum supercurrent to show interference effects as a function of magnetic field intensity. This effect can be utilized in sensitive magnetometers.

(These results can be derived mathematically, relatively easily).

Fig 13
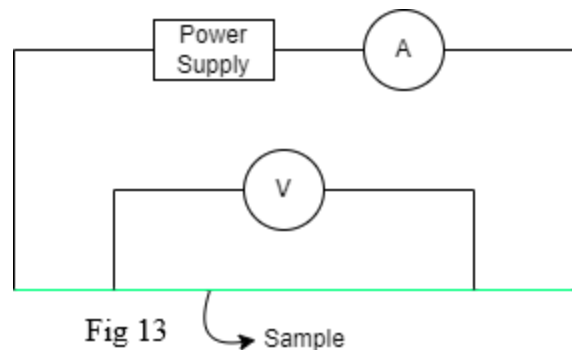
5. Experimental Methods

I don't wish to turn this paper into a purely theoretical one, so, I have included some experimental methods of how to practically measure various properties of superconductors.

5.1. Measuring the electrical resistance

Measuring the resistance of a superconductor is quite straightforward.

● First, we need a power supply that can supply us with a constant current with variable voltage.
● Then, we can connect our superconducting material sample and measure how much voltage is required to pass the set amount of current (see Fig. 13).
● When the sample is in a normal phase we will get a finite amount of voltage on our voltmeter.

- When the sample is cooled down to its critical temperature, the voltage across the sample suddenly drops to zero.
- We can use the simple equation $R = V / I$ in classical Ohm's law to depict that the resistance has truly reached zero.
- Of course, the instruments used have to be extremely precise, and the resistance of the

Fig 14

connecting wires must be taken into account and calibrated accordingly.
This technique is called the four-point measurement technique.

5.2. Critical Magnetic Field Determination

When the magnetic field reaches a certain value, the superconductivity breaks down. It is extremely important to keep this phenomenon in check, whenever dealing with superconductors. This also enables us to measure the properties of the material below the critical temperature that, otherwise would have been affected by superconductivity.

- To measure the critical field, we can follow a simple procedure.
- First, we set up the apparatus for the 4-point-measurement technique.
- Then, we cool down the sample till the superconducting state is achieved.
- Then, constantly looking at the reading, we slowly turn on the magnetic field and proceed to increase it while keeping the temperature of the superconductor constant.
- During incrementing the magnetic field, at some point, the superconductivity will vanish even while maintaining the critical temperature.
- This value of this magnetic field is called the critical magnetic field.

6. Applications of Superconductivity

Whenever we study a topic, we must look at its applications.

Firstly, the most important application of superconductors is the ability to form strong electromagnets with no wastage of energy. The following are some applications of the magnetic effect of superconductivity:

Magnetic Resonance Imaging (MRI): You have most probably heard of the word MRI before. It refers to a test to see the insides of your body through very strong magnetic pulses. The frequency of these pulses is very sophisticated to get the best result. It is mostly used to 'look' inside a person's head. The name MRI is actually derived from NMR which stands for 'Nuclear Magnetic Resonance' (it is quite clear that doctors had to make this change to not scare people

away). MRI usually focuses on the nucleus of the hydrogen atom, because our tissues (especially our brain) have a lot of water, thus a lot of hydrogen atoms. The magnets in these machines need to be at least a couple of teslas (our earth's magnetic field is roughly 0.00005 tesla), so normal electro-magnets waste a lot of energy as heat, but superconductors can do this job easily and quite efficiently (the only inconvenience is that we have to cool the superconductor).

Magnetic Levitation Trains (Maglev): Trains that rely on electromagnets for levitation, rather than conventional wheels. This requires extremely strong electromagnets to lift the train, and creating such magnets via conventional methods would waste so much energy that all the gain of efficiency gained by frictionless travel would be eclipsed by this loss. Hence, the use of electromagnetics made of superconductors is essential.

Particle Accelerators: Particle accelerators are used in particle colliders like the large hadron collider in the USA to study elementary particles and discover their properties. This works by accelerating the particles to relativistic speeds (near light speeds), by using strong electromagnets. These electromagnets also require a lot of power and current to run. This has been solved by superconductors. To demonstrate just how efficient superconductors are, see Fig-14.

Electric cables for accelerators at the **European Organization for Nuclear Research**. Both the massive and slim cables are rated for 12,500 A. Top: regular cables for LEP; bottom: superconductor-based cables for the LHC

Quantum Supercomputers: The CPUs and GPUs in our conventional servers can draw dozens of amps and get heated quickly. To solve this, we employ coolers which in turn waste more energy. But this sort of inefficiency is a fatal problem for supercomputers. So, we use superconductors to minimize the amount of heat generated (I say minimize as the transistors and other components made of semiconductors will unavoidably generate heat, so some heat will still be produced).

7. Current Challenges in Superconductivity

The study of superconductivity is a relatively new and unexplored one. There is no shortage of things in superconductivity that are covered in mystery.

One example of this is **High-Temperature Superconductivity** (HTS). To begin with, materials that have been observed to show HTS cannot be fully explained by the BCS theory, this demonstrates the point that we are far from being done with the development of theoretical models explaining superconductivity.

Discovering materials that exhibit HTS is a challenging task. Though many families of superconductors have been discovered that have much higher transition temperatures, the conditions they require to get to a superconducting state are non-practical. For example, the highest temperature superconductor currently known is LaH_{10} and its critical temperature is -27ºC but it requires 170 GigaPascals pressure (for reference, 1atm = 0.1 Gpa). See Fig 17
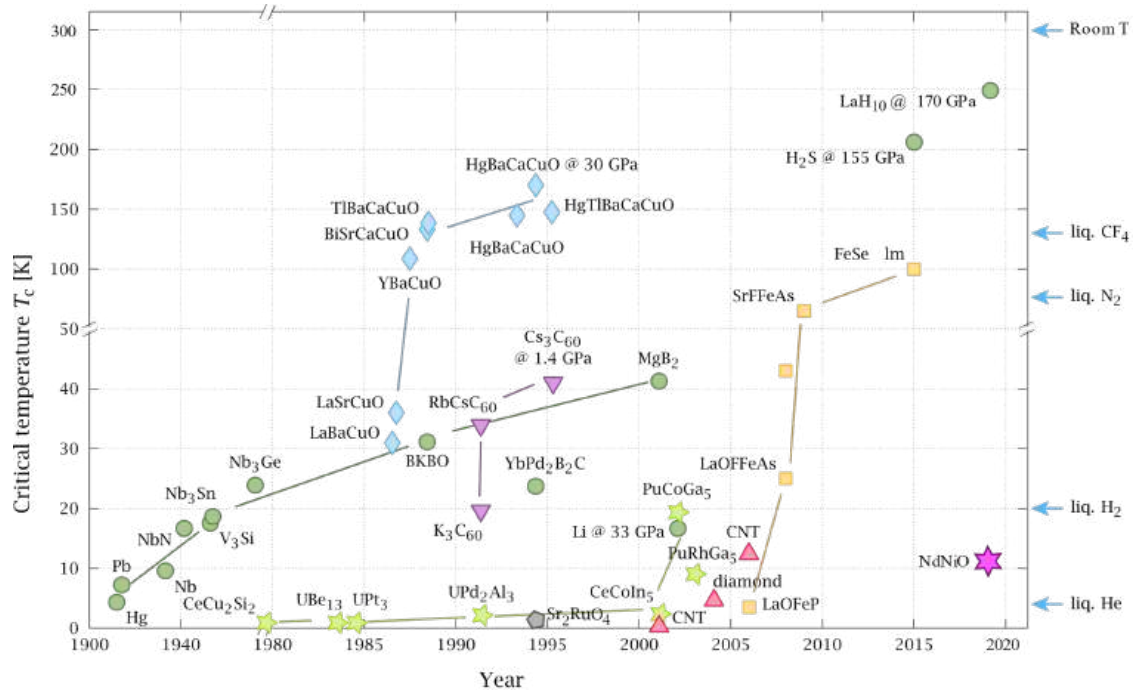
Fig 17 shows the discovery of various superconductors and the conditions for them to achieve superconducting state.

Another problem to consider is, that even if a room-temperature superconductor at atmospheric pressure was discovered, taking it from a lab sample to production at a large scale at a reasonable price range is, in itself, a challenge to be reckoned with.

8. What the Future Holds(conclusion)

While it is true that no man can predict the future, I believe with almost absolute certainty, that we will discover ways to make room-temperature superconductors and make them viable commercially. I have here some applications of superconductors at room temperature.

The first use that comes to mind is **commercially available supercomputers**, we can fit supercomputers into regular laptops and desktops if they don't require too much cooling and work without wasting much energy. This will revolutionize the tech industry in almost every way. As more people gain access to enormous amounts of processing power, more people can work on developing stuff to improve our lives.

Another use of superconductivity might be in space travel and exploration. Energy efficiency is a major problem in satellites and rockets. What's more, is that it is really hard to gain any heat energy in space (that is if the object isn't exposed to the sun). So, we just have to cool our material down once and after that, we just need to maintain the pressure required for the transition.

Superconductivity can even be used to stabilize the orbits of old satellites by flux pinning, which would also enable us to re-vitalize the satellite with fuel and other supplies. If we manage to develop this kind of technology quickly, we may even be able to extend the lives of many of our satellites, even the International Space Station. If humanity gets to the level of having asteroid mining or perhaps even a Dyson sphere, no doubt, superconductors will be a big help.

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Impact of Gambling on our Future Generations By Vivaan Sharma

Abstract

Gambling has emerged as a pervasive societal issue, affecting individuals across diverse demographics and age groups. This study explores the prevalence and impact of gambling behaviors among individuals of varying ages, employing a comprehensive survey methodology. The research investigates demographic variables such as age, gender, educational background, and occupational status to discern patterns in gambling habits and their associated consequences. Findings highlight distinct trends in gambling frequency, expenditure, and psychological effects across different age cohorts, underscoring the need for targeted interventions and preventive measures.

1. Introduction

The prevalence of gambling has expanded significantly in recent decades, driven by technological advancements and increased accessibility to online platforms (Griffiths, 2016). This growth has raised concerns about the potential negative impacts on individuals' financial stability, mental health, and social well-being. Understanding how gambling behaviors vary across age groups is crucial for developing effective interventions and policies to mitigate its adverse effects.

1.1: Background and Context

Research indicates that gambling participation rates vary significantly across age groups. Young adults, particularly those in the late teens to early 30s, are more likely to engage in risky gambling behaviors compared to older adults and seniors (Derevensky & Gupta, 2000; Welte et al., 2004). Factors such as increased disposable income, peer influence, and accessibility to gambling opportunities contribute to heightened gambling activities among younger demographics (NCRG, 2018). Conversely, older adults may engage in gambling as a recreational activity, with fewer instances of problematic behaviors.

1.2: The Problem

Gambling can lead to severe consequences, including financial hardship, psychological distress, and strained interpersonal relationships (Kalischuk et al., 2006). Problematic gambling behaviors are associated with co-occurring mental health issues such as depression, anxiety, and substance abuse disorders (Petry & Weinstock, 2007). Understanding the factors that influence gambling behaviors across different age groups is critical for developing targeted interventions and support services.

1.3: Objective

This study aims to investigate the prevalence and impact of gambling behaviors among individuals of varying age groups, identify risk factors associated with problematic gambling, and explore effective interventions for mitigating gambling-related harms.

1.4: Hypotheses

The study hypothesizes that:

1. Younger adults will exhibit higher rates of gambling participation and more frequent engagement in risky gambling behaviors compared to older adults and seniors.
2. Younger individuals will report higher expenditures on gambling activities, potentially leading to financial instability and debt accumulation.
3. Younger individuals will experience more pronounced psychological distress, such as anxiety and depression, related to gambling behaviors compared to older age groups.
4. There may be gender variations in gambling behaviors, with males potentially exhibiting higher rates of gambling participation and riskier behaviors than females.

1.5: Significance

The findings of this study will contribute to a deeper understanding of the social, psychological, and financial impacts of gambling across different age groups. By identifying vulnerable populations and risk factors associated with gambling addiction, policymakers, educators, and healthcare professionals can develop targeted interventions and preventive strategies to mitigate the negative consequences of gambling.

2. Literature Review

2.1: Prevalence and Patterns of Gambling

Gambling participation rates vary significantly across age groups, with younger adults exhibiting higher rates of engagement in gambling activities compared to older adults. According to the National Center for Responsible Gaming (NCRG, 2018), young adults aged 18-24 years are more likely to participate in gambling due to factors such as increased exposure to online gambling platforms and peer influences. In contrast, older adults tend to engage in gambling as a leisure activity, with lower rates of problematic behaviors.

2.2: Gender Differences

Gambling Research suggests gender differences in gambling behaviors, with males typically exhibiting higher rates of gambling participation and riskier behaviors compared to females (Welte et al., 2004). However, the gap in gambling participation between genders has narrowed in recent years, particularly with the rise of online gambling platforms that appeal to both men and women (Griffiths, 2016).

2.3: Impact on Mental Health

Gambling can have profound effects on mental health, particularly among young adults who are more susceptible to developing gambling-related disorders. Petry and Weinstock (2007) found a strong association between gambling addiction and mental health issues such as depression, anxiety, and substance abuse disorders. The stress and financial strain associated with gambling can exacerbate these mental health conditions, leading to a cycle of addiction and psychological distress.

2.4: Financial Consequences

The financial impact of gambling is significant, with younger individuals often reporting higher expenditures on gambling activities compared to older adults. Studies indicate that young adults may engage in risky financial behaviors, such as borrowing money or using credit cards to fund their gambling habits, leading to financial instability and debt accumulation (Derevensky & Gupta, 2000).

2.5: Social and Familial Effects

Problematic gambling behaviors can have ripple effects on families and communities, contributing to strained relationships, domestic violence, and financial hardship (Kalischuk et al., 2006). The social stigma associated with gambling addiction can also deter individuals from seeking help, exacerbating the negative impacts on family and social networks.

3. Methodology

This study employed a cross-sectional survey design to collect data on gambling behaviors among individuals of different age groups. The survey included demographic questions (age, gender, educational background, occupation), gambling frequency, types of gambling activities, financial expenditure on gambling, and psychological impacts of gambling. Participants were recruited through online platforms, social media, and community organizations, ensuring a diverse sample representative of various age cohorts.

4. Results

Participants in the study varied widely in demographics and gambling behaviors. The following summarizes key findings based on age, gender, ethnicity, educational background, occupation, gambling frequency, types of gambling activities, monthly expenditure on gambling, and responses to specific gambling-related questions.

4.1: Demographics

The study included individuals across all age groups, from teenagers to retirees. The survey comprised 29 individuals who were asked questions ranging from their age to how the community can help gamblers recover and spread awareness of this growing problem. According to the survey, young adults are more susceptible to gambling due to peer pressure, family

problems, or online advertising. The study also found that older individuals tend not to gamble as frequently as the younger population.

Education plays a key role, as individuals who gamble more frequently tend to have lower levels of education. Out of the 29 individuals, 55.2% are males (16.008, rounded to 16), with 9 of the 16 individuals (52.94%) gambling frequently (daily, weekly, monthly) compared to the other 47.06%. There is also a correlation between the 9 individuals being younger, with some who graduated from high school in their late 20s and early 30s.

Out of the 29 individuals, 44.8% are females (12.992, rounded to 13), with 9 out of 13 (69.2%) gambling more frequently than the other 30.8%. Females who have attended some college or graduated from high school tend to gamble more frequently than those who completed college and obtained a master's or bachelor's degree.

The types of gambling activities also varied, with teenagers (<19 years) tending to gamble on sports and even having access to casinos. One 13-year-old mentioned placing minor bets with friends, which strained his friendship when he lost. He also mentioned that he gambles monthly, which is very frequent for his age. Another teenager, 17 years old, in his senior year of high school, gambles weekly, spending hundreds of dollars.

There is also a growing trend suggesting that online gambling is the most prevalent form of gambling among young adults, with sports betting coming close. Older adults and seniors are more inclined towards lottery or casino gambling rather than online or sports betting.

Individuals with lower education levels also seem to spend more money on gambling compared to those with higher education levels. Young adults show a trend where they progressively spend more money, starting from $0-100 and going beyond $1,000. A 29-year-old female with a bachelor's degree, who gambles daily, mentioned how she usually spends between $1,000 to $3,000 on average while gambling. She noted how the concept of the "big win" made her hooked on winning more money, leading to severe mental and general health problems.

4.2: Psychological and Behavioral Aspects

Participants were asked several questions to gauge the psychological and behavioral impacts of their gambling habits. Key themes emerged from the responses:

- Attempts to Cut Back: Many individuals reported unsuccessful attempts to cut back on gambling. About 62.1% said no, who also were not as frequent as the other 37.1% who gambled either every day, week or at least 5+ times a month.
- Increasing Amounts: Some felt the need to gamble with increasing amounts of money to achieve the desired excitement. Many including the teenagers (13-year-old and the 17-year-old) have both said that after a win, when they put that money in the next bet with more risk involved, they feel more of a thrill than the first time, which has gotten them into trouble. Although about 65.6% said no, the rest 34.5% did say yes. All the people that did say "yes" were also young adults in their early 20s, developing severe addictions to gambling and alcohol.

- Gambling to Escape: Several individuals gambled to escape from problems or to relieve feelings of helplessness, guilt, anxiety, or depression. About 69% said they didn't gamble to escape from these feelings, the rest 31% said that they needed to gamble to distract themselves from these feelings. The 31% were also the more frequent gamblers (daily and weekly). Some even mentioned that their anxiety had gotten so bad that they didn't talk to anyone, not their friends, family, no one, and just remained inside their houses for months at a time, just gambling and sometimes even crying loudly.

Based on these responses, it is evident that some participants may be considered pathological gamblers. The behaviors described align with diagnostic criteria for gambling disorder, including persistent and recurrent problematic gambling behavior leading to clinically significant impairment or distress.

4.3: Pathological Gambling

Pathological gambling, or gambling disorder, is characterized by a chronic and progressive inability to resist the impulse to gamble. Several participants in this study exhibited symptoms consistent with pathological gambling. For instance, a 29-year-old female who gambles daily reported spending up to $3,000 monthly on gambling activities and experiencing significant distress and impairment in her daily life. Similarly, a 17-year-old male who gambles weekly described losing substantial amounts of money, leading to strained relationships with family and friends. These cases align with findings from previous research indicating that individuals with gambling disorder often experience severe financial, social, and psychological consequences (Petry & Weinstock, 2007; Kessler et al., 2008).

4.4: Social and Financial Consequences

Participants were asked about their financial status, if they had problems with keeping and saving money that they otherwise spent on gambling. They were also asked about their social life, dealing with important family events, or if due to gambling they strained their relationships. The following are the results:

- Relationship problems: Several participants mentioned how gambling caused strains in their relationship with friends and family. Many said how they lied to their significant others, how they stole money from their friends and family members to finance their addiction, and also stating how they were absent for days at a time. About 65.5% said they never had a problem, while the rest 34.5% said they have strained relationships with their significant other or parents and even some friends that they don't interact with anymore.
- Borrowed money and sold possessions: Most of the participants have said no, even a few frequent gamblers. Though 24.1% still said yes, as they had lost so much money they didn't have food for the month, but the addiction had taken over and they had sold family goods or even "borrowed" money from friends, that

actually they stole, which their friends later found out and now those individuals said they don't talk to each other anymore.

- Missed work: Many young adults mentioned how they missed their tests or places they used to work to gamble for hours and sometimes even days. About 27.6% mentioned how they missed work. Some of the individuals in their 30s and 40s who started to gamble since their teenage years also reported to miss work to go to casinos or online gamble for hours and then just stay inside their house when they lost. Some even mentioned how they may break things because they lost tons of money. This trend is also related to individuals that gamble very frequently (daily and weekly).
- Financial difficulties: Many participants reported that betting on big games and gambling for days at a time, often losing significant amounts of sleep, had left them financially unstable. They frequently found themselves without enough money at the end of the month to cover food or other essential bills. About 34.5% of the individuals were very frequent gamblers, who also mostly were young adults, or older individuals that started gambling since their 20s.

The impact of gambling on financial status and social relationships was a recurring theme among participants. Many reported that gambling had caused significant strain on their relationships with family and friends. For instance, a 25-year-old male described how his gambling habit had led to frequent arguments with his spouse and resulted into eventual separation. Similarly, a 19-year-old female mentioned how she had spent her entire paycheck on a big sports event and lost it all, left with nothing for the month and her family didn't approve of her gambling activities, and eventually denied help because of her addiction.

4.5: Personal help and help seeking:

Participants were asked if they believed they had a gambling problem. Many denied having an issue, attributing it to their gambling not being frequent. However, those who gambled frequently acknowledged their problem but did not seek help. They often felt alienated, which led to procrastination and gambling with money they had either legally or illegally borrowed. Some frequent gamblers did seek help and reported improvements in their health. Gambling can lead to poor physical health, malnutrition, and substance abuse, as many in the sample noted significant alcohol and nicotine use.

When asked about effective support or treatment for gambling addiction, most participants suggested counseling as a key solution. They recommended increasing the number of counselors specialized in gambling issues and adding financial counselors to address money problems. Many also advocated for more therapy facilities, noting that therapy had been beneficial in their recovery. While specific types of therapy were not widely discussed, one individual highlighted cognitive behavioral therapy (CBT) as particularly effective, asserting it was more helpful than other methods.

Participants frequently mentioned the importance of support groups, recovery programs, group discussions (such as Gamblers Anonymous), hotlines, and accessible rehab centers. One participant even suggested that religious faith could play a role in overcoming addiction, recommending that individuals embrace spirituality as part of their recovery process.

Overall, there was a strong consensus on the need for more therapy centers, counseling services, support groups, and educational programs to assist individuals in overcoming gambling addiction and getting their lives back on track.

4.6: Open-ended questions:

There were three questions that participants were asked to truly see the negative impacts of gambling and how gambling could quickly infect the body of the gambler. The following are the results:

- **Personal experience:** When participants were asked about their personal experiences with gambling, many who gambled frequently mentioned being introduced to it around the age of 18, often due to peer pressure from friends. A significant number reported having family members, such as fathers or uncles, who were severe gamblers and alcoholics. One participant shared that their family had suffered from poverty because of their grandfather's gambling addiction.
  - The allure of the "big win" was a common hook that led many into a gambling lifestyle. They recounted initial small victories followed by significant losses that they couldn't recover from, plunging them into dark periods in their lives. Some college dropouts or graduates confessed that online gambling had caused them to miss important exams and family events. Many admitted to stealing money from friends or family to fund their gambling habits. Instances of deceit were also common, with participants knowing individuals who lied to their significant others and took money from joint accounts.
  - One participant described working at a casino and witnessing the extreme behaviors of gamblers, including heavy alcohol and drug consumption, people passing out on the floor, in unsanitary conditions with vomit and urine. The casino environment lacked windows and clocks, further trapping individuals in the gambling cycle.
  - Another participant worked at a smoke shop with slot machines and observed people of all age groups, including high school and middle school students, gambling for hours and losing significant amounts of money. These young individuals were often consuming THC and alcohol while gambling. Despite signs prohibiting underage entry, the owners overlooked these rules as long as money kept flowing in.
  - Overall, these personal experiences highlight the profound and often destructive impact of gambling on individuals and their families.

- **Negative Impacts and Suggested Measures:** Many participants highlighted the need for stricter regulations and increased awareness to combat gambling addiction. They emphasized the importance of providing more information about the addiction, especially targeting schools and gamblers to inform them about the negative impacts.
  - Participants suggested the following measures:
    - **Awareness and Education Programs**: Implement comprehensive programs to educate the public about the risks and consequences of gambling addiction.
    - **Stricter Regulations**: Enforce tighter controls on gambling activities, including taxation on casinos, limiting the number of lottery tickets an individual can purchase, and capping the number of casinos.
    - **Mandatory Information Packets**: Require casinos to distribute informational packets about gambling risks and have patrons sign waivers acknowledging the potential dangers.
    - **Advertising Bans**: Prohibit gambling advertisements on platforms such as YouTube and Instagram, as these ads can tempt individuals to gamble.
    - **Elimination of Gambling**: Some participants advocated for the complete eradication of gambling, suggesting that the government should take over gambling operations, establish more therapy centers, and fund further research into gambling addiction.

These suggestions reflect a broad consensus on the need for proactive measures to mitigate the negative impacts of gambling and support those struggling with addiction.

5: Discussion

The results highlight significant variations in gambling behaviors and their impacts across different demographic groups. Younger participants tend to exhibit riskier behaviors, such as high-frequency gambling and higher expenditures, compared to older adults. Gender differences also influence gambling patterns, with males generally engaging in gambling more frequently and with higher stakes than females. The findings also underscore the importance of educational attainment in mitigating gambling-related harms, as individuals with higher levels of education were less likely to engage in problematic gambling behaviors.

5.1: Implications for Policy and Practice

The findings of this study have important implications for policy and practice. To address the growing trend in gambling, policymakers should consider implementing stricter regulations on gambling advertisements, particularly those targeting young adults. Additionally, educational programs aimed at raising awareness about the risks of gambling should be incorporated into school curricula. For individuals already affected by gambling addiction, access to specialized treatment programs and financial counseling services is essential.

6: Conclusion

Gambling is a complex and multifaceted issue that affects individuals across all age groups and demographics. The findings of this study highlight the urgent need for targeted interventions and policies to address the growing trend in gambling and mitigate its adverse effects. By understanding the patterns and impacts of gambling behaviors, stakeholders can develop comprehensive strategies to promote responsible gambling and support individuals at risk of or affected by gambling addiction.

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Free Will and Determinism: A Survey of Philosophical, Scientific, and Technological Perspectives By Xianyang Max Zou

Abstract

This paper explores the debate between free will and determinism, investigating whether human actions are freely chosen or predetermined. By examining historical and contemporary viewpoints, the paper discusses the implications of these concepts on ethics, morality, and legal responsibility. The study also considers the impact of advancements in neuroscience and technology on the discourse, aiming to provide a comprehensive understanding of how free will and determinism shape our worldview and ethical frameworks.

Introduction

In this paper we will explore the debate between free will and determinism. This is a fundamental philosophical question that asks whether we control our own lives or if everything that happens is predetermined. Imagine you're at a crossroads and have to decide which way to go. This situation is a bit like the big question of whether we control our own lives (free will) or if everything that happens is already set in stone (determinism). This discussion is important because it touches on how we think about choices, responsibility, and even how we see the world.

In this paper, we're going to dive deep into this debate. This will be a survey, meaning that I will not be taking any sides. We'll look at determinism, which is believing that life is a book with all its pages already written. Then we'll explore free will, the idea that we're the ones writing our story, making choices as we go along. We'll see what thinkers, scientists, and philosophers have said about this and try to understand the impact of these ideas on how we live and think.

Incompatibilism

Incompatibilism holds that free will and determinism are fundamentally at odds. Incompatibilists argue that if determinism is true, then every action is the result of preceding events, leaving no room for free will as traditionally conceived. If both were to exist at the same time, which actions are predetermined and which are of your free will? For example, if at this moment you drink some water, how does one decide if that was predetermined or of your choice? Since there does not exist a clear line differentiating deterministic choices from free will choices, they are not both compatible at the same time.

Section 1: Understanding Determinism

Determinism is like watching a movie that's already been filmed. Everything that happens in the movie follows a script, and nothing can change. Determinism says that all events in the universe, including human decisions and actions, are the result of preset conditions bound by unyielding laws. At the heart of determinism lies the premise that every state of affairs is the

consequence of a causal chain originating from the cosmic tapestry of the universe's inception. This deterministic viewpoint asserts that if one were omniscient, possessing complete knowledge of all particles and forces at any given moment, it would be possible to predict the future with absolute certainty.

From the Greeks believing in fate, to Ragnarok for the Norse, to Calvinist ideologies, and to Mayans predicting the end of the world.

Historical and cultural beliefs in determinism are varied and rich. The ancient Greeks, for instance, attributed a significant role to fate in human lives, believing it to be a predetermined force that none could escape. This notion is evident in their mythology, where the Moirai, or Fates, were thought to control the destinies of both mortals and gods alike.

In Norse mythology, the concept of Ragnarok, a prophesied apocalypse involving the great battle that leads to the death of major gods like Odin, Thor, and Loki, reflects a deterministic view of the universe. This event was seen as inevitable, marking the end of the cosmos in its current form and the rebirth of a new world.

Similarly, Calvinism, a major branch of Protestantism, emphasizes predestination. According to this doctrine, the eternal fate of human souls—whether to salvation or damnation—is predetermined by God, underscoring a theological interpretation of determinism.

The Mayans, known for their astronomical and calendrical systems, also embraced a deterministic universe to some extent. Their ability to predict celestial events and the infamous conclusion of their calendar cycle in 2012 popularized the notion that they had foreseen the end of the world, although interpretations of what the Mayans believed vary widely.

Each of these examples illustrates how the principle of determinism has been integral to human understanding across different eras and societies, shaping how people interpret the universe and their place in it.

Philosophers like Spinoza argued that free will is an illusion. They believed that every action or event is the result of previous conditions and that nothing happens without a reason. This perspective views the universe as a giant clockwork, with every part moving in a predetermined way.

From the motion of planets to the growth of plants, the natural world seems to follow specific patterns or laws. This predictability in nature suggests that if we knew all the laws and the state of everything at one time, we could predict the future completely. The idea of determinism has been instilled in our society throughout history.

Section 2: Exploring Free Will

Free will is the philosophical and intuitive notion that individuals have the capacity to make choices that are not pre-determined by past events or external circumstances. It implies a level of personal autonomy and decision-making power, suggesting that, to some extent, individuals can shape their own destinies independent of a fixed causal chain. It is undebated that past events always have an effect on the present, but it is your free will to choose to act or react to the change. This concept is fundamental to our understanding of moral responsibility, ethics,

and individual agency, framing the human experience as one of active participation rather than passive observance.

Philosophers have long grappled with the concept of free will, often aligning themselves with either deterministic or libertarian viewpoints. Determinists argue that every action is the result of preceding events and conditions, thus negating true free will. In contrast, libertarians maintain that individuals have the inherent ability to make free choices, independent of past influences.

Psychology offers insights into the mechanisms of decision-making and consciousness, exploring how perceptions of free will affect human behavior. Cognitive psychologists study the mental processes involved in making decisions, while behavioral psychologists examine how environmental factors influence actions, often questioning the extent of individual autonomy in decision-making.

Section 3: Arguments

In this section, we will explore various arguments related to the concepts of determinism and free will from different philosophical, scientific, and experiential perspectives. This analysis will help illuminate the intricate dynamics between determinism and free will, setting the stage for the ethical and societal implications discussed in the subsequent section.

Theological Determinism:
- Determinism: The belief in an omniscient God—who knows the past, present, and future—also supports the idea of determinism. In many religious frameworks, God's omniscience is thought to extend to every event and decision, suggesting that all outcomes are foreknown and, thus, fixed. This viewpoint argues that if God already knows everything that will happen, then events must unfold according to that divine foreknowledge, leaving no room for alteration. This form of determinism implies that the trajectory of the universe and all actions within it are not just predictable in theory but are also part of a divine plan.
- Free Will: One significant counterargument to theological determinism comes from the idea that an omniscient God or multiple gods could choose to create a universe where free will exists. There are two trains of thought here. The first notion follows the idea that God knows all past, present, and future. The other says that God knows all there is to be known, but since the future has not happened yet, no one, not even God, can know that is to happen. In this view, God's foreknowledge does not necessarily dictate or constrain human actions, which maintains the possibility of true freedom of choice. Additionally, critics of theological determinism often cite the problem of evil and moral responsibility. If all actions are preordained by God, it raises ethical questions about the responsibility for evil acts. Advocates of free will argue that moral accountability requires free agents capable of choosing between good and evil, a choice that theological determinism appears to eliminate.

Quantum Mechanics:
- Free Will: This branch of physics studies the smallest parts of the universe, like atoms and particles, and has found that they can behave unpredictably. This randomness at the quantum level challenges the idea that everything is predetermined because it suggests that some events happen without a direct cause.
- Determinism: In the realm of quantum mechanics, where randomness and probability challenge the classical notion of determinism, a more nuanced interpretation emerges to bridge these seemingly conflicting paradigms. The concept of statistical determinism posits that while individual quantum events may display randomness, the collective behavior of large particle groups adheres to predictable statistical patterns, suggesting a macroscopic layer of determinism atop the quantum indeterminacy. This perspective is complemented by theories such as decoherence and the Many-Worlds Interpretation, which reconcile quantum randomness with determinism. Decoherence describes the process by which a quantum system loses its superposed states, settling into a definite state through interaction with its environment, thus introducing a deterministic element to quantum mechanics. The Many-Worlds Interpretation expands this deterministic framework by positing that all potential outcomes of quantum phenomena actually occur in separate, parallel universes, each following deterministic paths, thereby maintaining a universal determinism across an infinite array of branching realities.

Complexity of Prediction:
- Free Will: While emergent determinism suggests that large-scale patterns can be predictable, it doesn't fully account for the true unpredictability in chaotic systems. If outcomes depend on initial conditions, even tiny unknown variables can drastically change the future, making true determinism practically impossible. Additionally, quantum mechanics introduces fundamental randomness that challenges the idea that everything is predetermined. This randomness suggests that not all outcomes are strictly determined, allowing for the possibility of free will and the idea that human actions are not entirely controlled by deterministic laws.
- Determinism: The complexity of predicting outcomes in deterministic systems, particularly within chaotic systems where initial condition sensitivity leads to apparent unpredictability, does not invalidate determinism but rather highlights the limits of our predictive capabilities. In such systems, the deterministic nature persists even in the face of unpredictable outcomes, exemplified by the butterfly effect, where small variations can lead to vastly different futures. This leads to the concept of emergent determinism, where deterministic patterns emerge at larger scales from the interactions of numerous unpredictable or indeterminate components. For example, weather systems, despite their inherent complexity and the unpredictable behavior of individual elements, exhibit predictable patterns over time, illustrating how deterministic processes can manifest in complex systems. Thus, the deterministic universe, characterized by its orderly and

predictable laws, accommodates the layers of randomness and unpredictability within its fold, suggesting a coexistence that enhances our understanding of the cosmos's intricate workings.

Epiphenomenalism vs Experience of Choice:
- Determinism: Epiphenomenalism suggests that our sense of making free choices is an epiphenomenon—an incidental byproduct of our brain's processing rather than a true influence on our actions. According to this view, while our brains generate feelings of autonomy and decision-making, these experiences do not actually impact our actions but are merely side effects of brain activity. This concept implies that the perception of free will is a psychological mechanism evolved to maintain mental stability and coherence; it helps individuals rationalize their experiences and actions in a complex world.
- Free Will: In our daily lives, we feel like we make choices, from simple ones like picking a snack to major ones like choosing a career. This feeling of making decisions seems to conflict with the idea that everything is predetermined. If our choices can change the course of events, then how can everything be pre-decided?

Section 4: Ethical and Societal Implications

The debate between free will and determinism extends beyond theoretical discussions, impacting our ethical frameworks and societal norms significantly. This section explores how the philosophical positions on free will and determinism influence our views on morality, justice, and personal accountability.

Ethical Implications of Free Will and Determinism

The concept of moral responsibility is deeply intertwined with the notion of free will. If individuals are considered to have free will, they are generally seen as morally responsible for their actions. This perspective is foundational to ethical theories that emphasize virtues, duties, or consequentialist outcomes based on personal choice and intention. In a deterministic framework, however, the basis for moral responsibility becomes more complex, as actions are viewed as outcomes of preceding causes rather than autonomous decisions. This raises challenging questions:

Moral Responsibility: If our actions are predetermined, can we be held morally responsible for them? Determinism suggests that individuals have limited control over their actions, leading to debates about the fairness of assigning blame or praise for actions that may have been unavoidable.

Ethical Theories: Different ethical theories handle the tension between determinism and free will in varied ways. For instance, utilitarianism focuses on the outcomes of actions rather than the free will of the actor, while deontological ethics emphasizes duties and intentions that presume the capacity for free decision-making.

Societal and Legal Considerations

The legal system heavily relies on notions of free will and personal responsibility. Legal practices often presuppose that individuals have the free will to choose between right and wrong, and this assumption underpins the justice system's approach to crime, punishment, and rehabilitation.

Legal Accountability: The concept of culpability in law assumes that individuals are free to make choices and, therefore, can be held accountable for their actions. Determinism challenges this assumption, suggesting that if actions are the result of past events and external conditions, the traditional understanding of culpability and punishment may need reevaluation.

Rehabilitation and Determinism: If determinism holds true, it could shift the focus from punishment to rehabilitation, emphasizing the modification of environmental and psychological factors that lead to criminal behavior rather than retributive justice based on the notion of free will.

Political Decisions: The mere act of voting, such as for presidents, exemplifies the societal assumption of free will. The meaningfulness of voting hinges on the belief that citizens have the genuine freedom to choose among candidates based on their values and judgments. If determinism were true, the entire premise of democratic participation would lose its essence, as the choice of a leader would be preordained rather than an expression of the electorate's free will.

Impact on Social Policies

The interplay between free will and determinism also has significant implications for social policy and the structuring of societal institutions. Policies that aim to modify behavior, such as educational programs, public health campaigns, and criminal justice reforms, are often predicated on assumptions about human agency and the ability to choose.

Behavioral Change and Autonomy: Social policies that promote behavioral change typically assume that individuals have the autonomy to alter their behavior. Deterministic perspectives, however, might advocate for policies that focus more on altering external factors and conditions that deterministically influence behavior.

Ethical and Social Justice: Questions about free will and determinism also intersect with broader discussions about social justice and equality. For example, understanding the extent to which societal conditions determine individual behavior can influence views on poverty, education, and criminality, shaping policies to address these issues more effectively.

In conclusion, the philosophical inquiries into free will and determinism are not just academic exercises but have profound implications for ethical theory, legal responsibility, and the design of social policies. The ways in which societies interpret these concepts can significantly affect how individuals are judged, treated, and supported in their efforts to lead fulfilling lives within the communal fabric.

Section 5: Current Debates and Future Directions

The discourse surrounding free will and determinism continues to evolve, fueled by advancements in various fields such as neuroscience, psychology, and philosophy. This section explores the current state of the debate and anticipates future directions in understanding the complex interplay between determinism, free will, and their implications for human agency.

Advancements in Neuroscience and Implications for Free Will

Neuroscientific research has significantly contributed to the debate, particularly through studies examining the neural underpinnings of decision-making and consciousness. Experiments have shown that brain activity indicating a decision occurs before individuals become consciously aware of making a choice, challenging traditional notions of free will.

Brain Imaging and Decision Processes: Advanced imaging techniques allow scientists to observe the brain in action as decisions are made, offering insights into how choices are formed at the neural level. These findings suggest a more nuanced understanding of free will, one that integrates neurological determinants.

Neuroplasticity and Human Agency: Research on neuroplasticity, the brain's ability to reorganize itself by forming new neural connections, also informs the free will debate. It suggests that while our decisions may be influenced by brain structure and past experiences, there is potential for change and adaptability, indicating a form of agency.

Future Directions

Looking forward, the exploration of free will and determinism is likely to be characterized by interdisciplinary research, integrating insights from science, philosophy, and the humanities.

Interdisciplinary Research: Collaborative research across neuroscience, psychology, philosophy, and other disciplines promises to deepen our understanding of free will and determinism, potentially leading to new models that synthesize these perspectives.

Technological and AI Developments: Advances in artificial intelligence and technology, which challenge our notions of agency and autonomy, will likely influence the free will debate, prompting questions about the nature of consciousness and decision-making in both humans and machines. Another argument is that if computers become advanced enough to calculate our decisions based on our past life, are our lives free anymore?

Uploading The Human Consciousness to the Cloud: As we venture further into the realm of technological possibilities, the concept of uploading human consciousness to a computer presents a fascinating frontier in the discussions of free will and determinism. This potential ability to digitize and preserve a person's mental essence raises profound philosophical questions. For instance, if one's consciousness is transferred to a digital medium, does the original person still exist, or is the digital copy merely a new entity with similar memories and characteristics? Furthermore, if our thoughts and decisions can be accessed and potentially manipulated digitally,

what does this mean for our autonomy and free will? Are we merely complex algorithms predestined by the programming parameters, or do we still possess a unique agency?

Importantly, it is to distinguish if it is still a human making the decision. Under the conditions mentioned above, it is assumed that the human brain is simply preserved in a computer or any other physical form that still ensures the ability to be independent. Under the assumption made it is assumed that we still have complete control over our distinctions. However, this raises questions about potential subconscious effects the computers could have on us. In addition, this brings up the topic of freedom of thought vs freedom of action. While our thoughts may remain free, the ability to act upon these thoughts would be constrained by environmental conditions, limited by the computer. If our thoughts and decisions can be accessed and potentially manipulated digitally, what does this mean for our autonomy and free will? Are we merely complex algorithms predestined by the programming parameters, or do we still possess a unique agency?

Conclusion

The intricate debate between free will and determinism encompasses a profound exploration of human nature and the universe's fundamental workings. Through the journey from the philosophical and scientific underpinnings of determinism to the nuanced considerations of free will, and the complex landscape of compatibilism versus incompatibilism, we have navigated a spectrum of perspectives that illuminate the multifaceted nature of human agency and causality.

This discourse reveals that the questions surrounding free will and determinism are not merely academic; they resonate deeply with our understanding of morality, ethics, and personal responsibility. The ethical and societal implications of this debate extend into the realms of law, social policy, and individual conduct, challenging us to consider how we assign blame, reward, and responsibility in a world that may be fundamentally deterministic, yet experientially free.

As we have seen, advancements in neuroscience and philosophy continue to enrich and complicate the dialogue, blurring the lines between determined actions and autonomous decisions. The ongoing synthesis of scientific discoveries and philosophical inquiry promises to further our understanding of this timeless debate, suggesting that the dichotomy between free will and determinism may not be as clear-cut as traditionally conceived.

Looking ahead, the interplay between deterministic structures and the experience of agency will likely remain a central theme in philosophical, scientific, and practical inquiries. As technology, especially in fields like artificial intelligence, continues to evolve, it will further challenge and refine our concepts of decision-making, consciousness, and free will.

In conclusion, the debate over free will and determinism stands as a testament to the enduring complexity of human thought and the perpetual quest for understanding the essence of our existence. It compels us to continuously reevaluate our perceptions of freedom, choice, and the nature of reality itself, ensuring that this philosophical inquiry remains a vibrant and essential feature of the human intellectual landscape.

Acknowledgement

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Holistic Analysis of Effects and Habits of Nicotine E-cigarette Use Amongst US Teens By Cecilia Anderson

Abstract

The purpose of this paper was to examine the effects of e-cigarettes and factors that affect the usage of e-cigarettes. Specifically, information was collected regarding health effects, mental health, age, gender, social media, environmental influences, and smoking abstinence associated with e-cigarettes from several recent studies from online databases. The products in e-cigarettes were shown to have negative health effects, especially on the respiratory system, the cardiovascular system, and the central nervous system. Gender and age affect both e-cigarette usage and its effects on the body, including behavioral issues and mental health. Outside influences such as peers, social media, and regulations can also play a role in who and how often a person is consuming e-cigarettes.

Introduction

Tobacco and nicotine products have been a staple in recreational drug usage in the United States for centuries. There are many different types of tobacco products, such as cigars, cigarettes, e-cigarettes, and hookahs, with cigarettes being the most common. There are also many smokeless tobacco products like chewing tobacco and snuff. Tobacco can cause many health risks. Smoking tobacco is the leading cause of premature death in the US and harms almost every organ in the body, causing 480,000 deaths annually. Tobacco products, including smokeless ones, contain chemicals that are carcinogenic. For example, ninety percent of all lung cancer deaths are due to smoking, and many mouth and esophagus cancers can be caused by smokeless tobacco products. Smoking can also cause other respiratory diseases such as chronic bronchitis, emphysema, and chronic obstructive pulmonary disease (COPD). Besides those, smoking tobacco has also been linked with many other diseases. Smoking tobacco increases the risk for cardiovascular diseases, due to its potential to damage a person's blood vessels and increase their blood pressure, which in turn can cause clots that lead to strokes. Additionally, smoking during pregnancy has been shown to cause low birth weight, preterm birth, restricted head growth, placental problems, and an increased risk of stillbirth and miscarriage (Health Effects of Cigarette Smoking).

More recently, there has been an explosive increase in the usage of vape and e-cigarette products, especially among young adults and teens. Vapes have become increasingly popular among teens due to their accessibility and appealing flavors. As of 2023, 1 in 22 middle school students and 1 in 10 high school students reported using e-cigarettes in the last thirty days (Youth and Tobacco Use). Some people believe that e-cigarettes are less harmful than other tobacco products, but vapes still have toxic chemicals, such as acetaldehyde and formaldehyde, and can lead to health consequences (The Impact of E-Cigarettes on the Lung). For teens, vaping can lead to nicotine addiction and affect their abilities to regulate their mood, focus, and impulse control. Another misconception about e-cigarettes is that they can help people quit smoking.

Vapes still contain nicotine, a highly addictive substance which has been shown to lead to addiction to other drugs, also known as a gateway drug. Furthermore, studies have shown that people who smoke vapes are more likely to use other tobacco products (Vaping Devices (Electronic Cigarettes) DrugFacts).

Although e-cigarettes and vapes have been in the market for several years, little is known about the long term effects of chronic nicotine usage, particularly in younger people. This paper will discuss the physical and mental health effects of e-cigarettes, the impact of age, gender, regulations, social media, and environmental influence on their use, and the association of e-cigarettes with smoking cessation. This paper will provide an updated review about tobacco products and their association to chronic disorders, with a focus on e-cigarette and vape usage for teenagers and adults.

Health Effects

Given how vaping is a recent phenomenon that has started to gain prevalence, there are no longitudinal studies yet but there are several studies that can be used to help to build a foundation for the potential health effects of vaping. In e-cigarettes, the nicotine liquids comprise of nicotine, propylene glycol (PG), vegetable glycerin (VG), water, and sometimes flavoring. However, the contents can vary depending on the product. While the liquid is purified, there are still traces of nicotine-related alkaloids and tobacco-specific nitrosamines also known as TSA's, which are carcinogens. The concentration of nicotine varies depending on the product and has been increasing in recent years. While the full extent of the effects of PG and VG are still unknown, trials have shown that PG and VG statistically increase the likelihood of development of lung adenocarcinoma(Cao, Dazhe J. et al.). Moreover, the lungs have many defenses such as physical barriers, reflexes, the cough response, and more which help protect the lung. However, exposure to toxic substances can weaken their defenses and reduce their efficiency. For example, substances in cigarettes that are inhaled can penetrate the lung and be deposited (Pulmonary Diseases). While there are not yet longitudinal studies on the exact effects of e-cigarette usage on lungs, given the information discussed previously about lung adenocarcinoma and lung defense mechanisms, it is likely that e-cigarettes could be considered detrimental to lung function.

Beyond impacts to the lungs, data suggests that there are impacts to many other parts of the body as well. It was reported that in the short term, nicotine increases heart rate and diastolic blood pressure (Cao, Dazhe J. et al.). Nicotine is absorbed in the bloodstream and transferred to the adrenal glands in the kidney which are then stimulated. The glands then release adrenaline which leads to the increase of blood pressure, respiration and heart rate. Nicotine also activates reward pathways in the brain that lead to the feeling of pleasure (How Does Tobacco Deliver Its Effects?). The dopaminergic system has nicotine receptors that nicotine binds to, activating the system. This releases dopamine and causes feelings of pleasure. According to researchers, this is one of the reasons why nicotine reinforces behavioral change and leads to dependence of nicotine (Tiwari, Raj K. et al.). Cardiac function can also be affected by e-cigarettes. The formaldehyde from the e-cigarettes and its combustion products can cause a decrease in the left

ventricle end-systolic pressure and cardiac output. Similarly, aldehyde can cause myocardial mitochondrial damage. Additionally, the nicotine from the e-cigarettes can lead to an acute cardiac arrhythmia, where signals sent to the heart to beat do not work properly (Espinoza-Derout, Jorge et al.). It was reported that there was an increase in worsening asthma, coughing and wheezing in adolescents who smoke e-cigarettes (Cao, Dazhe J. et al.). Studies have also reported that the usage of vapes and e-cigarettes during times of brain growth during adolescence can lead to behavioral changes and hyperactivity. A study found that smokers had an increased risk of physical fighting and attempted suicide compared to non-smokers (Jones and Salzman). While there is still still very little known about the long term effects of e-cigarettes, these studies point to the potential impacts across many components of physical health.

Mental Health

Beyond the physical health impacts, the mental health impacts of nicotine were examined. Nicotine from vaping has been commonly used and abused because of its effects on a person's mood, specifically because nicotine activates reward pathways, giving a feeling of pleasure. One study conducted to understand the association between electronic vaping devices and mental health in adolescents found that 47% of adolescents who were current e-cigarette users reported having symptoms of depression compared to the 38.3% and 27.3% of former and never e-cigarette users. Additionally, the percentage of current e-cigarette users who had suicidal thoughts was 26.1%, while it was 19.9% for former users and 13.6% for never users. As for adolescents, the percentage of those who made a suicide plan and had a suicide attempt was consistently higher for current users compare to those of former e-cigarette users and never users (Baiden, Philip et al.). For adolescents, those who had or were currently using e-cigarettes showed an increase in symptoms of depression and suicidal thoughts, suggesting that e-cigarettes can cause a shift in mood.

There are also differences in mental health between genders. Statistics from a study showed that women in general were almost twice as likely as men to have depressive episodes. Additionally, those who smoked e-cigarettes were twice as likely to have depressive episodes than those who did not smoke. Former e-cigarette smokers were also still more likely to have depressive episodes, for both genders, compared to non-smokers (Sung, Baksun). Another study found that among current e-cigarette users, females adolescents were more likely to have symptoms of depression, suicidal thoughts, and suicide plans compared to males (Javed, Sana et al.). Overall, depression was shown to increase the likelihood of triggering e-cigarette usage. Concurrently, e-cigarette usage was found to cause elevated depressive symptoms (Lechner, William V, et al.).

Predictive Likelihood of the Relationship Between Suicidal Thoughts and Use of Vaping Products in Men and Women (Figure 1)

Predictive Margins with 95% CIs
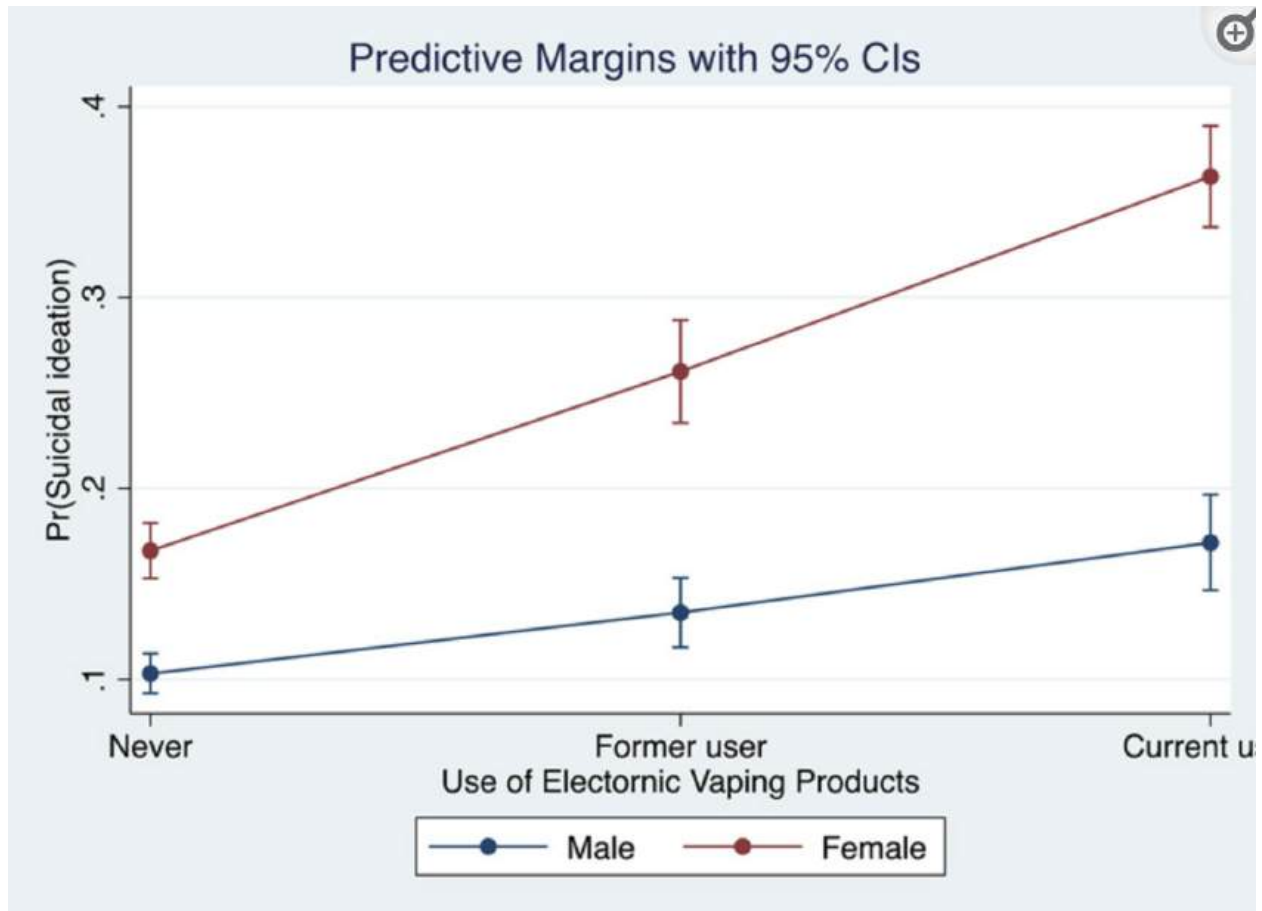
(Baiden, Philip et al.)

Age

Age was examined to understand the pervasiveness and change of e-cigarette usage across different populations, as well as the potential impacts on different age groups. E-cigarettes have been becoming increasingly popular among teens and young adults. In 2014, they were the commonly used tobacco products by US adolescents, with a dramatic increase in vaping in high schools. The PATH survey was conducted with two cohorts, one before the rise of e-cigarettes (Pre-JUUL) and one during the JUUL era. They found that in both cohorts of new users, the age group with the highest usage of e-cigarettes was between 14 to 17 years old. The age group 18-21 also showed an increase in usage from the Pre-JUUL to JUUL era. In terms of daily users, there was a significant increase in the amount of e-cigarette usage, especially for the 14-17 and 18-21 age groups (Pierce, John P et al.). Overall, in recent years, adolescents and young adults are the leading age groups in e-cigarette usage. According to the CDC, there was a 78% increase in the usage of e-cigarettes by high school students in 2018. Furthermore, in 2021, 4.5% of adults were current e-cigarette users with the highest being within the age range of 18-24. As of 2020, 3.6 million US youth smoke e-cigarettes with 80% using flavored e-cigs. A study which compared the current use and frequent use of e-cigarettes for high school students in 2015, 2017, and 2019 showed that there was an increase in usage. This increase was not only with former

cigarette smokers but also people who had never smoked cigarettes. They reported a 464% increase in the frequency of e-cigarette smoking out of previous never cigarette smokers (Mirbolouk, Mohammadhassan et al.). The rise in popularity in e-cigarette has led to an increase in usage, especially among youths, and a leap in new e-cigarette smokers.

In order to understand the impact of e-cigarettes on various youth populations, a study was conducted on rodents who have similar patterns of brain development with those of humans to see the effects on nicotine. In the rodent models, nicotine amplified neural activity in regions involved in reward systems, more so for young mice than adult mice. Young mice were shown to have a higher sensitivity for the reward effects of low levels of nicotine. This brings up the likelihood that human adolescents might be vulnerable to becoming dependent on e-cigarettes as there is more sensitivity to nicotine reward pathways compared to adults. This vulnerability can lead to an increased risk of drug-seeking behaviors, attention deficits, and mood disorders. Models have also shown that adolescents' brains are still maturing and can be subject to long-term modification because of nicotine (Health Effects of E-Cigarette Use Among U.S. Youth and Young Adults). While more research is needed, the results from the rodent study suggest that e-cigarettes could have potentially damaging effects on adolescents.

Gender

Another key factor that was examined was the differences that gender might have on the severity of e-cigarette usage and its effects. While previously, smoking was higher among men compared to women, recently e-cigarette usage among women has been increasing, causing the difference between the two genders to decrease. E-cigarette products have promoted things such as weight loss as well as having packaging that is appealing to women. Furthermore, the effects of nicotine in women and men are different. Nicotine is metabolized by women at a faster rate than men due to women's higher amounts of estrogen, leading to a harder time quitting smoking, less rewarding effects from nicotine, and worse side effects (Kong, Grace et al.).

One study found that among people who currently smoked e-cigarettes, the probability of them quitting was higher for men than women. Similarly, the study found that there were more women who switched to using e-cigarettes when trying to quit compared to men. However, according to the study, in terms of 6-month cessation, there was no significant difference between gender and e-cigarette usage (Abrams, Leah R et al.).

E-cigarette regulations

Given the increasing frequency of vaping usage, especially among youth populations and the aforementioned impacts on physical and mental health, the regulatory framework of e-cigarettes was examined to understand its impacts on the consumption of e-cigarettes. As e-cigarettes are the most commonly used tobacco product among adolescents, states have started to put regulations and restrictions on e-cigarettes. One study found that states with restrictions on non-tobacco-flavored e-cigarettes had a decrease in sales. Although the decrease in non-tobacco-flavored e-cigarettes prompted an increase in tobacco-flavored e-cigarettes, the total

net amount of e-cigarettes bought had decreased (Ali, Fatma Romeh M. et al.). Furthermore, a study found that restrictions of certain flavors led to a change in the device they were using, what flavors they used, the places they bought from in order to obtain the flavor, or if they made their own flavors (Bold, Krysten W. et al.).

Previous regulations on tobacco products showed that it was hard to limit the youth purchase of tobacco. However, regulation entitled Tobacco 21, which raised the legal purchase age in California to 21 years of age, resulted in a decrease of 8% in smoking for high school students. Young adult users of e-cigarettes were less likely to agree to the regulation, signifying that it was due to their lack of knowledge about the damaging effects of e-cigarettes. Since the passing of the Tobacco 21 regulation in California, there has been a dramatic decrease in the amount of tobacco products used among California youth. The effectiveness of the restriction showed that a similar process can be taken in order to reduce the vaping epidemic (Kim, Samuel C J. et al.).

Of the 50 states, the age limit for purchasing vapes are 19 for Alaska and 18 for Arizona, Kansas, Michigan, Missouri, Montana, North Carolina, South Carolina, West Virginia, and Wisconsin. The other states have an age limit of 21(Lombardi, Kevin). The Preventing Online Sales of E-Cigarettes to Children Act was a bill passed by Congress on July 2nd, 2020 which subjects the sale and delivery of nicotine delivery systems including tax, licensing and labeling requirements; prohibits the sale and delivery to those underage; requires the US postal system to implement regulations when delivering; and requires the National Institute of Health to conduct a study on the health impacts of e-cigarettes on youth (S.1253 - Preventing Online Sales of E-Cigarettes to Children Act). Given the success of the California Tobacco 21 regulation, similar policies could be implemented to reduce e-cigarette usage.

Influence of Social Media/Advertisements

Social media is undoubtedly a huge influencer on all aspects of life and thus the impact that social media platforms have on the promotion of e-cigarettes was examined. Social media platforms have two main types of exposure to promote e-cigarette. One is content from a pro-substance/e-cigarette person and the second is advertisements. These types of exposures can influence people, specifically young adults. The most common types of advertisement were vape stores, convenience stores, gas stations, on TV, Facebook, Instagram, Youtube, and other websites (Groom, Allison L. et al.). E-cigarettes are often advertised to be a safer option compared to cigarettes and the "cool" or more socially favorable choice. In a study conducted on college students from two year and four year colleges in Oahu, they found that higher social media exposure was associated with higher positive outcome expectancies or positive smoking experiences, also related with current e-cigarette usage (Pokhrel, Pallav et al.). Other research has shown that young adults exposed to messages that display e-cigarettes as socially favorable have an increased susceptibility to smoking e-cigarettes.

Additionally, a study conducted to examine tobacco advertisement liking with tobacco use found that for liking e-cigarette advertisements, there was a greater chance of e-cigarette use.

Another report found that a greater amount of exposure to e-cigarette ads led to an increased positive outcome expectancy. The participants reported seeing e-cigarette related posts and advertisements sometimes or often on Facebook and Instagram(Pokhrel, Pallav et al.). A study conducted in 2014-2016 reported that 78% of middle and high school students had been exposed to e-cigarette advertisements (Mirbolouk, Mohammadhassan, et al.).

From Google trends, since 2004, there has been a gradual increase in the amount of interest in "vapes" (Figure 2). For the term "Electronic Cigarette" there was also an increase in interest overtime with a peak in September of 2019 (Figure 3).

Popularity of Google Searches for the Word "Vapes" from 2004-2023
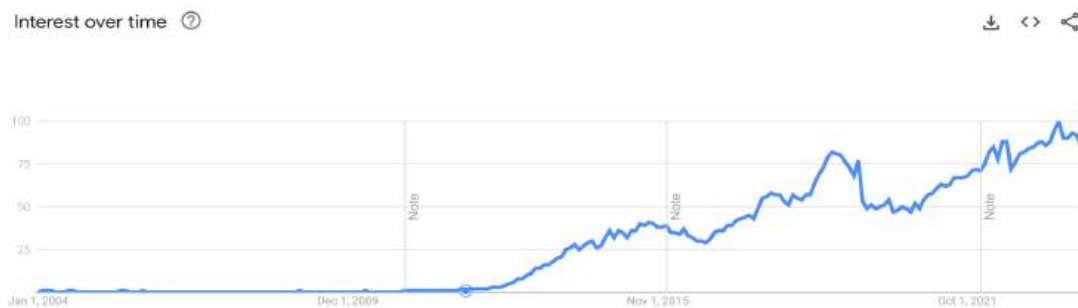
Popularity of Google Searches for the Word "Electronic Cigarette" from 2004-2023
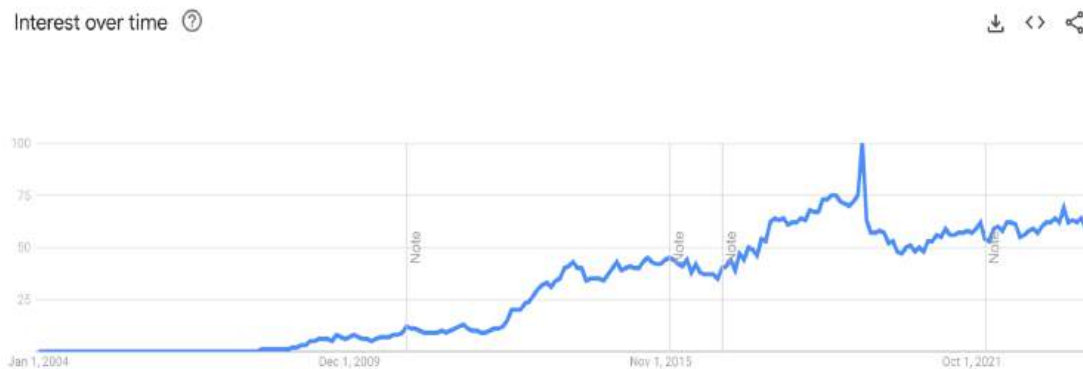
Overall, increased social media exposure plays a role in elevated e-cigarette usage and experience.

Environmental Influence (Family, Peers, etc.)

Beyond social media, family and peers can heavily influence the usage of e-cigarettes, especially among certain younger populations. A qualitative and quantitative online study conducted on US teens ages 13-18 to see the influence of friends on vaping in teens found 54% of them reported trying their first e-cigarette while they were with friends. Furthermore, many of the respondents reported that after their first vaping experience, they bought more on their own through a friend, a friend's older sibling, or a friend of a friend. The respondents wrote that they would vape with friends and while socializing with friends. Many also wrote that they would often vape less when in the presence of friends who did not vape (Groom, Allison L. et al.). At 16 years old, there was an increase in odds of using e-cigarettes by 1.39 in males and 2.01 in females when increasing the number of friends who used e-cigarettes by one. At 20 years old, the likelihood of using e-cigarettes for every friend who used e-cigarettes was 2.24 for males and 1.74 for females(Etim, Ndifreke et al.).

Another study conducted found that having family members who smoked had an increased likelihood of e-cigarette usage. More specifically, the probability was the highest when a sibling smoked (Wang, Jian-Wei et al.). The same study also found that adolescents who had friends who smoked had a higher probability of using e-cigarettes. Furthermore, a study conducted on alternate high schoolers between 15-20 years of age found that female students that were living with an e-cigarette user had a higher probability of currently using e-cigarettes than those who lived with a non-user (Etim, Ndifreke et al.). Ultimately, social pressure as well as modeling from peers can influence adolescent's e-cigarette usage.

Quitting Smoking : How vapes help or don't help to quit smoking?

One of the often heard perceptions of e-cigarettes is that they aid in the cessation of traditional smoking. Thus, the data related to whether or not there are any positive benefits from e-cigarettes was explored. One study found that in 2014-2015, 17.4% of US smokers used e-cigarettes to quit smoking. In 2017-2018, of those who used e-cigarettes to quit smoking, 12.9% abstained for at least twelve months compared to the 11.3% who did not use e-cigarettes to quit (Chen Ruifeng et al.). Furthermore, another study found that of current smokers who used e-cigarettes, 81.3% used them to reduce smoking, 78.2% for enjoyment, and 74.5% because they believed vaping was less harmful than smoking to others (Gravely, Shannon et al.). It was found that abruptly switching to e-cigarette usage from other tobacco products such as cigarettes instead of gradually switching led to a longer duration of smoking abstinence. Additionally, using e-cigarettes more frequently throughout the day instead of just once or twice a day led to 19 more days of smoking abstinence and vaping constantly during the day led to 30 more days of smoking abstinence (Bold, Krysten et al.).

A study examining the association between e-cigarette flavors and quitting smoking found that restricting certain e-cigarette flavors changed the participants' usage behavior but did not help them quit smoking (Bold, Krysten W. et al.). On average, people reported using 2.7 different flavors when trying to quit, however the type of flavor and number of flavors a person used was not associated with their length of time they quit smoking (Bold, Krysten et al.). To help quit smoking, people often use nicotine patches, gums, and lozenges. Using e-cigarettes

containing nicotine was found to be more effective in helping people quit smoking compared to the other nicotine treatments listed previously (Lindson, Nicola et al.). While there could be potential improvement of smoking cessation for prior tobacco smokers from the usage of e-cigarettes, more studies must be done to weigh the benefits and detriments of its usage.

Conclusion

  With the recent rise of e-cigarettes in the past couple of decades, there is still little known about the extent of its effects. However, there has been research that shows that substances contained in e-cigarettes can increase a person's likelihood for lung related diseases. In terms of e-cigarette usage, a variety of factors such as gender, age, mental health, social media, previous cigarette usage and more can affect a person's e-cigarette usage. As the usage of e-cigarettes continues to rise, more thorough studies should be conducted about the magnitude of its effects. For example, a longitudinal study on people who consistently smoke e-cigarettes compared to those who never smoke could be conducted to study the long term effects of e-cigarettes. Since e-cigarettes are popular among youths, it is important to examine the short and long term impacts of e-cigarette usage on their development.

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Current and Prospective Treatments for Triple Negative Breast Cancer By Sofia Green

Abstract

Triple negative breast cancer (TNBC) is a highly heterogeneous and aggressive subtype of breast cancer characterized by a lack of expression of estrogen receptors (ER), progesterone receptors (PR), and human epidermal growth factor receptor 2 (HER2). TNBC accounts for 15-20% of all breast cancers and has the poorest prognosis of all breast cancer subtypes. TNBC is especially challenging to treat because of a lack of well-defined molecular targets, and current treatments for TNBC, especially chemotherapy, often result in resistance, recurrence, and off-target toxicity. A promising solution for these challenges is precision medicine, a therapeutic approach that involves tailoring treatment to the individual patient by identifying the specific mutations driving their disease. This review will explore the current treatment options for TNBC, specifically chemotherapy and immunotherapy, emphasizing the limitations of these common modalities of treatment. Using precision medicine approaches, it may be possible to tailor currently available treatments to individual patients to improve outcomes and lessen side effects. This paper will also address the phenomenon of cancer resistance, one of the key challenges in treating TNBC, and highlight how precision medicine can address this issue.

Introduction

Triple negative breast cancer (TNBC) is a subset of breast cancer lacking overexpression of the breast cancer-associated markers estrogen receptors (ER), progesterone receptors (PR), and human epidermal growth factor receptor 2 (HER2) (Derakhshan and Reis-Filho). TNBC accounts for approximately 15%–20% of all breast cancers and is considered the most heterogeneous and aggressive subtype of breast cancer (Masci et al.). Additionally, approximately 19% of TNBCs have a mutation in the BReast CAncer gene (BRCA) (Derakhshan and Reis-Filho). TNBC tumors are considered highly aggressive due to their rapid proliferation and high likelihood of local and distant recurrence. TNBC therefore has the poorest prognosis of the breast cancer subtypes (Clusan et al., Zagami and Carey).

ER and PR are types of hormone receptors expressed by the luminal cells lining the inner space of mammary ducts. ER and PR both regulate cellular functions that can promote the development of breast cancers, namely ER positive and PR positive subtypes (Derakhshan and Reis-Filho). HER2 is a membrane-associated cell signaling receptor that is overexpressed in about 20% of BCs. When activated, HER2 sends potent proliferative and anti-apoptotic signals to the cell (Gutierrez and Schiff). Breast cancer subtypes that are positive for these receptors, as well as those overexpressing HER2, can be treated with targeted therapeutics. Targeted therapies can specifically inhibit proteins that are frequently mutated or altered in cancer to selectively target cancer cells. Many drugs have been approved to specifically target these mutated pathways, allowing for selective treatment of cancers (Zagami and Carey). Due to the absence of well-defined molecular targets such as ER and PR receptors in TNBC, finding effective treatment for TNBC has proven more difficult. Additionally, TNBC rapidly develops resistance

to many treatments through multiple mechanisms, providing another challenge in treating TNBC (Li et al.).

A promising option for the treatment of TNBC is precision medicine (PM). Precision medicine methods are based on the selection of suitable biomarkers to determine the optimal targeted therapy for a specific subset of patients. TNBC is associated with high interpatient heterogeneity. Precision medicine is tailored to the individual patient's disease, genetic background, environment, and lifestyle. Thus, adopting effective, personalized therapies for patients with TNBC may help to improve treatment outcomes and reduce recurrence (Subhan et al.). In this paper, I will discuss how precision medicine can be applied to TNBC, and its potential benefits for TNBC treatment.

Precision Medicine

PM describes an approach to cancer treatment that accounts for the heterogeneity between patients. These heterogeneities can arise from the genes, environment, and lifestyle of each patient. The precision medicine approach is based on the identification of biomarkers that may predict the efficacy of targeted treatment in a specific subset of patients (Subhan et al.). Through knowledge of the breast cancer subtypes and whole genome sequencing of individual patients, patients can be split into subgroups based on their targetable mutations. This ensures that they only receive treatment that will be effective against their specific mutation. This is known as patient stratification (Weng et al.).

PM is already being utilized in breast cancer using drugs that target the ER, PR, and HER2 receptors and has had a positive impact on patient outcomes. However, because TNBC lacks these clear targets, it is challenging for doctors and scientists to use precision medicine in TNBC treatment (Subhan et al.). Precision medicine is not yet used broadly due to a lack of data and high costs, but scientists are actively working to overcome these hurdles (Prosperi et al.).

PM treatments may help solve many of the common challenges in TNBC treatment. Firstly, by targeting specific mutations or pathways, precision medicine may reduce the off-target toxicity often present with chemotherapy regimens (Subhan et al.). Secondly, TNBC has a high rate of resistance and recurrence when treated with general chemotherapy and other standard treatments (Nedeljković and Damjanović). Precision medicine may help to reduce the rates of resistance and recurrence by targeting cells that express the specific mutations facilitating disease progression (Subhan et al.).

Resistance

Resistance is one of the major challenges in cancer treatment tha precision medicine may help address. Especially in metastatic cancers, chemotherapy resistance accounts for 90% of therapeutic failures (Nedeljković and Damjanović). Resistance may be partly attributed to the heterogeneity of the tumor microenvironment . The tumor microenvironment includes tumor cells, cancer-associated fibroblasts, immune cells, natural killer cells, tumor-associated macrophages, vasculature, and extracellular components such as the extracellular matrix,

cytokines, chemokines, metabolites, and exosomes. Many of the components of the tumor microenvironment can interact with each other, thus altering the external environment of the tumor and ultimately leading to drug resistance (Liu et al.).

Hypoxia

Hypoxia is a main mechanism by which resistance can develop in TNBC. Hypoxia occurs when tissues have insufficient oxygen supply. Angiogenesis, the formation of new blood vessels, is one of the hallmarks of cancer. As tumors grow, they create new blood vessels to transport blood to regions of the tumor that are too far away from the existing vessels. The blood vessels formed during tumor angiogenesis are often disorganized or leaky, and as a result, the ability of the vessels to transport oxygen is impaired (Ferrari et al.). This means that certain parts of the tumor that are reliant on these disorganized blood vessels do not receive sufficient oxygen. Hypoxia is an important factor in the TME and is associated with aggressiveness, invasiveness, and resistance to therapy (Nedeljković and Damjanović). Hypoxia contributes to chemoresistance in multiple ways. Firstly, insufficient vasculature hinders drug penetration into the tumor. Second, the acidic TME that results from hypoxia reduces the uptake of anti-cancer drugs. Further, the cytotoxic components of many drugs are oxygen-dependent (Ferrari et al.) .Additionally, hypoxia activates immunosuppressive pathways and acts as a barrier to immune effector cells (Nedeljković and Damjanović). Finally, hypoxia leads to cellular adaptations that hinder successful treatment, including increased expression of ABC transporters, decreased proliferation, modulation of cell senescence and apoptosis, induction of autophagy that aids in tumor survival, genetic instability and subsequent selection of aggressive phenotypes, upregulation of proangiogenic factors, and repression of E-cadherins that promotes metastatic spread (Nedeljković and Damjanović, Ferrari et al.).

The mutations that drive ABC transporter and hypoxia related resistance provide targets for PM. For example, identifying which patients overexpress the ABCC1 protein can help stratify patients for treatment that targets the production of that protein, thus decreasing the likelihood of ABC transporter-driven resistance (Ferrari et al.).

Current Treatments

Due to the lack of clear molecular targets for TNBC drugs, the standard of care for non-surgical TNBC remains conventional chemotherapy (Li et al.). However, most of these treatments are associated with numerous negative side effects and lack the desired specificity to effectively treat the cancer and prevent recurrence (Medina et al.). Many different types of chemotherapy are currently approved for TNBC treatment, and choosing what kind to use is dependent on the characteristics of the TNBC in the individual. The current major modalities of treatment are chemotherapy, immunotherapy, radiation, and surgery. Precision medicine can aid in deciding which modality of treatment to use depending on tumor location, presence of mutations, and expression of antigens.

Chemotherapy

        Chemotherapy uses chemical compounds to kill rapidly dividing cells in the body. It is meant to target tumor cells, but often has adverse side effects, killing other rapidly dividing cells such as hair, skin, and white blood cells (Li et al.). For this reason, it is important to explore precision medicine to help doctors decide which chemotherapy to use for each patient and identify the best target for treatment.

Microtubule targeting agents.

        Microtubule targeting agents (MTAs) are one class of chemotherapy that inhibits mitosis (Li et al.). These drugs are usually not prescribed alone, but rather in combination with other chemotherapy drugs or immunotherapies (Li et al.). Microtubules play a key role in many important cellular functions, such as motility, division, shape maintenance, and intracellular transport (Masci et al.). Motility and division are especially important in TNBC. Metastasis is one of the greatest challenges in the clinical treatment of cancer, and cell motility is the mechanism that allows cancer cells to migrate to other organs and tissues (Stuelten et al.). Cancer cells also undergo uncontrolled division due to deregulation in the cell cycle. MTAs work by blocking the function of cellular microtubules, thus leading to abnormal spindle fiber function and chromosome misalignment. This permanently activates the spindle assembly checkpoint and results in the arrest of the cell cycle and the induction of apoptosis. While these drugs are generally highly effective, they are not targeted drugs, and are therefore not a good fit for precision medicine. Their mechanism of action causes them to target any rapidly dividing cells, such as bone marrow cells, not only those that are cancerous (Chan et al.). This inability to distinguish between healthy cells and cancer cells accounts for many of the unfavorable side effects of chemotherapy, such as hair loss, infections, and peripheral neuropathy (Zajączkowska et al.).

Platinum

        Platinum-based anticancer drugs were one of the first chemotherapies developed, and they are still in use today. Cisplatin was the first Pt-based chemotherapy approved for human patients. Cisplatin has demonstrated therapeutic effects on malignant tumors (Zhang et al.). However, cisplatin is a nonspecific chemotherapy agent that causes systemic toxicity in addition to killing cancer cells. Therefore, cisplatin has many undesirable side effects such as dose-limiting toxicity and myelosuppression (García Sar et al.). Due to this, carboplatin was designed to offer improved safety and tolerability, and lower systemic toxicity. Less toxicity is achieved because of the different inhibitory effects on nuclear DNA synthesis (Vermorken et al.). Because it has a lower toxicity, carboplatin can be used as high dose chemotherapy. However, carboplatin and other Pt-based drugs are still not targeted, and not a good fit for precision medicine (Zhang et al.).

PARP Inhibitors

Poly (ADP-ribose) polymerases (PARPs) are a class of enzymes that facilitate the transfer of ADP-ribose to target proteins. PARPs are involved in various cellular processes, such as transcription, replication, DNA repair, and apoptosis (Masci et al., Morales et al.). As previously mentioned, about 19% of TNBCs have BRCA gene mutations (Derakhshan and Reis-Filho). The BRCA genes play an important role in DNA repair via homologous recombination (HR) and are associated with a hereditary predisposition to developing female breast cancer (Masci et al.). When cancer cells are deficient in or have a mutated/ineffective BRCA gene, they display impaired HR and are ineffective in repairing damaged chromosomes. Thus, they are more reliant on PARP activity and sensitive to its inhibition (Morales et al.). PARP inhibitors (PARPi) have recently been closely examined as one of the most promising targeted strategies to treat TNBC as they prevent cancer cells from repairing themselves. It has been demonstrated that the use of PARPis can create synthetic lethality and increased tumor cell death by blocking the mechanism that allows these cells to repair their DNA. Thus, PARP family proteins represent attractive targets for the treatment of TNBCs that harbor a mutant BRCA allele. The use of PARPis in BRCA mutant cancers is a clear example of PM. The stratification of patients through precision medicine will help doctors identify which patients would benefit most from PARPi treatment. Although BRCA-deficient tumors are more susceptible to the action of PARPis, about 40% of BRCA deficient TNBC patients do not respond to PARPis due to the emergence of drug resistance mechanisms in TNBC (Masci et al.).

While effective in treating TNBC, specifically in the neoadjuvant setting, meaning before the main treatment is given, conventional chemotherapy is not the most promising future for the treatment of TNBC. Drug resistance and recurrence continue to be a problem when treating patients, and the non-specific nature of chemotherapies causes many unwanted side effects. Precision medicine provides a more promising treatment style as it identifies strategic biomarkers to target for treatment. This provides a more selective chemotherapy regimen which would create fewer negative side effects (Medina et al.).

Immunotherapy

One example of a precision medicine treatment in current use is immunotherapy. In cancer, the immune system is often suppressed by tumor cells or the TME (Luo et al.). This suppression allows cancer cells to avoid detection by the immune system and thus avoid elimination by activated immune cells (Thomas et al.). Immunotherapy is a treatment strategy that stimulates the patient's own immune system to kill cancer cells (Liu et al.). Treatment with immune checkpoint inhibitors (ICIs) has been shown to induce a cell death response in metastatic breast cancers (Thomas et al.). Two main types of immunotherapies are ICIs and chimeric antigen receptor T (CAR-T) cell therapies (Thomas et al.; Nasiri et al.). The immunogenic landscape of some subsets of TNBC resembles that of lung cancers, which have been proven to benefit from immunotherapies, thus creating opportunities for the development of TNBC-targeting immunotherapies (Luo et al.).

Immune Checkpoint Inhibitors

Tumors adapt many mechanisms to avoid detection by the immune system, one of which is the activation of inhibitory pathways governed by immune checkpoints (Thomas et al.). An example of one such pathway is the interaction between programmed cell death protein-1 (PD-1) which is a checkpoint receptor expressed on the surface of many immune cells, and PDL-1, its receptor, usually expressed on tumor cells (Tang et al.). This pathway is the main target of many ICI drugs as it is highly expressed in TNBC. ICIs aim to target these pathways, which release the immune system from inhibition and revive the anti-tumor immune response, allowing tumor cells to be eradicated (Thomas et al.).

As previously mentioned, TNBC is a disease with high tumor heterogeneity (Masci et al.). Because of this, it has been suggested that only a subset of TNBC patients could benefit from ICI therapy. This presents a challenge in treatment, as it must be determined which patients would benefit most from ICI treatment. Thus, various parameters have been defined to help evaluate the potential efficacy of ICIs in TNBC and other breast cancers (Luo et al.). The unique nature of each patient's TNBC provides another argument for the use of precision medicine as a more effective treatment method.

Currently, the use of ICIs in combination with chemotherapy is being investigated. Chemotherapy can potentially enhance the immune response following ICI therapy as it has been found to increase the release of tumor cell antigens, promote the activation of dendritic cells, and trigger the production of PD-L1. This combination therapy has shown promising results in metastatic, locally advanced, and early-stage TNBC (Luo et al.).

CAR-T Cell Therapies

CAR-T cells are genetically modified T lymphocytes that use the individual's immune system to recognize and target cancer cells expressing certain tumor-associated antigens and eradicate them. While CAR-T therapy has been very effective in treating hematologic neoplasms, such as B cell lymphoma, it has proven much more challenging to use as a treatment for cancers with solid tumors, such as TNBC (Nasiri et al.).

For CAR-T therapy to be effective against metastatic TNBC, an appropriate target antigen must be identified (Toulouie et al.). Because of the high heterogeneity of TNBC tumors, it can be difficult to find an appropriate target. Tumor cells may express different antigens on their surface, and some may not express antigens that have been identified for treatment at all. This causes CAR-T cells to have difficulty recognizing malignant cells, thus leading to disease escape and recurrence (Nasiri et al.). CART-T cells are customizable to a patient's specific antigens, therefore offering a huge potential for PM. Gene sequencing and the stratification of patients through precision medicine will help to identify these antigens and provide treatment that directly targets them (Subhan et al.).

Conclusion

PM may be a promising future treatment for TNBC. Precision medicine provides new, effective approaches to the leading challenges in TNBC treatment, such as resistance, recurrence, and off-target toxicity. Many predictive biomarkers already exist in breast cancer that can be targeted with precision medicine (Subhan et al.). By dedicating more work to subtyping and understanding the different kinds of mutations that lead to TNBC, doctors can better stratify patients and provide therapy targeted specifically to their mutation (Weng et al.). The development of new and improved gene sequencing technologies continues to raise hope for the success of precision medicine in breast cancer and TNBC (Subhan et al.). If applied broadly, this field of medicine will likely improve patient outcomes in TNBC and other diseases, and reduce the normal complications associated with cancer treatment.

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A New Novel Solution to Encourage Green Energy Consumption using Nudge Theory in India: A Green Energy Signage By Avya Maini

Abstract

In recent years renewable energy has seen meteoric rises as the fervour around 'going green' rises. Responding to this, the Indian government has shown a desire to implement policies encouraging its consumption. One such type of policy the government could use is a nudge-based policy, which is a modern way to persuade a desired behaviour in consumers. This paper evaluates to what extent a green energy signage can increase the consumption of green electricity in India. Similar to the green number plates in an Electric Vehicle (EV), this nudge will also be provided when consumers purchase green electricity. This study reviews past research on nudge implementations, specifically in the energy sector, and reviews material on the Indian energy market. Thereafter, two surveys were sent to a random set of people from all over India, in which one of them included a nudge and the other did not. Both surveys primarily asked their subjects to mention a few details about getting electricity from different sources and why. The data from the survey revealed that the 'green signage', unlike the green number plates of EVs in the UK , does not have much of an effect on the consumption of green electricity in India. However, the surveys revealed a few interesting observations as well: regardless of the nudge most subjects wanted to switch only half their electricity to green energy sources. Finally, the policies derived from the surveys along with the usual policies to encourage the consumption of green energy are discussed.

Introduction

Green energy is an important aspect when considering carbon emissions, especially in India where the goal is to reach net zero carbon emissions by 2070 (Press Information Bureau). Green energy usage can be seen almost everywhere in India because it is a way to mitigate the issue of climate change. This is because it emits carbon when generating energy, unlike fossil fuels. While average annual particulate pollution levels have risen from 1998 to 2021 by 67.7% (Air Quality Life Index) India has tried to implement several policies to mitigate this by promoting green energy like solar, wind or geothermal energy. A policy that the government could use to encourage green energy usage could be to try and change the behaviour of different consumers when considering purchasing energy from different sources, which could be a nudge policy.

In simple words, a nudge policy is an intervention to promote desirable behaviour by the consumers in the industry (Singal). Nudges are based on evaluating the consumers' biases towards choosing a particular type of commodity, and they encourage consumers to purchase that commodity by making effective use of the biases that households face in their everyday lives. Hence why, a 'green energy signage' could be a viable nudge to promote the consumption of green energy. Whenever consumers purchase green energy, they would be able to show their

society that they have purchased green energy. It provides households with an incentive to purchase green energy as households' reputations are particularly significant for them.

This study will even answer whether it may incentivise consumers to a point where they are ready to pay a premium for renewable energy, which will be done via a survey. Overall, this paper will explore how a 'green energy signage' can affect households' choices towards purchasing green energy compared to a default nudge, and whether it can be an effective nudge to help mitigate the issue of climate change.

Literature Review

This section of the paper will be broken into three aspects, looking at the literature on nudges affecting green energy consumption from different angles, what are nudges, how they affect consumption in the energy industry in the past, and the context of green energy efficiency in India.

Electricity reaches its desired consumers through largely three different processes, which are generation, transmission and distribution (National Grid). The foundation of electricity can be done by different energy sources that could be either renewable or non-renewable. Renewable energy sources are ways by which energy is produced by natural sources and could be used without the problem of running out in the future. They do not cause carbon emissions when generating electricity and therefore are considered more desirable than non-renewable energy sources. One of the main sources of renewable energy in today's evolving modern age is solar power. Solar power is a mode of energy generated by converting the sun's rays into electricity. After the production of the electricity, it is transmitted across different parts of the country through conductors. Before reaching the end consumer, these conductors travel to a substation that lowers the voltage to reach the household's requirement. Lastly, through the use of different distribution companies and networks electricity eventually reaches the consumers. While it can be seen that renewable energy does not release any carbonised gases when generating electricity (United Nations, 'What is Renewable Energy'), many households prefer to consume 'non-green' electricity (Center for Climate and Energy Solutions). This causes the government to implement policies to decarbonise their nation from the increasing pollution being emitted due to the burning of fossil fuels. Usually, to resolve this issue the government can either try and reduce carbon emissions in general by using methods such as taxes on greenhouse gas emissions (carbon taxes), attempts to reduce deforestation or tradable permits (University College London), or encouraging the consumption of green energy production methods. In this paper, the latter will be spoken about.

The government can use various methods to promote the consumption of green energy. India itself has incorporated a variety of different schemes to encourage the consumption of renewable energy. For example, in 2022 the Ministry of New and Renewable Energy helped citizens by removing the laws limiting the use of renewable energy, making its usage more accessible and efficient (Ministry of New and Renewable Energy). However, the Indian government could also explore more nudge-based policies as well. A nudge-based

policy/intervention is a way to alter consumers' behaviour in a manner that they are encouraged to purchase or consume a particular commodity. Nudges are implemented by producers in almost every sector, from placing items in a particular position in a store to the use of scarcity in the same store (Change Management Insight). These may not seem to be significant changes; however, they can impact a consumer's behaviour when purchasing a commodity. Making use of scarcity makes people think that the product they are planning to buy is in high demand and the consumers should buy it immediately so that they evade a loss. Hence, this capitalises upon consumers' loss aversion bias because consumers believe that a loss is more significant than some sort of a win, and hence they would try and avoid the loss in most cases rather than try and get a win. However, will nudges really be effective in a green energy market?

Previous research has been conducted on nudges affecting consumers' choice of renewable energy, which has given readers insights into the extent to which they affect the consumption of renewable energy. In research done by Katherina Momsen and Thomas Stoerk in 2011, a survey was conducted among German and other international students on whether they would either buy 'conventional energy' or split their purchases evenly between renewable and conventional energy but at a higher price. However, this experiment was conducted when different nudges were implemented in the situation presented in the survey. The nudges included social norms, default (explained below in the paragraph), framing, mental accounting, priming, and decoy. All the aforementioned nudges are theoretically said to change consumers' behaviour to attain their desired consumption of a commodity, which in the case of the research was electricity from renewable energy sources, even though it was at a higher price. The results concluded that only the default nudge was able to persuade 44.6% of those sampled to purchase 50% renewable and 50% conventional energy (Frondel, 4048-4056). A default nudge is when a certain type of plan or commodity has already been pre-allotted to a person and set as a default. This nudge is based on one's status quo bias because a consumer would not want to 'waste time' looking for more viable options that could potentially be better than the pre-allotted default commodity or plan. Hence, in most cases, consumers would stick to the default rather than spend time looking for a better alternative, even if it is at a higher cost (Bifulco). One major example of the default nudge in today's evolving world is the 'automatic enrolment into savings plans'. Since evaluating savings plans can consume a lot of time, automatic enrolment in a particular savings plan saves households' time, even if it is a little worse than other savings plans in some aspects (Sunstein et al.). Another paper by Alcott & Kessler (2011), conducted a trial on the population of California, bringing out the effects of two other nudges on the energy market. The nudges used are the provision of personalised information and social comparison. The study shows that providing personalised information through mail or emails reduces the overall consumption of energy among households. This nudge just gives the users feedback on their energy usage and comparison to their previous use, which may cause households to feel overwhelmed. The social comparison nudge compares the usage of energy of a particular household to its peer or neighbour, which may influence their behaviour to consume energy. However, this nudge did not have an impact on the energy consumption of the population,

showing that there is no significant relationship between social comparison and energy consumption. This research overall highlights an extensive study of both these nudges and their effects on the energy market (Alcott).

Green energy usage in India has also been on the rise in recent years (Invest India). People are slowly starting to understand the importance of renewable energy sources. However, the government has recently put a tariff on green energy in some states (Council on Energy, Environment and Water). Procuring energy from a supposed 'green tariff route' (Singh, Garg and Joshi), offers consumers completely green energy at a lower transaction cost compared to buying green energy from a power exchange. While some states are yet to implement this tariff, some states are already doing so.

Methodology and Data

This section will bring out the data collection of the study's primary aim, which is to evaluate whether green signage can act as an effective nudge to promote the usage of renewable energy. Hence, to follow this, this section will be broken down into three distinct parts: the setting of the experiment, the explanation of the nudge, and the results.

The Nudge

In recent years the market for Electric vehicles has been booming (Livemint). One peculiar thing to notice about these electric vehicles is their differently coloured number plates (HDFC ERGO). A 2020 poll conducted by the automobile manufacturer Nissan suggested that the demand for Electric Vehicles will increase primarily because of their 'Green Number plates' in the UK (Nissan News). Applying the same logic to green electricity, the nudge being tested in this study is a 'Green Energy User' signage that will be provided to the consumers who purchase renewable energy. This is also based on whether green energy signage affects a consumer's reputation so much that he is ready to purchase more green energy. Additionally, the sign will be a free-of-cost service that will be provided as an incentive for consumers to buy green electricity. The sign shows the general public that a particular household is using green electricity so that it can encourage them to also procure it for themselves. This nudge may also target the 'social desirability bias'(Scribbr), which is when consumers change their behaviour in a way that will be accepted more favourably by the public, hiding their true opinions. This can be applied to the nudge because consumers may purchase the sign to show the public that they are purchasing green energy to build on their image or keep their reputation intact with their society, which would make people think that the consumers with the sign are very environmentally friendly people.

While a survey conducted in the UK shows that a green number plate may increase consumers' demand for electric vehicles, an article in India tells readers that a green number plate may not be enough to motivate consumers to purchase electric vehicles and that a few more factors will be required to influence the consumption of EV's (Bajaj Finserv).

The Setting

The data that will be collected will be done through two different surveys among a random sample of Indians. The sample could comprise people of different income levels, age groups, roles in households, and states in India as well. This is because the wider the array of people filling the form, there will be a lesser chance of a bias occurring towards one side. The surveys will be more or less the same, with both entailing a situation for the form fillers where they are given information about the approximate price of electricity, coming from conventional sources, and the average price of the electricity bill borne by a family of four. In addition to the aforementioned information, an approximate price of the green tariff applicable in different states of India will also be given, so that households understand that they have to pay a higher price for electricity coming from renewable energy sources. This may make consumers rethink their decision about choosing renewable energy over conventional sources of energy.

Many states in India are offering green electricity to consumers with a **premium price**. This survey aims to understand consumer preferences on this topic.

Approximate price of residential electricity in New Delhi in 2024 is 8.5 INR/kWh. The Average electricity monthly bills for a household of four is Rs. 7000.

Some states charge an additional amount of approximately of 0.65 INR/kWh to purchase green electricity → Pushing your usual electricity bills up by around 7.6%

The Control Form

However, in one of the forms, information regarding consumers getting green signage if they purchase electricity from green sources will also be mentioned at the top of the form.

Many states in India are offering green electricity to consumers with a **premium price**. This survey aims to understand consumer preferences on this topic.

Approximate price of residential electricity in New Delhi is 8.5 INR/kWh. The Average electricity monthly bills for a household of four is Rs. 7000

Some states charge an additional amount of approximately of 0.65 INR/kWh to purchase green electricity → Pushing your usual electricity bills up by around 7.6%

However, If you purchase a high proportion of green energy, you get a free sign saying you are a 'Green energy User'

The Nudge Form

Following the information that is provided in the blurb, the form fillers will be provided with a set of questions that asks them about how much and why they would switch to renewable energy for electricity provision. Along with the primary questions, a few general questions will also be asked about the form filler to see some sort of pattern that perhaps may be created by a certain type of person. This would remove bias in the study and help give an accurate result. Additionally, the language of the survey has been kept extremely simple and short, so that it is

easy to understand and quick to fill in as well. Many other studies have conducted surveys or questionnaires to collect data; however, this experiment was original. Additionally, there was an even distribution between the people filling both the forms as well through the use of the website 'Nimble Links'. This website made sure that similar amounts of people will be redirected to fill out each form.

Data

The survey was sent to a randomised group of people from all over India, via different social media platforms, wherein people from different parts of India have access to the form. However, since the study was conducted in New Delhi, India there may have been some bias in influencing the results of the survey because there may be a possibility of most of the subjects being from Delhi. Additionally, New Delhi does not impose a green energy tariff, unlike many other states in India, and hence the subjects of New Delhi may not understand this green tariff policy, which may lead to possible inaccuracies in the results of the survey. That is why the language was made as simple as possible, without the use of the word 'tariff' and rather just saying an additional cost, making it sound a little hypothetical. This will lead to subjects understanding the form better and giving more accurate results.

The form was evenly distributed among 76 subjects in which 39 subjects filled the control form and 37 took the nudge form. The following table shows the results of the primary motivations for switching to 'green electricity' from both surveys. It compares the motivations to the age groups of the subjects who filled in the form. The table shows that the most popular motivation to switch to green energy is 'environmental concerns' by a significant amount.

Sum of count	Column Labels							
Row Labels	25 and under	26 to 35	26–35	36 to 45	36–45	46 and above	(blank)	Grand Total
As long as it is cost and energy effective			1					1
Energy security	1	1		1	1	2		6
Environmental concerns	3	2	2	12	13	30		62
Green Energy User' sign						2		2
Not Applicable (I am not willing to switch to Green energy)			1			2		3
Not applicable (I am not willing to switch to renewable energy)		1				1		2
(blank)								
Grand Total	4	4	4	13	14	37		76

Table 1: Summary of the motivations for switching electricity by different age groups

Additionally, the following two graphs portray the percentage of electricity the subjects were willing to switch to green energy sources for both forms. These graphs display several similarities, with the most significant being the proportion of green energy demanded, which is consistently over 50%. Notably, in both graphs, the modal frequency of the proportion of green energy demanded is 50%.
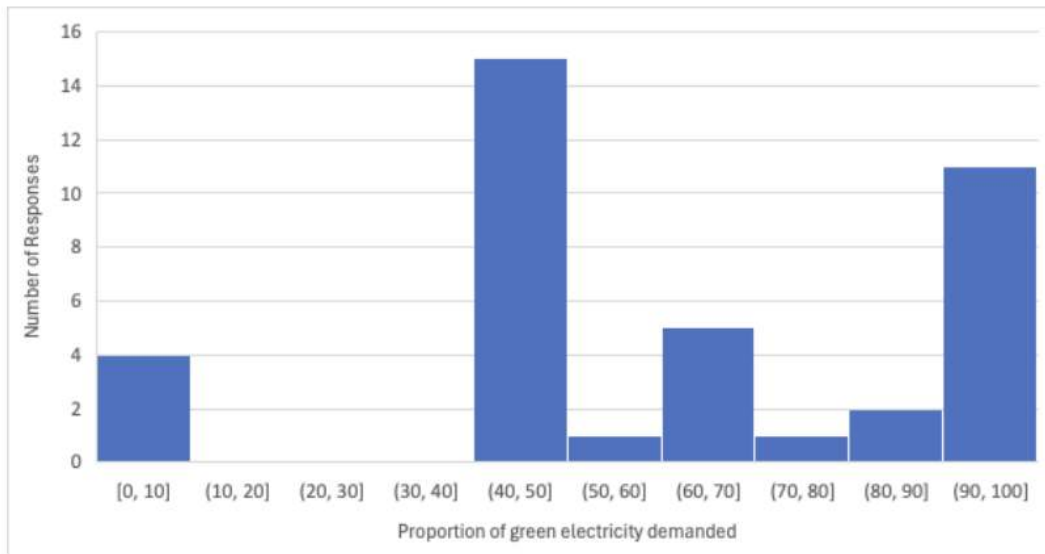
Figure 1: The distribution of electricity switching responses for the Control Form
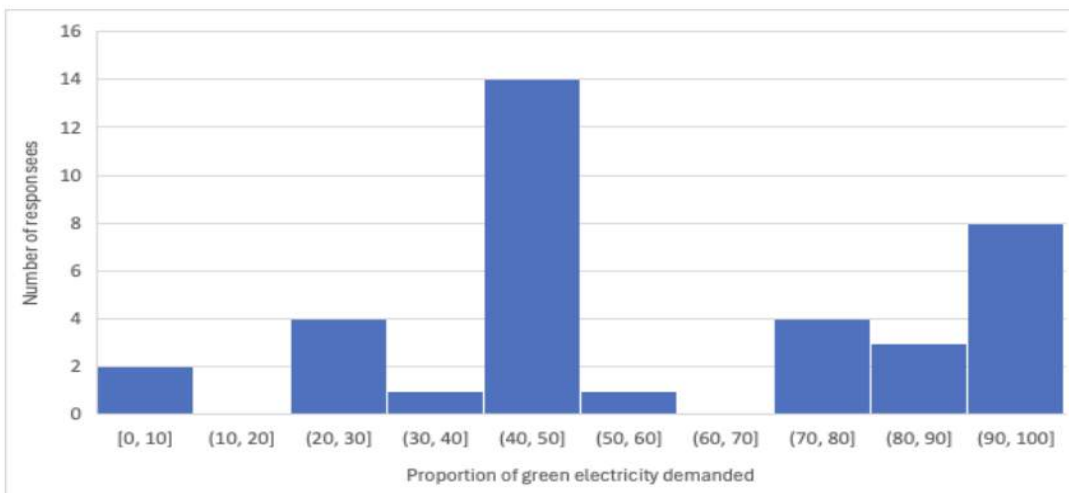
Figure 2: The distribution of electricity switching responses for the Nudge Form

The forms were evenly distributed among 76 people, with almost the same number of people filling in both forms. This allows for an accurate generalisation due to the similar sample sizes.

Results and Discussion

Under this section, an evaluation of the first and second forms will take place, which will also include their similarities and differences. Additionally, the overall effectiveness of the nudge and limitations of the study will also be discussed.

Control Form

After careful analysis of the results, the majority of the subjects would be willing to switch 50% or more of their electricity to green energy, with the average being 64.49%. This result was even higher than that of the nudge form. Furthermore, most of the subjects wanted only half their energy to be switched to green energy sources as seen in the graph. This shows that people understand the benefits of renewable energy sources to an extent; however, it is still not enough to switch most of their energy to those sources. Additionally, the primary motivation for the people who chose 50% or more of green electricity in their homes was Environmental concerns. However, the main reason for getting some of their electricity from other sources or not choosing green energy was mostly reliability concerns and in some cases costs as well. This shows that an increase in electricity bills by 7.6% due to purchasing renewable energy is overpowered by consumers' concern about the environment and that is why, if had an option, households would switch most of their electricity to green energy sources. Another surprising result is that, while so many of the subjects said that they would procure green electricity due to environmental concerns most of them don't even have renewable energy sources at their houses, even though they are quite ubiquitous nowadays. An interesting observation from the results of the first form is that most of the primary earners in their household are thinking from a more realistic point of view and not just putting in 100% for renewable energy consumption because it will be more costly for them. However, subjects like a child/ dependent have put more frequent 100% renewable energy consumption because they may not be looking at it from an electricity bill's perspective, and rather just how it will be more beneficial for the environment. In addition, most of the subjects whose role is of primary/ secondary earners are looking more at the extra costs as a motivation to not switch to renewable energy, while the dependents or homemakers have rather put 'reliability concerns' for a disincentive to switch to renewable energy.

The subjects who have opted to convert less than half of their total energy to renewable sources of energy have only chosen to get 0% of their energy from renewable sources of energy as seen in the graph. While only a really small proportion of subjects have chosen to get 0% of their electricity from green energy sources, all these people have either costs or reliability concerns as their primary motivation to not switch to renewable sources of energy. Additionally, except for one of these subjects, none of them has any renewable sources of energy at their houses, and another interesting observation is that all these subjects are either primary or secondary earners in their households.

Nudge Form

Similar to the control form, most of the subjects were willing to switch 50% or more of their electricity to green energy sources, with the average being 62.297%. Additionally, the

majority of the subjects once again were willing to switch only half their electricity to green energy sources. This similarity in both surveys highlights that subjects are not yet fully convinced with 'green electricity' to switch most of their electricity to green sources. Furthermore, most of their motivations to switch to green electricity were 'Environmental concerns' as seen in the table. Once again, similar to the first Form, there was quite a balance between the primary motivation to not switch to green energy, which was 'costs' and 'reliability concerns'. This shows that the green energy tariff played a significant role in impacting consumers' choice of why they should not convert all of their electricity to green energy. Moreover, it also shows that green electricity does not have the best reputation when it comes to delivering energy as in both the forms it can be noticed that subjects believe that renewable energy is not the most reliable source after all. Moreover, while almost every subject believes that carbon emissions associated with non-renewable energy are a significant problem, the majority of people in the survey do not have renewable energy-generating sources installed in their houses. Another interesting observation is that perhaps the reason for fewer people converting all of their electricity to green energy sources is that most of the subjects filling the form are some sort of income generators for their family, whether primary or secondary. That is why they may understand the importance of an additional cost added to their electricity bill, and hence not willing to fully switch to renewable energy. However, since the average proportion of electricity that the subjects are willing to switch to green electricity is more than half, the benefits of renewable sources outweigh the additional costs borne by households to purchase them in forms of electricity.

It is worth noting that, unlike the control group, the participants who were reluctant to switch less than half of their electricity to green energy sources showed some variability in their preferences. This is because they were open to switching to a range of values below 50%, rather than just 0%. The subjects who opted to convert less than half of their electricity to green energy sources have mostly chosen 'costs' as their primary motivation to not choose as much renewable energy. Additionally, aside from one of these subjects all of them do not have any green energy appliances installed in their houses, even though they all believe greenhouse gas emissions caused by non-renewable sources of energy are a significant issue. All the subjects who have chosen the option of converting less than half of their electricity to renewable energy fall under the category of either primary or secondary earners. This shows that costs matter more to these earners than the fact that renewable energy acts as a helping hand to the environment.

Effectiveness of the Nudge
After thoroughly analysing both surveys, the most common primary motivation to switch to green electricity in both forms was 'Environmental Concerns', with 62 out of the 76 subjects opting for it. While the information regarding the 'Green Energy User' signage was mentioned at the top of the form, it did not seem to have much of an effect on the choice of the consumers. The two subjects who chose the option of signage were not willing to switch most of their electricity to green energy sources. Additionally, the signage did not really impact the

consumers' choices as much as expected due to the review of the Nissan survey earlier in the study, hence the hypothesis of **green energy signage affecting consumers' choice to purchase more amounts of green energy did not end up being correct.** More than the green signage, environmental concerns were in popular demand as the primary motivation to switch to green electricity. Furthermore, the signage had minimal impact on encouraging the subjects to shift towards green energy sources. This is evident from the survey graphs, which consistently show that the majority of energy, at 50%, is derived from green energy sources. Hence, there was no major change from the control form to the nudge form. If anything, the graph shows a slight increase in the number of people who were willing to switch less than half of their electricity to green energy sources from the control to the Nudge form.

Limitations of the Study

The study took place in 1 and a half months where all the research took place along with the data collection. One of the major limitations of this paper was that the bias towards one region of India may have taken place during the data collection. Since the study took place in New Delhi, many of the subjects who filled out the form may have been from Delhi as well. New Delhi does not have a green tariff being charged to them as yet, and hence some people may not have understood the context of the tariff. That is why they may not have answered the questions based on the information they had read. Additionally, another limitation of the study was that there was not enough data on the green number plates affecting the consumption of EVs, hence not enough range of comparison was there between the EVs and green electricity. Another limitation of the study was that there wasn't another nudge implemented in a study in India like this, which could have been discussed as a mode of comparison to other nudges. Other nudges could have been tested through more forms; however, the sample sizes would have been too small to make generalisations. Including both surveys, the total sample size was 66. This was enough to generalise a conclusion in this case because the majority of the subjects had very similar answers, becoming a strength of this study.

Recommendations and Conclusion

Attempts to mitigate climate change throughout the world mainly concentrate on the development of new technology and increased government spending/ regulations in certain industries. Behavioural changes are also a huge aspect, as discussed throughout this whole study, in encouraging the consumption of green energy. The government should be implementing these policies frequently because they are free of cost and can be effective as well. While the signage was not as effective as it was thought it would be, there are other nudges to promote the consumption of green electricity. As stated previously in the literature review section the default nudge has been proven to be effective in the energy sector in a study implemented with German students in 2011. Similarly, it could be really effective in the Indian energy market as well. Perhaps it could be manoeuvred around the green energy tariff and charged initially. Due to the excessive status quo bias involved with changing the energy households are provided,

households may not want to change the type of energy they consume. Additionally, according to the results of both the forms, subjects believed that carbon emissions due to non-renewable energy is a significant problem, and the most common primary motivation to convert to green electricity was 'environmental concerns'. Hence, one major policy that the government could implement is a nudge that could change households' behaviour to bring out the true environmental concerns of the public. For example, perhaps a framing nudge could work, in framing the purchase of renewable energy in such a way that makes people think that they are big contributors in the carbon emission occurring in India because they are not regular buyers of green electricity/ energy. This will certainly bring out households' concerns regarding the environment because consumers will feel as if they are the reason the environment is being harmed, and hence will want to save it by purchasing renewable energy

   This research was really helpful in giving an insight into the renewable energy sector in India and as well as globally. While the 'Green energy User' signage nudge did not end up being effective, households' opinions on green electricity and reasons for them were brought out, which gave a significant overview of the energy market. Moreover, reviewing different pieces of research helped exemplify past nudges or policies that have been used in the renewable energy market and are known for uses in various other markets as well. A comparison of EVs with green electricity would have also been quite an interesting topic to research on as well because this study tried to incorporate one of the aspects of an EV, which is the number plate, but other factors of an EV could also perhaps influence the consumption of green electricity. Overall, the research was an incredible means to bring out some valid viewpoints regarding nudges and green electricity, and helped test a possible nudge that could potentially be implemented.

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Indigenous Women: Facing Oppression and Cultivating Resilience by Dhyana Abeysinghe

Abstract

Indigenous people remain some of the most vulnerable populations in the world. Indigenous women across the globe have faced a myriad of challenges ranging from intimate partner violence to community toxicity and a complete reversal of their roles due to historical colonization by Europeans and other groups. Many of these circumstances have taken a negative toll on the well being of Indigenous women, and have resulted in feelings of helplessness and a negative outlook. However, with protective factors such as family support, being able to express their experiences through creative outlets, and coming together with others from their community, Indigenous women have been able to cultivate resilience. These women have been able to come together to enact positive change and to bring attention to the issues and injustices against Indigenous women. As a result, many Indigenous communities have featured more female leaders and become more open places for women to come forward with their experiences.

Introduction

Indigenous peoples have been oppressed for centuries, dating back to the colonization of their ancestral lands and territories. However, a specific subset of Indigenous peoples have been disproportionately affected, spanning into the modern day: Indigenous women. The United Nations estimates that there are over 185 million Indigenous women across the world, belonging to over 5,000 various groups of Indigenous peoples (Food and Agriculture Organization of the United Nations). These Indigenous women have faced a myriad of challenges and obstacles, many of which have taken a negative toll on their mental health and wellbeing. Conversely, these adversities have also shed light on the resilience that Indigenous women have been able to cultivate with the help of multiple resilience factors and their communities. In looking through both a social-cultural and psychological lens, this paper will ask the important question "In what ways does the resilience of Indigenous women help them to overcome oppression?"

Oppressions Faced by Indigenous Women

In looking solely at Native American women, 84% of them have experienced some aspect of violence throughout their lives (Kapoor). However, violence experienced by Indigenous women is a global phenomenon. The influx of missing and murdered Indigenous women and girls has been labeled an epidemic known as the Missing and Murdered Indigenous Women's Crisis (MMIWC) (Weiss et al., 60). Oftentimes, not much action has been taken by governments and media to spread awareness about the MMIWC, which has resulted in false claims and the spread of misinformation (Weiss et al., 61). The Missing and Murdered Indigenous Women's Crisis is only one aspect of violence faced by Indigenous women. Intimate partner violence (IPV) and sexual violence are also experienced by many Indigenous women. Most of this violence has become normalized in Indigenous communities, with participants of a 2021 study noting that the culture in Indigenous communities is very toxic, with men devaluing

women (McKinley & Knipp, 294). The devaluing of Indigenous women can be traced back to the colonization of Indigenous tribes. In fact, what is occurring is a complete change in roles within Indigenous communities. In the United States, the Choctaw tribe [predominantly located in Oklahoma] transformed from a matriarchy, with women holding essential roles in their communities, to a patriarchy following European colonization, resulting in a lowering of status for many women (Burnette, 2). This reversal of roles has persisted into the modern time (Burnette, 2).

Indigenous women who experienced intimate partner violence and sexual violence showed overall lower levels of family resilience in their upbringing and social support (McKinley & Knipp, 310). In a 2016 study by Dr. Catherine Burnette and Timothy Hefflinger, historical oppression can be linked heavily to violence experienced by Indigenous women (Burnette & Hefflinger, 589). Furthermore, historical oppression has led to modern-day Indigenous community fragmentation, which has impaired the ability of Indigenous communities to support women who have experienced IPV (Burnette & Hefflinger, 594). These types of violence often lead to elevated post-traumatic stress disorder (PTSD) symptomology in Indigenous women (McKinley & Knipp, 310). A lack of justice for survivors of these events have further contributed to feelings of helplessness (McKinley & Knipp, 313) and feelings of inequality in their communities (Burnette & Hefflinger, 595). Fortunately, there are several positive factors which allow Indigenous women to successfully overcome some of these injustices.

Indigenous Women's Resilience & Ways to Overcome

Indigenous women have been able to overcome various adversities by utilizing multiple resilience factors and strategies. Most of these factors can be denoted as cultural factors, which include family and spiritual aspects which have the ability to help in coping with traumatic events (Rahill et al., 27). One example of such a factor is Indigenous women using the support and interconnectedness of their communities. A focus study conducted by psychologist Tinashe Dune PhD and other researchers found that the sense of identity of Indigenous Australian women was derived from community engagement and nurturance (Dune et al., 76). These findings are further supported by Dr. Catherine Burnette and Timothy Hefflinger, who demonstrated that all the women who had experienced IPV highlighted the importance of connecting their spirituality and faith within their communities (Burnette & Hefflinger, 593). Indigenous women were also able to benefit when there was a community rejection of violent behaviors towards women (Burnette, 5). These studies demonstrate how Indigenous women can derive both strength and support from their communities, which can help in promoting their growth and resilience. The psychological effects of traumatic experiences and the ability to describe them to others is also a characteristic of resilience (Rahill et al., 35). This strength has been demonstrated by the willingness of Indigenous women to discuss distressing events in their lives, bringing attention to the injustices faced. Many Indigenous women have utilized the ability to write about their experiences in English to try to heal and cope, as well as to disperse misconceptions and

stereotypes (Archuleta, 91). Writing about their experiences further proves Rahill's findings about psychological resilience, and how this can be applied to Indigenous women.

In contrast, 76% of women who were surveyed in a 2016 study noted a community norm of violence against women (Burnette & Hefflinger, 593). In addition, participants in a 2021 study on sexual violence against Indigenous women discussed how the culture in Indigenous communities could be very toxic, with men in those communities devaluing women (McKinley & Knipp, 294). This suggests that while Indigenous communities can help in promoting resilience in Indigenous women, they may also play a role in normalizing certain oppressions.

Familial support was overwhelmingly shown to have been instrumental in fostering Indigenous women's resilience. A study conducted by Dr. Catherine Burnette demonstrated that family support and resilience enabled Indigenous women to recover from IPV more quickly, end violent relationships, and cope with relationship dysfunction (Burnette, 2). She also found that the Indigenous family system encourages positivity and opposes violence (Burnette, 3). Elders, especially grandmothers, also played a large role in Indigenous women's resilience, as they were able to tell stories and give guidance (Burnette, 11). The findings of a study on Indigenous Australian women demonstrated the commitment that these women have to their families across generations and how they demonstrated leadership qualities that were respected amongst their families (Dune et al., 82). These studies cement the idea that Indigenous women rely heavily on family support and that they are contributors to their own families. Clearly, there is strong evidence to demonstrate the importance of family support in helping Indigenous women cultivate resilience and overcome past traumas.

Professor Guitele Rahill PhD and other researchers across various universities were able to determine that being resilient does not mean that individuals are not affected by adversity, but rather that they use tools to overcome that adversity (Rahill et al., 36). An excellent example of this is the International Indigenous Women's Forum, which is a network of female Indigenous leaders from around the world (Settee, 48). These women come together "to strengthen their communities, develop leadership, build unity, and fight for their rights" (Settee, 48). Another example of Indigenous resilience is when the Mississippi Band of Choctaw Indians were able to overcome both historical and patriarchal oppression when in 2011, Phyliss Anderson was elected as the first female chief in history (Burnette, 5). This was a complete reversal of the long-standing tradition of male chiefs and men in positions of power in Indigenous communities following colonization.

Furthermore, Indigenous women are organizing on an international level, such as the Permanent Forum on Indigenous Peoples that is held annually in New York to advocate for Indigenous women's rights (Settee, 48). The Forum has been able to help Indigenous women unite in solidarity to chart pathways forward. A study conducted on Australian Indigenous women showed the active roles that women play in Indigenous communities by being economic providers and cultural custodians (Dune et. al, 79). Many women even say that they have been able to mirror the leadership roles that they had prior to colonization (Dune et. al, 79). This

myriad of studies and examples demonstrate the creation of positive change and revitalization of communities that Indigenous women have been able to enact successfully.

Ideas of Survivance & the FHORT

Survivance is a term coined by Native scholar Gerald Vizenor, and can be defined as the ability of Indigenous peoples to overcome various oppressions and adversity (Burnette, 2). The idea of survivance has been shown to help Indigenous people overcome colonization (Burnette & Figley, 41). Other definitions of the word can include the ability for Indigenous peoples to live "a thriving life" (Weiss et al., 63). While the creation of this term may have been to encompass Indigenous resilience as a whole, it can also be applied to Indigenous women's ability to overcome historical oppression when they were stripped of their positions as leaders in their communities.

The FHORT stands for the Framework of Historical Oppression, Resilience, and Transcendance (Burnette & Figley). This framework can be defined as working "to both examine and understand the experiences of Indigenous women in the context of patriarchal and colonial historical oppression," (McKinley & Knipp, 293). It solidifies the notion that Indigenous women are able to overcome various oppressions by cultivating resilience. The FHORT puts an emphasis on Indigenous resilience in terms of people's interactions with their environment and how it connects to the harmony between the mind and body in promoting spirituality (Burnette & Figley, 40). This framework also suggests that building resilience in the face of oppression can lead to wellness (Burnette & Figley, 42). The mere existence of these terms and the ability to apply these to Indigenous women within their communities further proves that Indigenous women have successfully overcome various adversities with resilience.

Conclusion

It cannot be denied that Indigenous women across the globe have faced many challenges. However, it is also clear that Indigenous women have been able to overcome adversities, whether they be historical and rooted in colonization or in the modern day. There is still more work that needs to be done to make Indigenous communities safer and more open places for Indigenous women to thrive in. A lot of that work can be done by the public – by donating to female-led Indigenous organizations, by educating themselves and spreading awareness of the injustices against Indigenous women, and to help craft a world where women are unafraid to come forward to ask for help and support. It is vital to provide support for a group of women who have endured so much adversity and have still managed to keep moving forward.

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Enhancing Communication and Mobility for Quadriplegics through EEG and Machine Learning: A Neuroprosthetic Approach By Krithik Alluri

Abstract

Quadriplegia, resulting from spinal cord injuries or neurodegenerative diseases, profoundly limits mobility and communication, significantly impacting the quality of life. Recent advances in neuroprosthetic technology, particularly integrating electroencephalography (EEG) and machine learning offer new avenues for restoring these lost functions. This paper explores the application of EEG-based brain-computer interfaces (BCIs) in neuroprosthetics, detailing how these systems can enhance communication and mobility for individuals with quadriplegia. It discusses the specific methods used, including machine learning algorithms for signal processing and the development of assistive devices such as prosthetic limbs and voice-controlled wheelchairs. The paper also examines the broader implications for quality of life, including psychological benefits and the potential for neural regeneration through rehabilitative therapies. Despite the promising advancements, challenges such as signal acquisition, personalization, and ethical considerations remain. The paper concludes with a discussion of future directions for research and development in this rapidly evolving field.

Introduction

Quadriplegia, characterized by partial or complete loss of function in all four limbs and torso, is often the result of spinal cord injuries or neurodegenerative diseases. This condition severely limits mobility and communication, impacting the quality of life. Recent advances in neuroprosthetic technology, particularly involving electroencephalography (EEG) and machine learning, have opened new avenues for restoring these lost functions. This paper explores how these technologies can improve the quality of life by enhancing communication and mobility for individuals with quadriplegia. Furthermore, it examines the potential for regenerative therapies and the role of these technologies in rehabilitative medicine.

Background and Significance

Human-computer interaction technologies were initially introduced to compensate for sensory and motor deficits. For instance, voice-operated wheelchairs were developed for severely disabled persons who could no longer use their limbs to control their wheelchairs. (Nuttin et al.) Non-invasive input-output devices for communication, such as brain-computer interfaces (BCI), are available to facilitate communication with the environment without the need for sensors or muscle activity (e.g. eye tracking, head orientation, etc.) (). Brain-controlled applications range from home automation to telephone operation, remote control of a car,

adjustments to a stereo in the car, controlling a mobile robot, bedpal, and tracking applications in vocational rehabilitation. Most of these applications use an indirect neural control interface (NCI), in which case a signal used by the user is a measure of an underlying neuropsych biological system (which is never actually measured). (Aasted et al.)

Electronic neural interfaces (NI) are complex implants, thus surgery and the risks associated with it are usually avoided. Spinal cord injury patients prompted researchers to develop brain-controlled arm and upper extremity prostheses directly interfacing the nerves for the sensation of touch or motor control. In cochlear and retinal implants, signals provided by the artificial biosensors are adequate to directly stimulate specific sensory nerve cells, and accordingly, the signals are interpreted as a measure of the neural function of the sensorineural system. (Wilson and Dorman) The reduced effort necessary for the practical integration of this kind of device has favored a direct neural interface, such as the case of eye tracker, in which visual nerve function is lacking. Neural interfaces in development or the clinical research phase include visual prostheses, brain-controlled retinal prostheses, direct BM stimulation to allow somesthetic perception of objects, and brain-controlled stimulators to activate muscles for limb movement. (Chandrasekaran et al.) (Bouton) (Moritz et al.)

Neuroprosthetics and Brain-Computer Interfaces

Neuroprosthetics encompass devices that restore sensory or motor functions lost due to neurological conditions. Central to this field are brain-computer interfaces (BCIs), which translate neural activity into commands for external devices. EEG-based BCIs are particularly prominent due to their non-invasive nature and ability to capture brain signals. These systems typically involve electrodes placed on the scalp, which detect electrical activity from the brain's surface. This activity is then processed to identify patterns associated with specific thoughts or intentions (Musk, 2019).

Machine learning algorithms are crucial in interpreting these EEG signals. Techniques such as support vector machines, deep learning, and convolutional neural networks are employed to classify brain signals with high accuracy. These algorithms learn to recognize the neural signatures of different motor imagery tasks, such as imagining hand movements, which can be used to control prosthetic limbs or other assistive devices.(Triwiyanto et al., 2022)(Tayeb et al., 2019) The integration of functional near-infrared spectroscopy (fNIRS) with EEG, as studied by Buccino et al. (2016), enhances the system's ability to distinguish between different mental states, providing more precise control over the devices.

Methods of Understanding EEGs and Controlling Devices

Deep learning models are particularly well-suited for extracting complex features from EEG data. Convolutional neural networks, for example, can automatically learn relevant spatial and temporal patterns, making them a powerful tool for decoding motor imagery from EEG signals. At the same time, traditional machine learning techniques, such as support vector

machines, are still widely used for their interpretability and reliable performance. (Lin et al., 2017)

The process of developing an EEG-based BCI system typically involves several key steps. First, the system must reliably detect and extract relevant features from the EEG data. This can be achieved through techniques like common spatial patterns, which optimize spatial filters for enhanced signal-to-noise ratio, and power spectral density analysis, which captures frequency-domain characteristics associated with different mental states.

Next, the extracted features are used to train a machine-learning model to classify the user's intentions. For instance, the model may learn to recognize patterns associated with the imagination of left-hand or right-hand movement, which can then be mapped to control commands for a prosthetic limb or wheelchair.

There are 3 major methods to classify motor imagery movements from EEG signals: LSTMs, CNNs, and RCNNs (Tayeb et al., 2019).

LSTM-based models

Long Short-Term Memory Networks, a type of recurrent neural network, are well-suited for capturing the temporal dynamics of EEG signals. They work by maintaining an internal memory state that allows the model to integrate information over time, making them effective for decoding continuous or sequential neural patterns. (Palumbo et al.) They start by inputting preprocessed EEG data and then predict the associated motor imagery movement.

CNN-based models

Convolutional neural networks are widely used for automatic feature extraction from the spatial and temporal structure of EEG data. CNNs can learn hierarchical representations that capture the complex, nonlinear relationships between EEG channels and mental tasks. (Tayeb et al.)

RCNN-based models

Recurrent Convolutional Neural Networks combine the strengths of recurrent and convolutional architectures, allowing them to model both spatial and temporal dynamics in the EEG signals. The recurrent component helps capture the temporal dependencies, while the convolutional layers extract the relevant spatial features. (Kwon et al.)

Restoration of Communication and Mobility

For individuals with quadriplegia, regaining the ability to communicate and move independently is transformative. EEG-BCIs enable communication by translating thought patterns into text or speech outputs, using methods such as P300 spellers or motor imagery. (Mak & Wolpaw, 2009) These systems allow users to select letters or words by focusing on specific thoughts, which the BCI interprets and transmits to a communication device. This technology

offers a significant improvement over traditional assistive communication methods, providing more rapid and intuitive interaction. (Rezeika et al.)

Regarding mobility, EEG-BCIs have been integrated with assistive devices such as robotic prosthetic limbs and voice-controlled wheelchairs. By detecting the user's intention to move a limb or navigate a wheelchair, the BCI system can translate these thoughts into precise device control. Researchers have demonstrated the feasibility of these systems, with users able to perform tasks like reaching and grasping with a prosthetic arm or driving a wheelchair with their minds (Pai et al., 2023) (Mak & Wolpaw, 2009) (Leuthardt et al., 2009).

Mobility restoration through neuroprosthetics involves the control of robotic limbs or exoskeletons. The work by Bouton et al. (2016) demonstrates the potential of neuroprosthetic arms, which users can control via cortical signals. These systems use sophisticated decoding algorithms to interpret signals related to intended movements, enabling users to perform complex tasks such as grasping objects or manipulating tools. Similarly, neuroprosthetic exoskeletons assist with standing and walking, offering a level of independence that was previously unattainable for individuals with severe paralysis.

The development of voice-controlled wheelchairs and other assistive devices, as explored in the IEEE Xplore publication on Arduino-based systems, also plays a critical role in enhancing mobility. These technologies use voice recognition and EEG signals to provide a seamless control interface, allowing users to navigate their environment with minimal physical input.

Quality of Life Improvements

The impact of neuroprosthetic technologies on the quality of life for quadriplegics extends beyond physical capabilities. The ability to communicate more effectively and move independently reduces reliance on caregivers, fostering a sense of autonomy and dignity.(Cimolato et al., 2023) Social interaction is crucial for mental health, and neuroprosthetic communication devices can alleviate feelings of isolation and depression by enabling more meaningful engagement with others.(Graczyk et al., 2018)

Moreover, the psychological benefits of regained mobility cannot be overstated. Individuals who can perform daily activities such as eating, dressing, or moving around their homes experience a significant boost in self-esteem and overall well-being. These improvements in mental health are supported by the enhanced sense of agency and control that neuroprosthetic devices provide, contributing to a more positive outlook on life.

Notably, the potential for neural regeneration through targeted rehabilitation therapies further highlights the transformative nature of these technologies. By combining neuroprosthetic devices with physical and occupational therapy, some individuals may recover partial motor function, leading to additional quality-of-life improvements. (Moritz et al., 2016)(Morone et al., 2023)(Hidler & Sainburg, 2011)

Regenerative Potential and Rehabilitative Medicine

Neuroprosthetics are not only tools for compensation but also hold potential for rehabilitation and neural regeneration. The use of BCIs in therapeutic settings can promote neural plasticity, encouraging the brain to form new connections and pathways. (Kansaku, 2021) This potential for neural regeneration is particularly relevant in the context of spinal cord injuries, where reconnecting severed pathways could restore some degree of function.

Rehabilitation programs that integrate neuroprosthetic devices with targeted physical and occupational therapy have demonstrated promising results. By providing sensory feedback and engaging the user's motor cortex, these systems can stimulate neuroplasticity and potentially reverse some of the effects of the initial injury or disease. Researchers have reported cases of individuals regaining partial motor control and sensation after using neuroprosthetic limbs in conjunction with rehabilitative therapies, as described in the work of Bouton et al.(Popović et al., 2005)

Research into the regenerative potential of neuroprosthetics is ongoing, with studies exploring the use of electrical stimulation, neurotrophic factors, and other interventions to promote healing and growth in damaged neural tissues. The work by Raspopovic et al. (2010) on sensory feedback from prosthetic limbs suggests that sensory integration could play a crucial role in rehabilitation, helping users relearn motor control and coordination.

The NSF-DFG Workshop Report (2016) emphasizes the importance of interdisciplinary approaches in advancing neuroprosthetic research. Collaboration between neuroscientists, engineers, clinicians, and rehabilitation specialists is essential for developing therapies that not only restore function but also enhance the body's natural healing processes.(Bhadra & Chae, 2009)(Dingle et al., 2022)

Challenges and Future Directions

Despite significant advancements, several challenges remain in the development and deployment of neuroprosthetic technologies. Signal acquisition and interpretation are critical areas where improvements are needed. Current EEG systems can be affected by noise and require precise calibration to function effectively. Additionally, the development of non-invasive methods that match the accuracy of invasive techniques is a priority, as these would reduce risks and increase accessibility for users. (Casson, 2019)

Personalization of neuroprosthetic systems is another challenge. Individual differences in brain anatomy and signal patterns necessitate customized solutions, which can be resource-intensive to develop. (Dingle et al.) Machine learning models must be trained on large datasets to improve their accuracy and reliability, which requires extensive data collection and processing capabilities.

Ethical considerations also play a significant role in the development of neuroprosthetics. Issues related to user consent, data privacy, and the potential for cognitive enhancement beyond therapeutic needs must be carefully managed. The ethical landscape of neuroprosthetics requires ongoing dialogue among stakeholders, including patients, healthcare providers, and regulatory bodies. (Lane et al., 2016)

Future research should focus on enhancing the precision and usability of BCIs, exploring hybrid systems that combine multiple modalities, and integrating neuroprosthetic technologies with broader healthcare and rehabilitation frameworks. (Lin et al.) Advances in artificial intelligence, materials science, and bioengineering hold the potential to further revolutionize the field, offering new solutions for restoring function and improving the quality of life for individuals with quadriplegia.

Conclusion

The integration of electroencephalography and machine learning in neuroprosthetics represents a pivotal advancement in the field of rehabilitative medicine. These cutting-edge technologies offer unprecedented opportunities for restoring communication and mobility to individuals living with quadriplegia, profoundly enhancing their overall quality of life. Moreover, the exciting potential for neural regeneration and the augmentation of traditional rehabilitative therapies present promising avenues for future research and development in this dynamic field.

As the field of neuroprosthetics continues to evolve, sustained interdisciplinary collaboration and a steadfast commitment to addressing ethical considerations will be crucial in ensuring that these transformative technologies are developed and deployed in ways that maximize benefits for the end-users while meticulously mitigating risks. The future of neuroprosthetics holds immense promise, and with ongoing advancements in related scientific disciplines, this rapidly evolving field is poised to revolutionize the landscape of disability and rehabilitation, empowering individuals with quadriplegia to reclaim their independence and achieve a more fulfilling quality of life.

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Extraversion and Happiness: Are Extroverts Happier Than Introverts?
By Qingxuan Wang

Introduction

It is widely acknowledged that humans possess an innate inclination towards social interaction, and the cultivation of fulfilling social connections is a fundamental determinant of personal well-being (Wilson). The establishment and sustenance of robust social connections are not only crucial elements of the adolescent and adult stages of life, but they are also imperative for an individual's psychological and physical well-being (Abraham; Erikson). In recent centuries, the general public has long held the belief that extroverts are more outgoing, affectionate, friendly, and talkative, whereas introverts are portrayed as lacking confidence, passive, reserved, and socially distant (Costa and McCrae). Under the effect of these perceptions, various individuals have advocated that extraversion and positive affect are connected, which is also one of the most compelling discoveries in the study of personality and emotion (Henry). Extraversion is essentially a measure of sociability, which is a self-evident source of happiness. Is this, however, true? The present paper explores the relationship between happiness and extraversion levels.

Literature Review

Personality: Introversion—extraversion

Extraversion (E) and introversion (I) are significant personality characteristics that influence how people interact with the environment and live their lives. The description of E-I types of personalities has been argued during the early decades. Goldenweiser considered I as the intuitive mind and E as the adaptive or 'craft' mind (Mayor). In his theory, the former tends toward insanity, while the latter tends toward idiocy or the mechanical robot. According to Mauerhofer , the main characteristic of the I type is that he maintains his distance amid reality, and Thompson considered the I to be an "individualist" who wants to direct himself and the E to be an "externalist" who wants to be directed from the environment. These ideas, popularized by Swiss psychiatrist Carl Jung in his influential book Psychological Types, represent a spectrum along which people's inclinations for social connection, stimulation, and engagement with their surroundings vary.

Extraversion is characterized as a proclivity for external stimulation, social interaction, and engagement with the environment (Guilford). Extroverted people flourish in social situations because interactions with others inspire and motivate them. They charged themselves by seeking out new experiences, taking risks, and participating in a variety of social activities (Nicoll) and were more likely to express their thoughts and emotions openly and assertively (Freyd). This preference for external stimulation is often accompanied by sociability, excitement, and a desire for adventure. Introversion, on the other hand, is characterized by a preference for inward

experiences, introspection, and solitude (Allaopp and Eysenck). Introverts find peace and refreshment in less stimulating environments. They frequently need time alone to recharge their batteries and digest their ideas and emotions. When compared to extroverts, introverts have fewer close friends and may participate in deeper, more meaningful interactions (Young). They are typically distinguished by thoughtfulness, careful examination of their words and actions, and a preference for more serene one-on-one relationships.

Understanding extraversion and introversion is crucial for understanding how people perceive and interact with their surroundings, which determines their relationships, behaviors, and overall satisfaction (Rabiu). However, it is also critical to realize that extraversion and introversion comprise a wide range of personality qualities. The majority of people do not fit neatly into the categories of extraversion or introversion. Others display characteristics and behaviors related to both introversion and extraversion, typically falling somewhere in the middle of the introversion-extraversion spectrum (Petric), and are referred to as ambiverts. Ambiverts are neither strongly introverted nor strongly extroverted, but instead approach social interactions and energy management in a balanced or flexible manner. Most people, in fact, have a combination of both characteristics, with one being prominent (Young). An individual's extraction level, for example, can be measured on a scale of 1 - 7, with 1 suggesting lower openness and 7 indicating greater openness (Cobb-Clark and Schurer). Individuals' behaviors can differ depending on their environment and life circumstances. Recognizing extraversion and introversion in their entirety allows us to acquire insight into human behaviors and individual variations.

Happiness and subjective well-being

In positive psychology, happiness is commonly operationalized as subjective well-being (SWB) (Diener, "Subjective Well-Being: The Science of Happiness and a Proposal for a National Index."). According to Diener (Subjective Well-Being), subjective well-being typically consists of three components: positive affect, negative affect, and cognitive traits such as life satisfaction and self-esteem. It has been associated with a number of favorable outcomes, including better physical and mental health, stronger social interactions, greater resilience, and higher levels of life satisfaction. Therefore, numerous psychologists and researchers are interested in exploring the factors that contribute to higher levels of subjective well-being, as well as how they might be promoted and sustained over time.

Diener (Subjective Well-Being) distinguishes SWB psychological theories based on their emphasis on top-down (internal traits and processes) versus bottom-up (external/situational) impacts. According to bottom-up theories, SWB develops as a result of the accumulation of pleasant and unpleasant moments and experiences in a person's life (Subjective Well-Being); for example, happiness develops when pleasure times outnumber unpleasant ones (Brief et al.). External factors such as financial pleasures and social ties typically account for just 10-15% of the variance in SWB (Argyle). Top-down theories, on the other hand, ascribe SWB to internal characteristics and psychological processes such as objectives, coping styles, and adaptive

processes (Diener et al.). Top-down studies show that temperament and personality factors like neuroticism and extraversion are strong predictors of SWB (Subjective Well-Being).

Neuroticism, defined as the polar opposite of emotional stability, encompasses a wide range of negative emotional characteristics, including anxiety, impatience, sorrow, moodiness, and nervous tension (Benet-Martínez and John). Extraversion includes attributes such as activity and energy, expressiveness, dominance, sociability, surgency, and warmth (Rabiu). Top-down theories in SWB hold that an individual's temperament and personality qualities, such as neuroticism (emotional instability) and extraversion (sociability and positive affect), have a substantial impact on their general well-being. Individuals with high extraversion, for example, are more likely to have greater levels of SWB due to their friendly and pleasant attitude.

Happiness and extraversion in early research

Introduced by Jung in 1923, extroverts thrive when offered numerous opportunities for social engagement, whereas introverts thrive when given the ability to focus inward and withdraw from social circumstances. The study found no preference for introversion or extraversion as opposing qualities. The prior foundation study on introversion and extraversion revealed a reasonably objective and relatively non-critical attitude toward any type of personality. The primary distinction between introverts and extroverts is how they process information. Michael Cohen discovered that introverts and extroverts process rewards differently. Extroverts benefit from increased stimulation since their dopamine system drives them to seek out new experiences. Introverts, on the other hand, do not require extra stimulation to feel happy because their neurotransmitter provides a pleasant sensation that is more about introspection. This explains why extroverts enjoy attending numerous gatherings, while introverts prefer to stay alone and read books. As a result, while both introverts and extroverts are capable of being outgoing, sociable, or unsociable, both prefer to seek out and participate in interactions with others that are compatible with their personality type (Diener et al.).

Extroverts are happier, according to the claim, contradicting the ideas of classical philosophers such as Aristotle and Epicurus, who placed the most focus on human happiness. Their prescription of happiness includes avoiding many social aspects of life and living a tranquil, serene life in relative solitude. A wide variety of religious systems promote a similar way of living. Their purpose was to give immense personal happiness to their followers both in life and in death, and medieval hermits and recluses believed that complete isolation was the best way to accomplish this (Hills and Argyle). Aristotle believed that intellectual reflection and mental exertion were essential to eudaimonia (happiness). Introverts are naturally drawn to deep meditation and contemplation. Intellectual pursuits, self-reflection, and the examination of their inner thoughts and ideas may provide individuals with happiness and fulfillment. Despite the fact that introverts have fewer social interactions than extroverts, Aristotle recognized the importance of meaningful and virtuous relationships in achieving happiness. Introverts prefer deep, meaningful relationships to shallow social engagements, and they may enjoy close, trustworthy friendships. Aristotle's philosophy encourages the pursuit of activities that contribute to human

progress and fulfillment. Introverts usually prioritize meaningful connections and activities over a wide range of social activities. Activities that represent their ideas and interests may provide them with enjoyment. Therefore, it seems clear that introverts and extroverts should have equal odds of happiness.

Happiness and extraversion in recent popular theories

After years of development, researchers adopted Jung's typology and held that extroverted actions were signs of maturity and introverted behaviors were indications of arrested development (Costa et al.), and this view has a strong influence on people's perceptions of introverts and extroverts. The public begins to admire and favor extroverted features while subconsciously judging introverted traits as a restraining element of progress in modern social culture and insignificant. Furthermore, because of their more evident and clear reactions to social stimulation, extroverts are commonly considered to be happier than introverts. Over the last two decades, research investigations have frequently shown a positive relationship between extraversion and positive affect, happiness, and subjective well-being (Zuckerman et al.; Costa and McCrae; Diener et al.; Emmons et al.; Watson and Clark). According to studies, extroverts have more intimate interpersonal relationships than introverts. They show that extraversion has the strongest relationship with happiness and that happiness has a strong relationship with extraversion (Argyle and Lu). A meta-analysis, for example, discovered 0.17–0.27 correlations between extraversion and a number of subjective well-being measures (DeNeve and Cooper).

While there is an association between extraversion and pleasure, individual variances are significant. Introverts can be happy as well but in different ways, such as through deep, meaningful relationships and lonely activities. The previous study does not fully support personal observation. Most people have friends and acquaintances who appear to be happy while not being particularly outgoing (Hills and Argyle). Eysenck distinguished between introverts and extroverts in terms of cortical arousal. Because extroverts are not easily stimulated, they seek stimulation from a wide range of people. The extroverts need others to talk to, crave excitement and physical exercise, enjoy laughing and being entertained, and engage in a range of social contacts, all of which are key sources of happiness. Introverts, on the other hand, have a low arousal threshold and can function in the absence of excessive external stimuli.

Aims of the present research

According to numerous studies, extraversion is associated with higher self-reported levels of pleasure on average, owing to their inclination for socializing and experiencing more good experiences. Individual features, cultural factors, and life circumstances, on the other hand, all play important roles in determining individuals' overall sense of well-being and pleasure.

This distinction is based on differences in personal stimulation needs, but is stimulation synonymous with happiness? Introverts may not find much fulfillment in social circumstances since they do not need the external stimulation supplied by the presence of many others, but they could not be more open to other sorts of happiness. Extroverts need a huge number of people in

their lives, whereas introverts can be more selective, focusing on creating one-on-one, bonding connections with a few close friends, and experiencing higher levels of empathy with them. Introverts may enjoy very enjoyable leisure activities that they may pursue in relative solitude. They may also have an intense inner life focused on intellectual, musical, or religious activities that give them something to ponder about without relying on others (Storr). Therefore, in order to investigate the disparities between observation and some past reports, the aims of the present research are as follows:

1) Examine the positive relationship between extraversion and positive affect, as well as the negative relationship between extraversion and negative affect.

2) Examine the importance of extraversion in relation to other happiness-related traits.

3) Explore factors other than extraversion that may have an impact on happiness.

Method

Participants

The experiment recruited 152 college students from the Midwest of the United States, ranging in age from 18 to 24 years old (M = 18.81, SD = 0.958). The sample population consisted of 43.3% males and 55.3% females in terms of biological social identity, as well as 53.9% white and 44.7% black in terms of ethnicity.

Measures

Respondents were asked to complete and return an online questionnaire based on a range of previously published metrics relevant to this investigation. The first set of questions assesses their extraversion level (higher scores indicate higher extraversion). The second component comprises affect-related questions extracted from 25 different affect measures, including terms like "inspired" and "embarrassed," with the objective of evaluating the subjective well-being (SWB) of the participants. In order to ensure uniformity in the manner of presentation, the evaluation of items is conducted using a rating scale ranging from 1 (very slightly or not at all) to 5 (extremely). The individual items on all scales were merged and rearranged in random order prior to administration for the sake of participants' engagement. Aside from their extraversion level, participants were also asked about their financial circumstances in general by self-reporting with the question "Last year, what was your parents' combined household income before taxes?". The question assessed an external factor that could have an impact on happiness.

Designs

The entire data set was used for preliminary data characterization in terms of gender, age, and component scale behavior. The 25 affect-related questions displayed in Table 1 will be separated into three groups to compare the effect of extraversion on three components of SWB (Subjective Well-Being): negative affect, positive affect, and self-esteem. The above groupings

were then divided into four new groups for further analysis: (1) Extraversion to negative affect (2) Extraversion to positive affect (3) Extraversion to self-esteem.

Scale items for 25 affect measures.

Items	Items	Items	Items
Distressed	Afraid	Enthusiastic	Attentive
Excited	Lonely	Proud	Jittery
Upset	Rejected	Irritable	Active
Strong	Judged	Alert	Determined
Guilty	Calm	Ashamed	Nervous
Scared	Tired	Inspired	Embarrassed
Hostile			

Analysis

IIBM SPSS Statistics v.29.0.1.0 was used for data analysis. In each category, there were some missing data (N = 10) among all participants (N = 152). Missing data were handled using the full-information maximum likelihood estimation technique and fed into the analytical program with values of -999. A T-test was carried out for all variables across all groups to confirm the association in the composition of the three groups. The p-value associated with each of the variables was significant at the $p < 0.05$ level. Subsequent analyses were centered on intergroup comparisons, with a focus on the differences and similarities between the three groups. T-test statistics were investigated first, followed by Bivariate Pearson Correlational Analysis.

Results

Descriptive Statistics

Participants are primarily from affluent families, with a mean household income of $17,720 and a median income of $18,000 before taxes last year. The median household income ranged from $3,000 to $28,000 (SD = 7.645). This suggests that the participants' financial backgrounds can vary to some extent.

Table 2 shows that the difference in the mean extraversion (male = 3.40, female = 3.52) and positive affect scores (male = 3.23, female = 3.42) of males and females is larger than 0.1. The difference in mean negative affect (male = 1.70, female = 1.73) and self-esteem (male = 3.99, female = 4.00) is lower than 0.1. However, it merely displays minor differences.

Differences between Males and Females on Extraversion, Self-esteem, Positive affect, and Negative affect

	Gender	N	Mean	Std. Deviation	Std. Error

Exrtaversion	Male	60	3.3958	0.85089	0.10985
	Female	78	3.522	0.79179	0.08965
Self-Esteem	Male	60	3.9944	0.62434	0.08060
	Female	78	4.0000	0.66014	0.07475
Positive affect	Male	66	3.2273	0.80471	0.09905
	Female	84	3.4177	0.86983	0.09491
Negative affect	Male	66	1.7001	0.51614	0.06353
	Female	84	1.7266	0.44434	0.04848

The statistics on the relationship between ethnicity and SWB are presented in Table 3. Similarly to the aforementioned pattern in gender, the differences in the mean between white and black extraversion (white = 3.40, black = 3.55) and negative affect scores (white = 1.62, black = 1.84) are larger than 0.15. In comparison, there is a difference of less than 0.15 in the mean of pleasant feelings (white = 3.34, black = 3.22) and self-esteem (white = 3.93, black = 4.08). In conclusion, the difference between the scores of different ethnicities is too minor and, therefore, can be ignored.

Upon conducting a comparative analysis of Tables 2 and 3, it becomes evident that the data indicates a lack of significant variation in subjective well-being (SWB) levels across diverse cultural backgrounds and biological sexual identities.

According to Table 4, the mean of extraversion in the data gathered is around 3.45 (SD =.825), which is near the data of positive affect (mean = 3.33, SD =.844) and self-esteem (mean = 3.99, SD =.644). The data similarities between extraversion, positive feelings, and self-esteem are consistent with the general cognition of previous research (Costa and McCrae; Diener et al.; Emmons et al.). In contrast to the previous statistics on extraversion, pleasant feelings, and self-esteem, the mean of negative affect is 1.71 (SD =.476). The personality and emotions variables are scaled from 1 to 5, with a scale of 1 indicating "not at all" and a scale of 5 indicating "extremely."

Descriptive statistics on Self-esteem, Positive Affect, and Negative Affect

	Extraversion	Self-Esteem	Positive Affect	Negative Affect
Mean	3.4536	3.9881	3.3339	1.7150
Median	3.5000	4.0000	3.5000	1.6364
Std. Deviation	0.82455	0.64399	0.84436	0.47578
Range	3.75	3.33	4.00	2.00
Minimum	1.25	1.67	1.00	1.00
Maximum	5.00	5.00	5.00	3.00

Overall, the data show that the people who took part in this experiment had a fairly high level of subjective well-being (SWB), which was measured by the number of good and bad moments in a bottom-up model and by self-esteem in a top-down model (Subjective Well-Being).

Inferential Statistics

Extraversion and three components of SWB

The data was subjected to a bivariate correlational test in order to further investigate the relationship between extraversion and the level of SWB. As shown in Table 5, extraversion has a positive correlation with self-esteem (r =.205) and positive affect (r =.095) but a negative correlation with negative affect level (r =.099). While positive affect has a positive correlation with extraversion level, it is not significant (p > 0.05). Instead, with a p-value of 0.015 (p < 0.05), self-esteem has a substantial positive correlation with extraversion. The negative relationship between extraversion and negative affect is not statistically significant (p > 0.05).

These findings imply that the level of affect is not consistently a key component of extraversion (Argyle and Lu), with both the correlation between negative affect and negative affect being insignificant. This discovery contradicted some of the earlier findings (Emmons et al.; Watson and Clark). In SWB measures, extraversion is more associated with cognitive characteristics such as self-esteem.

Correlation of Extraversion to Self-esteem, Positive Affect and Negative Affect

		Self-Esteem	Positive Affect	Negative Affect
Extraversion	Pearson Correlation	0.205	0.095	-0.099
	Sig. (2-tailed)	0.015	0.270	0.247
	N	140	138	138

Extraneous factors: financial backgrounds

The results also reveal some intriguing findings on the relationship between individuals' financial backgrounds and their level of well-being. Table 6 illustrates that household income has a positive correlation with extraversion (r =.074), self-esteem (r =.184), and positive affect (r =.034), but a negative correlation with negative affect (r =.216). However, the correlation is only significant for self-esteem and negative affect level (p < 0.05), while it is not significant for positive affect (p > 0.05).

Correlation of household income to Self-esteem, Positive Affect and Negative Affect

	Self-Esteem	Positive Affect	Negative affect

Household income last year	Pearson Correlation	0.184	0.034	-0.216
	Sig. (2-tailed)	0.034	0.693	0.010
	N	133	140	140

The findings suggest that an individual's financial background can have an impact on one's self-esteem and negative affect. This means that the lower the SWB level, the worse the financial background and the higher the negative effect level. However, while financial backgrounds create a significant negative coefficient with the negative affect, they only have an insignificant correlation with the positive affect.

Discussion

The results of the present research are somewhat compatible with prior publications (Zuckerman et al.). Positive affect has a positive correlation (r =.025) with extraversion level, while negative affect has a negative correlation (r =.099) with extraversion level. This was consistent with the widely held belief that extroverts feel a high amount of pleasure emotions in their daily lives (Costa and McCrae). Previous research has suggested that happiness, or more precisely, positive affect, lies at the core of the extraversion characteristic (Tellegen). However, the preceding findings clearly indicate that rather than positive affect (p > 0.05), extraversion forms a more robust and stronger connection with cognitive qualities in SWB (happiness), including life satisfaction and self-esteem (p < 0.05). This contradicts the prior belief among SWB and extroverts that positive affect is more closely associated with extraversion level.

Other than the extraversion degree, the present research discovered other elements that have a positive significant correlation with self-esteem and a negative significant correlation with negative affect. While a significant correlation between financial background and positive affect has not been shown, it's worth noting that a strong correlation occurs with negative affect but not with positive affect. It may appear strange because positive and negative affect are typically assumed to have an adverse correlation with other variables.

Conclusion

The conclusion that can be drawn from the aforementioned results is that more extroverted individuals may experience an overall higher level of SWB than less-extroverted people; however, this higher level of SWB does not refer to a higher level of positive affect, as is normally mentioned in the previous related study (Tellegen), but rather to cognitive components of SWB such as self-esteem, as shown in Table 5.

The aforementioned findings corresponded with previous research findings demonstrating a correlation between extraversion and both positive and negative affect, with a correlation coefficient of .095 for positive affect and -.099 for negative affect. This is consistent

with one of the study's aims, which is to investigate the positive association between extraversion and positive affect as well as the negative relationship between extraversion and negative affect. Another aim of this study was to investigate the significance of extraversion in comparison to other variables such as self-esteem, which, with the exception of affect, were strongly and significantly connected with happiness. When the correlation between extraversion, affect, and self-esteem is examined, the p-value in the extraversion-self-esteem link is smaller than 0.05 level, indicating that self-esteem has a stronger relationship than affect. Furthermore, the findings suggest that individuals' financial backgrounds have a significant correlation with negative affect and self-esteem (Fan et al.). However, interestingly, the correlation between positive affect is not statistically significant. This result indicates that, in addition to extraversion, other factors could have an important effect on one's level of happiness, which corresponds to the study's final aim.

Studies on the relationship between wealth and SWB found compelling evidence of a high correlation between log-transformed income and individual life appraisal (Diener et al.). People with higher incomes are more satisfied with their lives. Therefore, the life satisfaction level in their SWB tends to be higher. Using data from the Gallup-Healthways Well-Being Index, Kahneman and Deaton discovered that increased income continues to improve life appraisal even after reaching $120,000 in the United States. On the other hand, low-income individuals may experience a higher level of negative affect due to the accumulated pressure exerted by daily financial stress. However, income-life evaluation connections are weaker at higher income levels, indicating that marginal utility is falling. Material prosperity also has varying patterns of relationship with other aspects of well-being. Therefore, positive affect may not strongly correlate to financial background due to the nature of diminishing marginal utility.

Nonetheless, despite the worthy results observed in this study, sample bias exists. Because the participants invited to the study are all college students between the ages of 18 and 24, the sample is well-educated and in a similar age range. This limits the ability to generalize the current study because it may not apply to the general public. Furthermore, the restrictions of the sample population impair the internal and population validity of the study because the results are only confined to college students from the same area and maybe cannot fit into a setting of old people or individuals from diverse cultural backgrounds. Furthermore, the measurements of positive affect, negative affect, and self-esteem are mostly self-reported, which makes the results more subjective and reduces objectivity. Future research could add objective measures of SWB to their research, such as psychophysiological measurements (Lyubomirsky and Lepper), to investigate happiness levels in relation to extraversion. Researchers can also include samples from other cultural backgrounds, such as Asians, with varying educational levels, and of mixed ages. This allows researchers to further investigate how SWB may be affected by various factors. Furthermore, it is noteworthy to explore why life desire differs between extroverts and introverts, as well as how one's financial background is related to one's happiness level.

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Geologically based correlation of bedrock type and indoor radon levels in southeastern PA from 531,799 ^{222}Rn measurements between 1990-2022 By Brian M. Yang

Abstract

The objective of this study was to assess if there was a correlation between geologic bedrock type and indoor basement radon levels in five eastern Pennsylvania counties. This was a secondary data analysis of 531,799 "closed-house" indoor basement radon tests from 241 zip codes collected between 1990-2022 (Yang). Analysis of the data revealed that the average basement radon level for the 224 zip codes was 5.64 pCi/L; the median was 4.4 pCI/L. The highest recorded radon level in this study was 5,336.0 pCi/L in zip code, 18036. Lehigh County had the highest average radon level of 11.5 pCi/L. The radon zip code data was analyzed alongside the digital geologic map developed using bedrock data obtained from the PaGEODE website in order to determine the corresponding geologic rock type. The twelve predominant rock types assessed in this study were argillite, dolomite, gneiss, granitic gneiss, gravelly sand, limestone, mudstone, oligoclase, quartzite, quartz sand, sandstone, and shale. The rock type associated with the highest average basement radon level was shale, 15.6 pCi/L, followed by limestone, 8.6 pCi/L. The five highest average radon levels were associated with sedimentary rock: shale, limestone, dolomite, sandstone, and mudstone. There was a statistically significant difference in average radon level between sedimentary versus other rock types. The lowest average radon levels were found in the areas with the predominant rock types, quartz sand and gravelly sand. Analysis of these data points produced a geologically based indoor-radon potential map, which allows for detailed assessment of radon exposure risk as a public awareness tool.

Introduction

Lung cancer is the leading cause of cancer deaths worldwide; in 2020, there were 2.21 million new cases and 1.8 million deaths due to lung cancer (Sharma). Radon is the second leading cause of lung cancer and the leading cause of lung cancer in nonsmokers. (Urrutia-Pereira, Chatkin, Chong-Neto, & Solé). Notably, radon is the leading environmental cause of cancer mortality in the United States (Michigan Dep). Radon is recognized as one of 19 environmental carcinogens by the World Health Organization (WHO)[,] and recent studies have also suggested relationships between radon exposure and hematologic malignancies, dementias, and even brain tumors (Ngoc, Park, & Lee; Zhang et. al; Palmer, et. al,). Radon is a naturally occurring, odorless, tasteless gas that develops principally from the radioactive decay chain of uranium-238 (UNESCAR).

Radon gas migrates into buildings, where it can accumulate at potentially high levels. When inhaled, it deposits in the lungs and causes genetic mutations at the cellular level, thus leading to the development of lung cancer. Radon levels vary depending on multiple factors, including the geologic characteristics of the area. The state of Pennsylvania has some of the highest reported indoor radon levels in the world, with the highest known recorded radon measurement obtained recently in Southern Lehigh County (Lewis, Bleiler, Smith, & Allard).

This measurement was found in a housing development of 87 new homes, of which 19 had basement radon-222 (^{222}Rn) concentrations greater than 1000 pCi/L, including one home which is believed to have had the highest ever recorded result of 17,500 pCi/L. The United States Environmental Protection Agency (EPA) action level for ^{222}Rn is 4 pCi/L. To put these numbers into context, a radon level of 4 pCi/L is the equivalent of smoking 8 cigarettes/day or 200 chest x-rays per year. The highest recorded result of 17,500 pCi/L has the equivalent impact of smoking approximately 35,000 cigarettes/day. The authors cited "the unique geology and high ^{226}Ra soil concentrations" as the cause of these extraordinarily high radon levels (Lewis, Bleiler, Smith, & Allard).

Radon has been detected in all 67 Pennsylvania's counties (PA Assembly). While it is understood that radon comes from the decay of uranium and other radioactive heavy metal deposits, there is conflicting and limited information regarding which bedrock characteristics of Pennsylvania's unique geology give rise to the elevated radon measurements observed in the region. There is limited awareness and knowledge of the danger that radon poses in Pennsylvania as well, despite the fact that approximately 40% of homes in Pennsylvania have radon levels approximately five times to 25 times the recommended EPA action levels (Lee).

This study aims to expand understanding of how bedrock type may contribute to elevated indoor radon levels by assessing whether there is a correlation between bedrock type and elevated indoor radon measurements, in order to identify areas where elevated radon levels are likely to occur. Targeted testing and mitigation have been shown to be an effective public health strategy to reduce lung cancer rates (Ford et. al). This work could be applied to other areas with known geographic risk and provides actionable ways to identify areas at highest risk, thus, decrease the morbidity and mortality associated with radon-induced cancer.

Previous Work

In the United States, radon‑potential maps have been based on factors such as bedrock geology, soil, airborne radiometry, and housing stock data combined with indoor radon test results to produce a single radon hazard estimate for each county (Schumann). The relationship between different bedrock or sediment types and indoor-radon concentrations has also been examined in multiple other countries, including Norway, Great Britain and Russia (Smethurts et al.; Miles & Appleton, ; Zhukovsky et al.,). Most recently, the work described by Hahn et al., and Haneberg et al., is relevant to this research as these studies provided the geological and statisical basis for the current geologically based radon-potential map of these five Pennsylvania counties (Hahn et. al,; Haneberg, et. al,.)

Methods

Between 1990 and 2022, millions of indoor radon tests were performed in Pennsylvania by homeowners and the private radon industry. This data was compiled and made available to the public on the Pennsylvania Department of Environmental Protection (PA DEP) website. For this research project, five eastern Pennsylvania counties were selected. These counties were: Lehigh,

Northampton, Montgomery, Bucks and Philadelphia, comprising 224 zip codes and 531,799 radon tests. Radon measurements were analyzed by zip code and county. The average radon level for each of the 224 zip codes was calculated and then used to create a radon potential map, using a color-coded legend that corresponds to the following average indoor radon measurements: >4pCi/L, 4-8 pCi/L, 8-12 pCi/L, 12-16 pCi/L and >16pCi/L. Each zip code was colored according to the legend and this map was overlaid on a map of the five counties, thus approximating the zip code locations on the map and graphically demonstrating each zip code's "radon potential" based on its average radon level.

 Radon zip code data was matched to a publicly available digital geologic map, PaGEODE, to identify the predominant geologic rock type for these counties. The data was analyzed by county and zip code, as well as grouped by rock type. Zip codes that contained less than 30 test results were not evaluated in order to examine zip code data suitable for comparison. For illustration purposes, the color radon potential map was overlaid on top of an existing geologic map using Adobe Photoshop. Additional geologic factors such as soil type, proximity to mapped faults or proximity to sinkholes, or non-geologic factors, such as age of home, home construction type, season of testing, were not assessed during the development of the radon potential map of the five Pennsylvania counties, although these factors may affect radon concentration and exposure levels (U. S. Environmental Protection Agency).

Results

 This study's indoor radon potential map of five eastern PA counties is based on 531,799 radon test kit results collected between 1990 and 2022 and provided by homeowners and radon companies and listed on the PA DEP website. Table 1 outlines the number of radon tests by county and average radon level for that county. Lehigh County had the greatest number of indoor radon test data available, 77,948 tests, and highest average radon level of the five counties analyzed. Lehigh and Northampton Counties had average radon levels significantly higher than the EPA action level of 4 pCi/L. It should also be noted that four of the five counties had average radon levels above the EPA action level of 4 pCi/L. The significantly elevated levels observed in Lehigh and Northampton Counties can be explained by their proximity to geologic formations such as the Reading Prong.

Table 1: Radon Tests and Average Radon Level (pCi/L) by County in Pennsylvania

County	# Tests	Average radon level (pCi/L)
Lehigh	77,948	11.5
Northampton	52,582	10.0
Bucks	136,384	5.5
Montgomery	203,195	4.5
Philadelphia	61,470	2.2
Total	531,799	

 Utilizing the available indoor radon measurement tests for the five counties, a radon potential map was developed, which allows visual depiction of radon potential by zip code and

county. This map was developed using average radon levels by zip code, thus allowing for detailed analysis of the pattern and location of radon potential. The visual representation of radon potential highlights the pattern of potential radon exposure based on geology. The large data set (n=531,799) allowed for characterization of radon variability that may occur with different testing parameters and setting. Zip code indoor radon measurement data were grouped by average radon level into five categories: <4 pCi/L, 4-8 pCi/L, 8-12 pCi/L, 12-16 pCi/L and >16 pCi/L.

Average radon levels were mapped by zip code onto the map of the five Pennsylvania counties and highlighted the radon potential in Lehigh, Northampton, Montgomery, Philadelphia, and Bucks Counties. This map is a visual representation of the radon risk potential, which correlates with the known geologic factors that give rise to radon emission. The zip codes with the highest radon potential were largely in Lehigh and Northampton Counties. These two counties are geologically similar, and their unique geology gave rise to average indoor radon levels that exceeded 16 pCi/L.

Figure 2 is a Geologic Map of Pennsylvania, Bureau of Topographic and Geologic Survey, 2007. This figure was included to highlight the proximity of Lehigh and Northampton County to the Reading Prong and provide a visual depiction of the predominant rock type found in these counties. This map depicts the predominant rock type in Lehigh and Northampton Counties, Ordovician sedimentary rock, which typically occurs only in the subsurface of northern and western Pennsylvania.
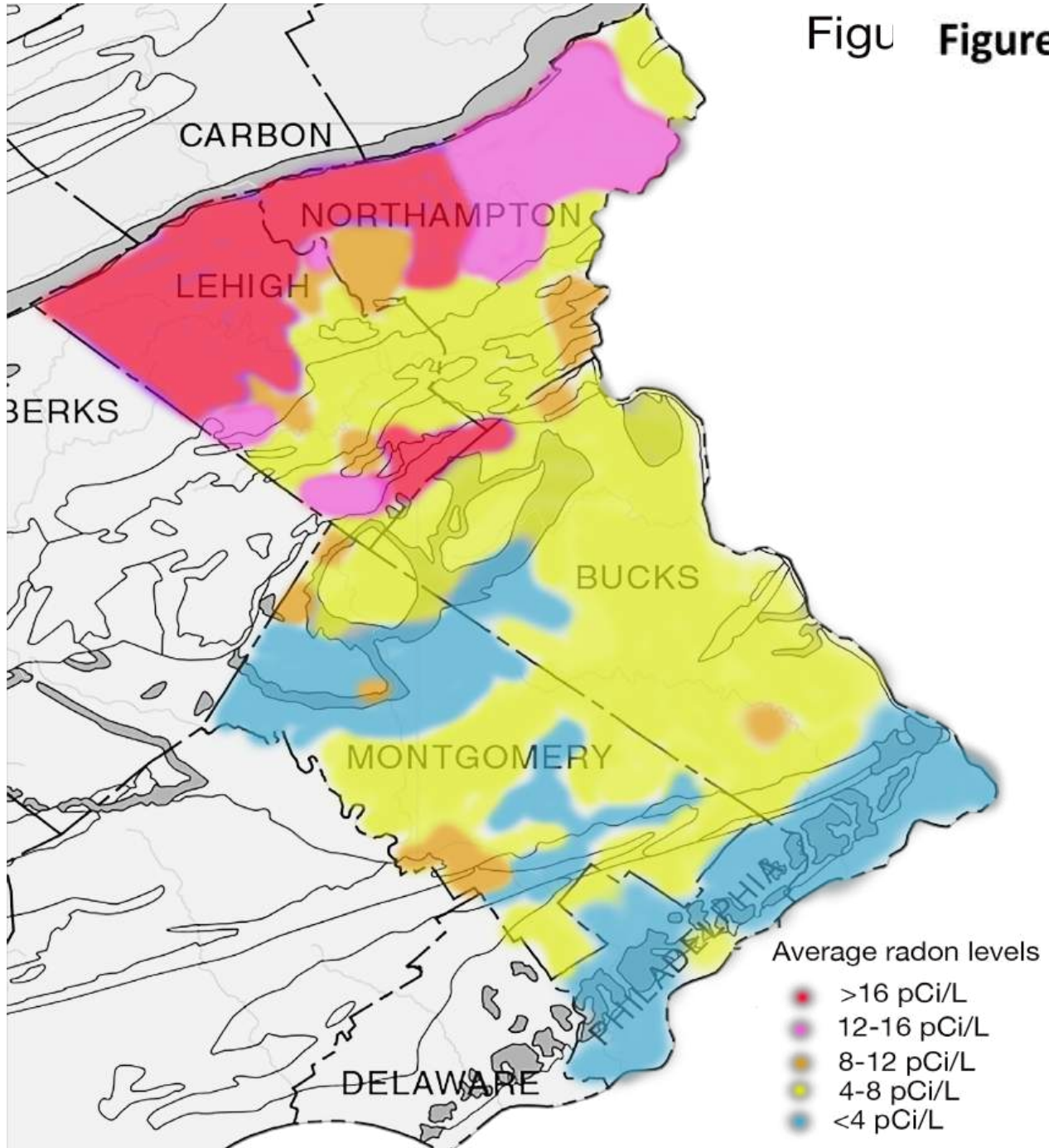
Figure 1: Indoor Radon Potential Map for Lehigh, Northampton, Bucks, Montgomery, and Philadelphia Counties
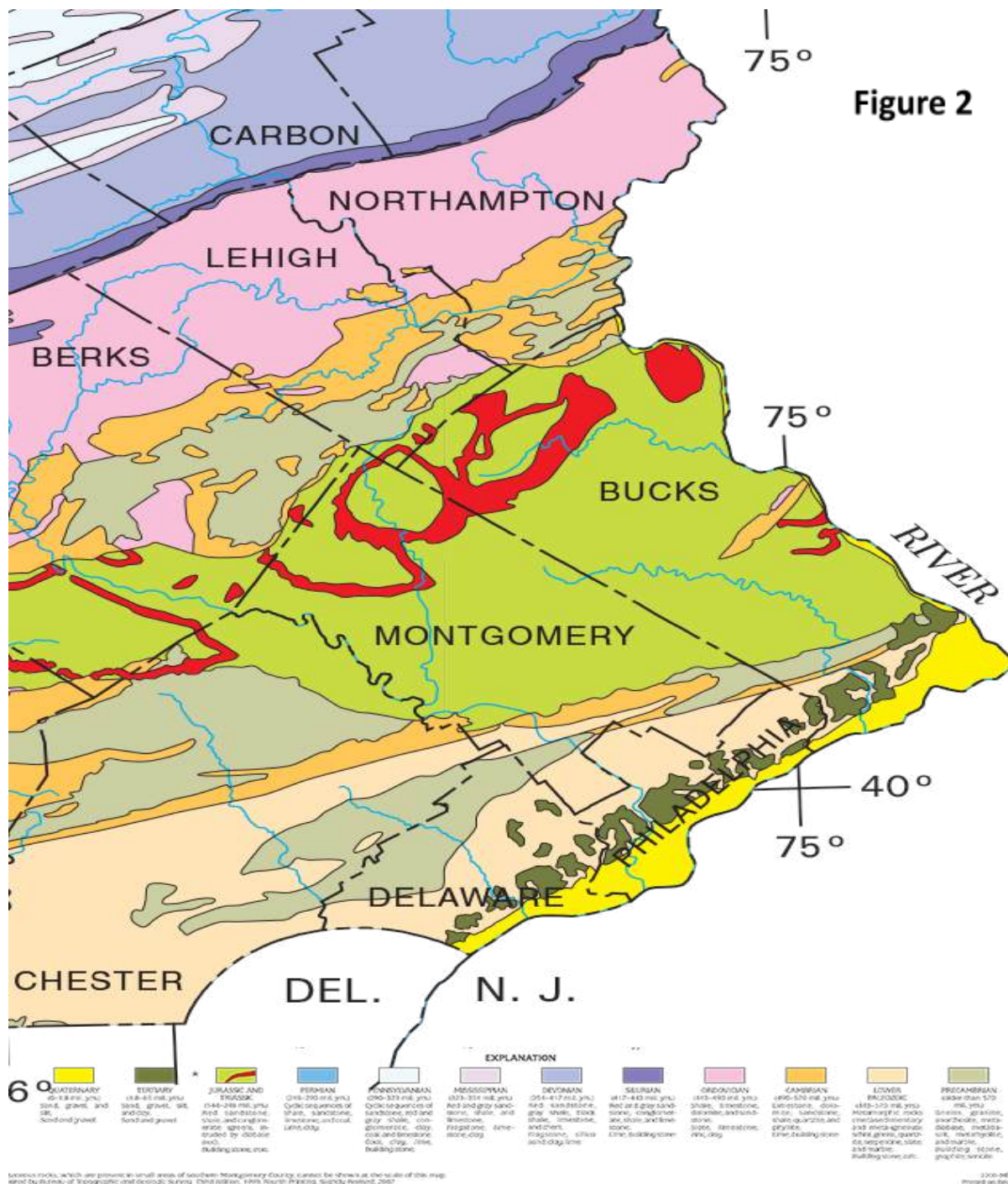
Figure 2: Predominant Geologic Formations found in Lehigh, Northampton, Bucks, Montgomery, and Philadelphia Counties Geologic Map of Pennsylvania, Bureau of Topographic and Geologic Survey: Third Edition, 1990; Fourth Printing, Slightly Revised, 2007

Twelve predominant bedrock types were assessed using the PaGEODE digital geologic map: argilite, dolomite, gneiss, granitic gneiss, gravelly sand, limestone, mudstone, oligoclase, quartzite, quartz sand, sandstone, and shale. Measured indoor radon data were analyzed by

predominant rock type and average radon level by zip code and county. The rock types associated with the highest measured indoor radon levels were sedimentary, of which shale was associated with the highest average indoor radon measurement, 15.6 pCi/L. (See Table 2). The five highest average radon levels were associated with sedimentary rock; shale, limestone, dolomite, sandstone and mudstone. The lowest average radon levels were found in the areas that had quartz and gravelly sand. The average measured radon levels associated with the sedimentary rock type, shale, was significantly higher compared to other rock types.

Table 2: Predominant Rock type Correlated with Radon Levels (pCi/L)

Rock type	# of tests	Max radon level (pCi/L)	Average radon (pCi/L)
Shale	28894	848.1	15.6
Limestone	29695	949.0	8.6
Dolomite	82586	1440.4	6.7
Sandstone	66853	803.2	5.9
Gneiss	16757	1286.2	5.6
Mudstone	78697	5336.0	5.5
Quartzite	19588	529.2	5.5
Argilite	80682	1000.0	4.8
Granitic Gneiss	10701	87.5	3.4
Oligoclass	59858	315.5	3.3
Gravelly sand	26038	847.6	2.3
Quartz Sand	25469	341.4	2.3

Discussion

More than 238,340 new cases of lung cancer and almost 130,000 deaths from lung cancer occur in the United States each year (American Lung Association, 2023). It is estimated that radon contributes to approximately 21,000 deaths from lung cancer each year. In addition, recent studies suggest a positive correlation between radon exposure and other cancer types as well as dementia. Despite the hazard that radon poses, people are frequently unaware of the environmental risk radon poses, which is compounded in populations who are also exposed to tobacco smoke. Radon testing and mitigation requirements vary from state to state, and there are limits to resources available to test and mitigate. Thus, targeted testing and mitigation through improved understanding of the highest risk areas is an effective way to use limited resources.

The results of the study demonstrate that the predominant bedrock type plays a significant role in the level of radon gas that could accumulate in buildings. Areas where the predominant bedrock was the sedimentary rock, shale, had an average radon level almost four times the EPA action level and, in general, sedimentary rocks such as limestone, dolomite and sandstone were the predominant bedrock type in areas that had radon levels higher than EPA action level of 4 pCi/L. These findings help to further clarify the connection between high radon levels and sedimentary rock such as shale. This project will also help communities determine where potentially high radon levels are just by looking at a geologic map.

This study also demonstrates the interplay between geologic factors which give rise to potentially dangerous accumulation of indoor radon gas. Radon arises principally from uranium and emanation of radon can be impacted by geologic factors; the proportion of clay, which can impede the migration of fluids and gases, and the presence of other rocks, such as limestone, which may facilitate fluid and gas migration.

In the Lehigh Valley, it has been theorized that some areas of the Reading Prong give rise to a "perfect geologic storm," where high levels of uranium within the Reading Prong may have closer access to the surface because of thinner layers of overlying sedimentary rock which have been thrust over it (Lewis et al., 2022). Knowing the geology and bedrock type will help predict indoor radon potential with high accuracy. There are different levels of measured indoor radon in the five PA counties examined in this study. Lehigh and Northampton Counties have the highest levels of measured indoor radon. Geologic maps which identify predominant rock types in these five counties provide visual confirmation that the areas associated with the highest radon levels are associated with sedimentary rocks. Furthermore, the Lehigh Valley possesses unique geology, not in just the bedrock, but in other geologic features as well, such as sinkholes and fault lines. An improved understanding of how these geologic features may be related is an area of possible further exploration.

This study's radon potential map is novel for several reasons. This map is based on numerous indoor radon test results (n = 531,799), reducing variability and provides the ability to correlate radon results with geologic results, producing radon-predictive information that may be applied to other areas where the bedrock geology is known. Understanding where the hazard is greatest can direct limited resources for testing and mitigation. Additionally, this type of map has not been created specifically for the state of Pennsylvania or the Lehigh Valley, an area with some of the highest radon levels in the world.

Radon exposure has been associated with not just lung cancer, but also has been associated with the development of brain and breast cancer, as well as leukemia and lymphomas. Children and pets are known to be affected by radon exposure disproportionately compared to adults due to their faster respiration rates. In addition, children are known to be more radiosensitive to radiation as they are still growing. Radon and smoking have a synergistic effect on the development of lung cancer as well. These factors have particular significance in Pennsylvania due to the high percentage of smokers here. Unfortunately, legislation to support testing in schools, daycares and rental building has not yet been implemented in the state of Pennsylvania. With this map, legislators may be able to identify schools, daycares and rental properties that may be at risk, and direct resources in a targeted manner, thereby saving time and resources as well as potentially saving lives in the areas with the highest radon levels.

Conclusion

The highest average level of radon was found in Lehigh County. From 531,799 individual radon tests found in 224 zip codes, this study found that the highest average radon level was predominantly associated with the presence of shale rock. Overall, sedimentary rock was

associated with higher levels of radon, which also has been observed in other studies. Creating a geologically based indoor-radon potential map allows for better future risk assessment. Pennsylvania's high levels of radon require further assessment/ monitoring of radon levels to reduce cancer risk to the population and ultimately save lives.

Future implications

Future areas of study include novel and more effective ways for buildings to disperse radon in order to address the costs of mitigation. A future possible study would be to expand this study to include all the zip codes in Pennsylvania for a comprehensive analysis of Pennsylvania, its bedrock geology and other related geologic features. This investigation could include a study of fault lines and sinkholes, which could clarify the impact of these geologic hazards on radon levels. And finally, another possible benefit of this work would be improving radon awareness among the general population and in particular local state representatives who have the ability to enact laws for more comprehensive radon testing and mitigation. For example, an amended bill is up for review in the PA state house, SB339, which would require radon assessment/mitigation in daycares and schools. Understanding this pervasive hazard is related to the presence of specific bedrock, which would allow for targeted testing and mitigation, may persuade lawmakers to support this legislation.

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Simulations on the Impact of Aircraft Design on Flight Efficiency by Aryan Chowdhury

Abstract

Due to pressure to reduce carbon emissions produced by the aviation sector, it is now crucial to better understand and evaluate the performance of turbo engines before they are physically built. Simulation is a helpful tool for that. Here, simulation using the SUAVE package was used to evaluate the effect that the bypass ratio of an engine, a key parameter for classifying a turbofan, has on the power and fuel efficiency of flying. A bypass ratio of 8-9 was identified as the optimal value from a fuel consumption standpoint, which is consistent with the ratio used in commercial B737-MAX airplanes.

Keywords:

Aviation, fuel consumption, efficiency, emissions, bypass ratio

Introduction

Aircraft are now capable of transporting passengers to the opposite side of the globe daily, without having to stop for refueling. These planes emit large amounts of carbon and are estimated to contribute to around 3% of the world's carbon emissions.(Sgouridis et al.) Because emissions are roughly linked to the amount of fuel used, researchers are interested in better understanding the relationship between an aircraft's total fuel consumption and its design and characteristics.(Brueckner and Abreu)

This is further aggravated by international pressure to reduce carbon emissions produced by aircraft, such as the new EU fuel efficiency standard which will take effect in 2028.(Mouawad and Davenport) In fact, between 1960 and 2019, the average block fuel intensity of new aircraft witnessed a remarkable decline of 41%, equivalent to a compound annual reduction rate of 1.0%. Notably, during the 1980s, the block fuel intensity dropped at an average rate of 2.8% annually. This was followed by two subsequent decades with more modest improvements, averaging less than a 1% reduction each year.(Zheng and Rutherford) This paper presents how these trends are linked to a better design of aircraft.

The average fuel consumption of newly introduced aircraft experienced a significant decrease in the early 1970s, followed by a rebound until 1980. This initial reduction can be attributed mainly to the introduction of modern widebody planes, specifically the Boeing 747 series, which began in 1969. The Boeing 747-100 model alone constituted almost 40% of all aircraft delivered in 1970. This aircraft's fuel efficiency was driven by its high bypass turbofan engines and substantial payload capacity, establishing it as a leader during that era. Bypass ratio (BPR) is the rate between the engine fan airflow and the engine core airflow mass.(Barbosa) However, the decline in fuel consumption slowed down in the late 1970s as the market share of the 747 dwindled and stabilized at around 10%. The fluctuation in average fuel consumption during the earlier years was also influenced by the limited variety of aircraft available in the market. The 1980s witnessed a rapid reduction in aircraft fuel consumption, with an average annual decrease of 2.7% according to block fuel intensity measurements. This further

improvement was attributed to the introduction of more fuel-efficient narrowbody and small widebody aircraft like the Boeing 757 and 767 families, along with the Airbus A320 family, which utilized high BPR engines. However, the decrease in fuel consumption slowed down during the 1990s and 2000s. This period of stagnation coincided with the continued use of older narrowbody and widebody aircraft introduced in the 1980s and 1990s, such as the Boeing 737 Next Generation, Airbus A320, Boeing 777, and Airbus A330, and the introduction of relatively fewer new aircraft models and engines. The pace of fuel consumption reduction picked up again around 2010, ranging from 1% to 1.5% per year, depending on the measurement method. A comprehensive assessment of technology indicated that the rate of fuel efficiency enhancement in new aircraft could potentially be increased to 2.2% annually until 2034 through the adoption of cost-effective technologies. This trend of improving fuel efficiency continued until 2019 due to the introduction of new, more fuel-efficient aircraft models. Notably, "Clean Sheet" widebody planes like Boeing's 787 in 2010 and Airbus's A350-900 in 2015, as well as upgraded narrowbody jets like the A320neo in 2016 and 737 MAX in 2017, contributed to these improvements. A clean sheet design comes into play when it is no longer possible to get meaningful improvements by modifying existing designs or when an aircraft is needed to serve markets in different ways than is possible with existing or derivative designs.(Kharina and Rutherford) Additionally, newer aircraft models like Comac's ARJ 21 and Embraer's E-Jet E2 were recently introduced. These enhancements at the aircraft level have translated into improved overall airline fuel efficiency in recent times and BPR has been a key contributor to these improvements.

It is crucial to understand and evaluate behavior, performance, safety, and other aspects of the systems before and after they are physically available for testing. Simulation models are used to gain knowledge in order to make decisions at all development stages.(Steinkellner) In this paper, simulation is used to understand how changing BPR, a key parameter linked to the large historical improvements in fuel efficiency, affects some key parameters related to the performance and fuel efficiency of aircraft.

Materials and Methods

Simulation was used to understand the impact that different parameters within an aircraft have on efficiency. This is key to driving better design for more efficient flight travel. SUAVE is used because conceptual aircraft design platforms offer a range of analysis and optimization tools for various aircraft setups. It seamlessly integrates multiple software, enabling the use of both empirical correlations and physics-based methods to perform multi-fidelity analyses. The system operates based on a predefined mission, which comprises different mission segments like takeoff, climb, cruise, descent, and landing.(Nicolay et al.)

We made a table to identify which parameters of an aircraft were most crucial in determining aircraft performance.

Table 1 - List of variable parameters from the SUAVE package.

Parameters that can be studied using SUAVE software

Vehicle
    - Max takeoff (mass at which to start the flight)
    - Mass passengers

Wing
    - Aspect ratio
    - Thickness
    - Area
    - Span
Flaps, slats, and ailerons
    - Span
    - Angle of deflection
Landing gear
    - Diameter of wheel
    - Number of wheels

Fuselage
    - Nose and tail lengths
    - Width and diameter
    - Height at different parts of aircraft
Turbofan
    - Number of engines
    - Engine diameter
    - Bypass ratio - this is the one simulated from 2 to 15, in steps of 1

A key parameter for classifying the turbofan is its bypass ratio, defined as the ratio of the mass flow rate of the bypass stream to the mass flow rate entering the core. Since the highest propulsion efficiencies are obtained by the engines with the highest bypass ratios, one would expect to find all engines of that design in this flight speed regime. (Some of the variation derives from historical evolution.) In actuality, however, one finds engines with a broad spectrum of bypass ratios, including medium-bypass engines (with bypass ratios from 2 to 4), high-bypass engines (with bypass ratios from 5 to 8), and ultrahigh-bypass engines, so-called UBEs (with bypass ratios from 9 to 15 or higher).(Baxter and Ehrich)

We simulated the aircraft performance of a Boeing 737-800 on a 400-minute flight by increasing the bypass ratios from 2.0 to 15.0 with increments of 1.0. All other parameters were kept the same as shown in the SUAVE demo notebook.(Wendorff) The variables were measured

200 minutes into each flight. We then measured the resulting throttle, thrust in newtons, lift coefficient (CL), drag coefficient (CD), weight in pounds, and specific fuel consumption (Sfc) in pounds per pound force hours of the flight to see which bypass ratio led to the best performance. The decision to change the bypass ratio was an arbitrary choice as we believed that this would have the greatest effect on the performance of the aircraft

Results and Discussion
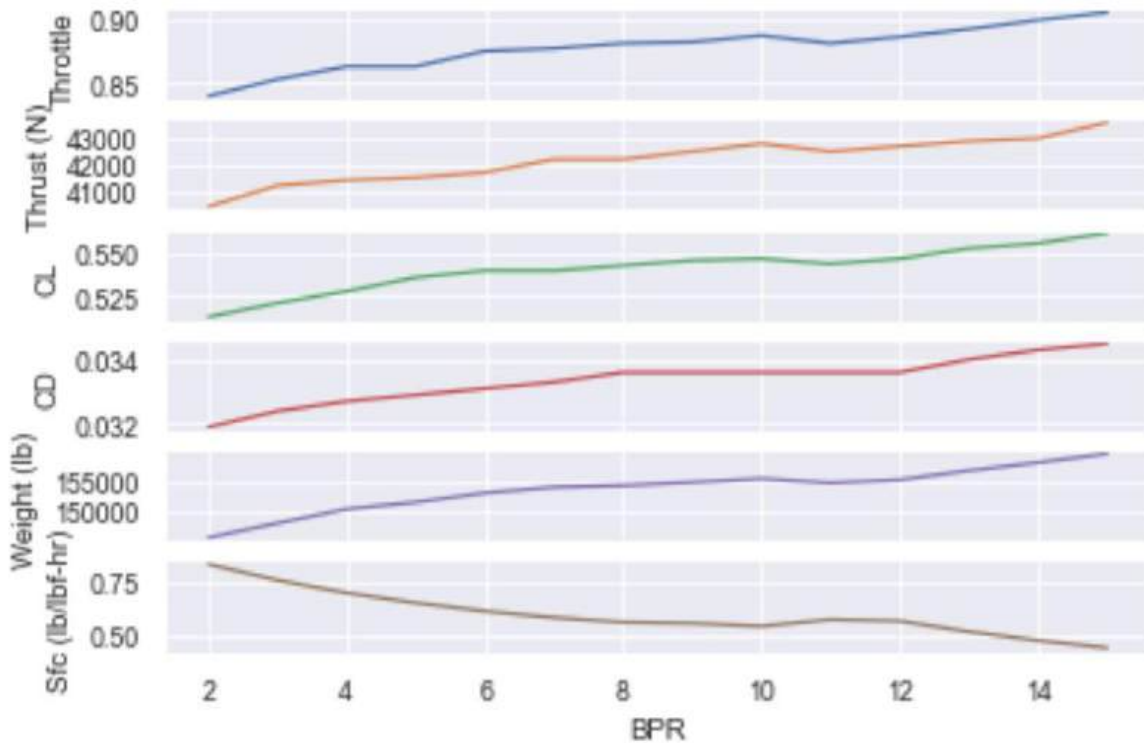
Figure 1 - The effect of increasing bypass ratio (BPR) on different simulated parameters: throttle, thrust, drag coefficient (CL, CD), weight, and fuel consumption (SFC).

In this section, the effect of increasing bypass ratio (BPR) on different simulated parameters is presented, in particular, we focused on the following parameters: Throttle and thrust, where the key difference is that thrust is the force the engines are creating while throttle is the amount of fuel-air mixture that can enter the engine. Drag, which is the force the aircraft faces as it travels through the air can be both in the lift (CL) and in the drag (CD). Finally, the effect of BPR on both the weight and the specific fuel consumption (SFC) per unit of power output is also presented, both key parameters linked to fuel efficiency.(Dankanich and Peters) Simulation using the SUAVE package resulted in Figure 1, which indicates the trends in how these parameters change as the BPR increases. Throttle, thrust, CD, CL, and weight increase as BPR increases at 200 minutes into the flight. The throttle increased from 0.840 to 0.905, the thrust from 4.04E+04N to 4.36E+04N, the CL from 0.513 to 0.562, the CD from 0.032 to 0.035, the weight from 1.46E+05 lbs to 1.59E+05 lbs. However, the Sfc decreased from 0.835

lb/lbf-hr to 0.437 lb/lbf-hr. The increases and decreases are non-linear as shown in the graph. They are more pronounced as the BPR goes from 2.0 to 10.0 but then slows down up to 15.0. BPR 11.0 to 12.0 does not follow the trend which may be attributed to a simulation artifact, however, these simulations were repeated 3 times and the average value was taken.

These trends can be interpreted by understanding how each parameter is linked to the physics of turbo engines.(Dankanich and Peters) Thrust, the force engines are creating, is linked to the throttle. Since throttle is linked to the amount of fuel or the fuel-air mixture that can enter the engine, the higher the BPR the higher both throttle and thrust are. Higher BPRs require bigger engines that rotate faster, resulting in larger lift and drag coefficients, consistent with Figure 1.(Stankowski et al.) Due to the larger engines required with higher BPRs, the specific fuel consumption (SFC) decreases as mass flow has to be increased to keep mass flow constant for the larger engines.(Dankanich and Peters) Finally, the increase in weight for higher BPRs may be attributed to both the need for bigger engines and for more fuel at the given flight time (after 200 min of flight) for the BPR where the engines burned at lower fuel consumption.

Based on this analysis a BPR of 8-9 seems optimal from a fuel consumption standpoint. In fact, the most commercially available plane, the B737-MAX, has a BPR of 9, which is consistent with this study.(Langston) The B737-MAX was designed to be a more fuel-efficient version of the B737-800 that we used to simulate the aircraft's performance. This paper shows the importance of simulation during aircraft and engine design. Simulations are less time and capital-intensive than setting up prototypes, which helps speed up new technology developments, to for instance further reduce emissions. Note these results are limited as these simulations were made on a narrowbody plane, the B737, and optimal values for BPR may vary for widebody planes. This should be the subject of further studies.

Conclusion

This study has shown how simulation can help understand and evaluate behavior, performance, safety, and other aspects of aircraft before they are physically built and available for testing. BPR has been identified as a key parameter for classifying the turbofan engine, defined as the ratio of the mass flow rate of the bypass stream to the mass flow rate entering the core. The SUAVE package enabled the simulation of how key parameters like throttle, thrust, drag, weight, and fuel efficiency change as the BPR increases. Based on this analysis, a BPR of 8-9 was identified as optimal from a fuel consumption standpoint. Simulations are less time and capital-intensive than setting up prototypes, which helps speed up new technology developments, to for instance further reduce emissions.

Acknowledgments

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From Calhoun to Cicero: Breaking the Southern Link to Roman Slavery
By Matthew A. Bowers

When Eli Whitney invented the cotton gin to accelerate the production of cotton fabric in 1793, the Antebellum American South converted into a cotton empire, rehabilitating the institution of slavery and initiating a mass influx of slaves into the Deep South states. As slavery strengthened, so did anti-slavery sentiment: In 1831, William Lloyd Garrison published The Liberator in Massachusetts and Nat Turner led an unsuccessful slave rebellion in Virginia. Faced with Northern opposition and paranoia surrounding Turner's slave uprising, Southerners realized they needed to defend and justify slavery to ensure its survival. They argued slavery represented a positive good, citing the Bible, economic benefit, and White Man's Burden. Many, such as John C. Calhoun, also invoked classical history and formulated an argument that spoke to the classical upbringing of every educated person in America at that time: slavery permeated the Greek and Roman world. (Ochs).

Although Roman and American slavery shared some similarities, Calhoun's justification of American slavery by reference to Rome represents a misuse of classical references, institutions, and texts because Roman and American slavery differed regarding (1) the role of race, (2) the extent and rate of manumission, (3) the effect that slavery had on the enslaved and enslaver, and (4) the brutality endured by slaves. This paper will examine these differences through the writings of Cicero and Frederick Douglass on slavery and compare those texts with John C. Calhoun's justification of slavery on behalf of the American South to demonstrate Calhoun's misuse of the Roman slavery example. Cicero's work should have had a considerable influence on Southern thinking regarding Roman slavery because his writings were prominently known and would have represented the period of Roman history that would first come to early Americans' minds (i.e., First Century BCE).

As an initial matter, some clarifications regarding slavery in both America and Rome are necessary. Slavery was not a uniform practice across boundaries and across time in the evolution of the Roman Empire (Bradley). As Rome expanded from a few huts to a massive empire, Romans added more slaves when conquering more territories over time. Similarly, slaves were more prevalent in Roman Italy than in Roman Egypt even as the empire expanded (Bradley), while the treatment of slaves by their masters also varied from place to place and person to person in both America and Rome. Nonetheless, slavery existed throughout the Roman Empire and the American South, and the existence of such slavery in the Roman Empire represented a historical reference point for the Southern defense of slavery that, as argued below, was misplaced.

John C. Calhoun, a senator and slave owner from South Carolina, was the leading voice in the Southern defense of slavery, and he referenced the Greeks and Romans as specific examples of how society benefits from a slave underclass. He argued in "Slavery as a Positive Good" that "there never has yet existed a wealthy and civilized society in which one portion of the community did not, in point of fact, live on the labor of the other" (Calhoun). Other

southerners also looked to the experience of ancient empires with slavery, citing slave systems as the catalyst for not just economic, but also cultural growth as well. Southerners such as Calhoun saw Roman slavery as the engine of good that allowed members of the elite such as Virgil to produce their influential and cultural works that still influence us and our republic to this day (Blight). Calhoun saw as a law of nature that one people exploited the labor of others and traced these systems of labor exploitation through history from the Greeks and Romans, through the Middle Ages, to the Antebellum North and South. So convinced was he of this natural law that he believed "to destroy [slavery] would be to destroy [America] as a people" (Calhoun). Calhoun drew his own comparison between ancient slavery and modern American slavery by characterizing ancient slavery as "brute force and gross superstition" and modern slavery as "subtle and artful fiscal contrivances" (Calhoun). He even went as far to claim slavery was beneficial to the slave. Building on Aristotle's view in his Politics that there is a "natural ruler" and "natural subject" (Aristotle), many southerners applied this concept to the whole African race, claiming that Africans were scientifically inferior to whites (ushistory.org). Commenting on the civilizing nature of slavery, Calhoun declares that "never before has the black race of Central Africa, from the dawn of history to the present day, attained a condition so civilized and so improved, not only physically, but morally and intellectually" (Calhoun). Classical references thus infuse Calhoun's claims and defenses of slavery in the South.

By employing classical references in his argument, Calhoun hoped to convince not just Northerners of slavery as a positive good but also other Southerners. Every educated man in America in the 1800's, North and South, would have benefitted from a classical education and could look to the ancient Greeks and Romans with veneration and acknowledge their influence. Thus, references and re-interpretations of Roman history would have spoken to an educated audience. With visions of great Roman architecture, history, and writings, a Northern audience that appreciated these references might appreciate the perceived necessity of slavery to establish a great power like the Romans. They might also believe that Roman slavery was more brutal and more easily accept Calhoun's argument that southern chattel slavery was not merely continuation but an improvement of the natural slave condition. For the Southern audience, the comparison would comfort them and ease their minds as worries regarding the morality of slavery would succumb to thoughts of American brilliance and growing might.

But the words and experiences of Frederick Douglass, a former slave who wrote about his life in slavery, provides a more accurate depiction of slavery in the American South than Calhoun's. In his autobiography, Narrative of the Life of Frederick Douglass: An American slave, Douglass comments on the brutality that he witnessed towards slaves: "I have often been awakened at the dawn of day by the most heart-rending shrieks of an own aunt of mine, whom he used to tie up to a joist, and whip upon her naked back till she was literally covered with blood" (Douglass 6). Calhoun references the "brute force" of ancient slavery, using it to justify the American South's own abuse of their slaves by making it seem less harsh. Douglass dispels this notion. Douglass also countered Calhoun's argument that slavery was beneficial for slaves because it civilized them. When he learned to read, he understood that barring the education of

African slaves is "the white man's power to enslave a black man" (Douglass 33). By keeping important aspects of education and Western society from slaves to keep them submissive, slave owners never did "civilize" their slaves like Calhoun claimed they did. Douglass, however, takes it a step further to argue that there are "brutalizing effects of slavery upon both slave and slave owner" (Douglass 45). Here, he comments on the moral decay that slavery had on the slave owner as they abuse their power over their slaves, a common occurrence in the South.

With help from Douglass's more accurate perspective invalidating Calhoun's claims regarding slavery in the Antebellum South, classical evidence further proves Calhoun's misuse of the Roman example given the critical key differences between the two institutions. First, unlike in America, slavery in Rome was far more diverse and not rooted in a specific, identified racial class. People in Ancient Rome were enslaved in many different manners, ranging from enslavement because of debts or crimes to being born into a slave family (British Museum). The most common form of enslavement resulted from taking hostage conquered peoples across the Empire as an initial tribute to the Romans. Caesar references enslavement of conquered peoples in his Commentarii de Bello Gallico when the defeated Britons "promise to give hostages" (Caesar 4.26). While there were no racial categories of slaves as even Romans could end up enslaved for debts or crimes until it was abolished in 326 BCE (Livius 8.28), some form of racism and xenophobia was admittedly common towards conquered peoples that the Romans considered "uncivilized." These racist and ethnic sentiments heightened the Romans' perceived intellectual, cultural, and physical superiority, and in fact, slave traders had to disclose the origins of those slaves that they were selling, indicating that the Romans applied crude stereotypes in other peoples (British Museum). For example, when writing to Atticus about Caesar's conquest of Britannia, Cicero implies that Atticus should not buy a British slave because "[he] do[esn]'t suppose [one] can expect any instructed in literature or music" (Cicero 4.16.17). This quote from Cicero demonstrates both the practice of taking conquered peoples as slaves and the Romans' assumed superiority over "barbaric" peoples. Cicero's opinion on the inferiority of conquered slaves of another nation lines up somewhat with Calhoun's view of black slaves. Nonetheless, slavery did not rest on the foundation of the belief in a superior race based on a particular race or color of one's skin like it did in America where even freed African Americans faced the same racial challenges endured by enslaved African Americans. Given that the point of slavery in the Antebellum South was both economic and to suppress a defined population that shared the same skin and origins while Roman slavery lacked any racial roots and was far more dispersed, Calhoun could not legitimately use the Romans as a justifiable example for a race-based slavery.

Second, Calhoun overlooks the wide differences in extent to which freedom could be obtained in both societies. In the American South, African slaves faced two options: hope their master will grant them manumission or flee the plantation entirely like Frederick Douglass did. These choices left slaves with little hope of freedom, and they quickly realized that absent some unlikely event, they were guaranteed to spend their lives in slavery focusing on the needs and work of their masters. State laws such as blanket bans on manumission in Louisiana, Maryland, Arkansas Alabama, and Mississippi further made the legal process of freeing a slave difficult, if

not impossible (Klebaner 1). There existed some cases where slaves were allowed to purchase their freedom; however, as in the case of many slaves such as Josiah Henson, this process was fraught with fraud as owners attempted to swindle the slaves out of their money or claim the price for freedom to be higher (Brock). By contrast, manumission was more common and appears to have been considered honorable in the Roman world. Manumission by a Roman master included three official methods: inclusion in the census, a lawsuit, or as a provision in their master's will (British Museum). For example, Cicero freed his slave Marcus Tullius Tiro, who had helped Cicero with his literary works, because of his fondness for and friendship with him (Giannella). Cicero's brother Quintus, in writing to Cicero on the topic of Tiro's freedom, expresses his admiration for Tiro's manumission: "I am delighted about Tiro…Believe me when I read your letter and his I jumped for joy" (Cicero Epistulae ad Familiares 16.16). While it is important to keep in mind that Tiro's situation did not reflect the experiences of domestic and agricultural slaves who rarely achieved manumission in Roman times, Quintus's letter shows how the Romans broadly appeared to honor and respect the manumission of slaves. Calhoun ignores this Roman view on slavery, which would have been unheard of in the American South, and he instead pursues the interpretation of classical material to fit his own purposes.

Third, while Calhoun and other Southerners looked at the effects of slavery as a "positive good" for both the enslaved and the slave owner, Cicero and other Romans understood the one-sidedness of slavery as benefiting the master. While Aristotle had argued for natural slaves, the existence and accessibility of manumission in the Roman empire inherently suggests that slavery is an undesirable and unnatural situation (Bradley), differing from Calhoun's view that slavery helps both the slave and the slave owner. Thus, one can reasonably assume the Romans understood that only the owner benefitted economically from slavery; Romans, however, did not appear to accept Douglass's view and admit the negative effects on the slave owner. Cicero and Quintus demonstrate this position when Quintus writes regarding Tiro's manumission: "He was much too good for his position and I am truly glad that you preferred that he should be our freedman and friend rather than our slave" (Cicero Epistulae ad Familiares 16.16). The Cicero brothers' view of slavery in the context of Tiro shows how they believed some people deserved slavery while others did not, suggesting neutrality on the basic morality of slavery. In the case of Tiro, Cicero believed he was too skilled and valuable to remain in slavery, and while his view acknowledges Aristotle's position that some people must inherently be slaves, his actions evidence that slavery is an undesirable position that does not benefit the slave. As Calhoun attempted to argue slavery as a benefit economically to the master and intellectually to the slave, Cicero's apparent view that slavery benefits only the master counteracts Calhoun's use of the Roman example.

Fourth, as Douglass counters Calhoun's claim that American slavery was not brutal toward the slave, Cicero's views on virtue and Roman law illustrate an opposing Roman viewpoint on the treatment of slaves. One of the key Roman Imperial Virtues was clementia or mercy (Dubit). Just as Anchises told Aeneas that the Romans must "spare humbled foe, and crush to earth the proud" (Vergil 6.852-853), Cicero calls Romans to "behave justly even towards

the lowest kinds of people… insist that they do their work, but grant them what is just" (Cicero De Officiis 41). Cicero's adherence to Roman virtues such as mercy and care for his slaves stands in stark contrast to the Southern practice that Douglass spells out in his autobiography. Whether Cicero's views always presented themselves in practice or not, Roman law supported his admonition to his fellow Romans that "torture against slaves should be employed as the last resort" if accused of a crime (Ulpianus 8). This counters Calhoun's claim that ancient slavery was "brute" in comparison to Southern slavery, and Roman law and views of Cicero prove that in theory, Roman institutions and virtue encouraged slaveholders to be less harsh to their slaves. Harkening back to Frederick Douglass's accounts of slave life to provide a realistic view into the life of Southern slaves, the example of Cicero and Roman law breaks the bond created by John C. Calhoun between Antebellum Southern Chattel Slavery and Ancient Roman Slavery. Given that Cicero wrote for Roman slave owners to practice their Roman virtues of clementia on their slaves (which Cicero himself practiced on his own slave Tiro) and Roman law encouraged mercy, Calhoun warps the Roman tradition to cover up the institution that oppressed Frederick Douglass. John C. Calhoun misused the Roman example to continue the abuse of enslaved African Americans like Frederick Douglass and invented the concept that to be a great society like the Romans, slavery was a necessity in America.

The misuse of the classical tradition for Calhoun's own political gain helped spark a sectional divide in America as Southerners became more militaristic in defending their centuries-long institution of slavery. When dealing with the Classics, one must know when to commemorate and when to scrutinize the Romans' way of life with hindsight in assessing what benefits it may bring to society. The way towards progress in improving every human's condition is to learn from humanity's mistakes. By ferreting out misuse of Classical references, one must learn when to take what we need and leave what we do not in the pages of history.

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The Biden-Harris Administration's Impact on Disability Equality for Neurodiverse Communities by Maiya Kothari

The Americans with Disabilities Act has protected the rights of both the physically and mentally disabled population since 1990. The movement for disability equality began with the segregation of disabled children in school and the "establishment of the independent living movement which challenged the notion that people with disabilities needed to be institutionalized…" (Mayerson). As the movement progressed, legislation in congress changed, leading to the shift in beliefs of the extent to which both physical and mental disabilities imposed constraints on a person. No longer were the disabilities the cause for failure, but rather, the social barriers that led to disabled individuals not having the same opportunities were more the cause (Mayerson). Despite much progress after these early days, accessibility, cost, or direction to support have room to improve. A current focus of the Biden administration is to create further equality for people with both types of disabilities. Since the range of disabilities is so broad, government support must be narrowed to promote better outcomes for people with certain disabilities. There are positive and negative implications of such support. US society has moved towards saving lives and making the lives better for certain demographic groups. With this direction, the Biden administration has aimed to achieve further support for neurodiverse individuals by providing educational benefits for children, increasing medical aid for the elderly, and decreasing the cost of medication; however, the effort to achieve equality has had negative consequences on medication availability and cost at the drug counter.

Neurodiverse is a term that can be described as "a concept that regards individuals with differences in brain function and behavioral traits as part of normal variation in the human population" ("Awareness"). A term that is used to compare to this is neurotypical: "a type of brain and behavioral functioning that represents the middle 68% of the human population" ("Awareness"). Neurodiversity encompasses a variety of complexities that exist within the human brain that can result in learning, attention, anxiety, and other challenges. However, these challenges lead to individuals who observe, contemplate, and problem solve in unique ways. The Biden administration aims to achieve equity for these diverse individuals who have and are continuing to be contributing, maybe even thriving, citizens of society.

The government has attempted to support education initiatives because it believes such support will improve societal outcomes and make a positive economic impact on society. The programs are directed at age groups that could set up impacted youth for a better future and that makes life more bearable for elderly groups. The Biden administration has funded support for neurodiverse childrens' education, which primarily includes help in the classroom. Children aged 0-21 years with disabilities are able to receive free public education and special education through the administration's reintroduction of the Individuals with Disabilities Education Act ("About IDEA"). Neurodiverse children are able to get the support they need, which is equivalent to the support given to neurotypical students; it gives them the opportunity to rise to the same level of enrichment and excellence as neurotypical students. This early support can lead

to a more productive society and an improved economy as more capable and skilled individuals are able to enter the workforce. The education support may also include a teacher assistant dedicated to assisting the student in need, a speech therapist, a special counselor, etc. Not only would this help children complete their work, but it would build a basis for self sufficiency that these children would need in their future. These services especially come as a benefit when family and friends aren't certain on how to support their children. Children with special needs require care involving experts, and unfortunately, these experts come at a cost. However, thanks to the Biden administration, the specialized support comes without a cost to these families, making it more accessible to lower income families. To further lift the burden off the caregivers and guardians of these students, $14 million of the president's budget was created into "Individuals with Disabilities Education Act grants" which were distributed to states by the Department of Education to provide special education and early intervention services ("About IDEA"; The White House, "FACT SHEET: The President's Budget"). Through certain targeted education solutions, the Biden administration is supporting families of neurodiverse students to improve societal and economic outcomes.

Not only does the Biden administration aim to aid students in their education, but also through IDEA, "discretionary grants" were given to "state educational agencies, institutions of higher education, and other nonprofit organizations to support research, … technology development, personnel preparation and development, and parent-training and -information centers" ("About IDEA"). Through supporting the not-for-profit network, the government hopes to create public-private partnerships that leverage the financial donations from donors and creativity of members of society who have a passion to make an impact. Helping friends and family understand what the child is in need of and how they can best help, as well as the existence of life changing technology, gives the child a holistic approach to growing and obtaining their full potential. It can be argued that such support creates a domino effect through society that delivers better student outcomes. The negative side of such help is that it may get into the hands of inexperienced or wasteful organizations as there is not a perfect system to evaluate the good and bad nonprofits. At the moment, the recognition of neurodiverse students is relatively new in society, so the effect of such programs is still remaining to be seen. In difficult economies and under different administrations, there is a risk that these programs are funded inconsistently. Thanks to the extensive focus and support on this issue, many more children will be able to grow into independent persons, capable of supporting themselves and capable of integrating into society.

The Biden administration has also made other demographic groups, outside of young children to adolescents, a priority. The elderly are more susceptible to neurodegenerative diseases and also require more assistance. The Biden administration's focus on Medicare includes these people who may have diseases ranging from Alzheimer's to Parkinson's disease. One of the top priorities for the administration is to refocus Medicare agents and brokers on creating the most beneficial plan for the patient, rather than choosing what's best for direct profitability. Prior to this change, because of the health insurance brokers' decisions to promote

plans based on profit, the Medicare Advantage market was consolidating. Fewer options means that healthcare prices can be raised as there is no other competition that would require a provider to lower their costs. To counteract this tendency, the Biden administration gives the brokers higher pay so that they don't feel compelled to make a decision that would hurt the patient ("Biden-Harris Administration"). This will allow competition between providers to increase, which would lead to decreasing prices and increasing accessibility for care. The core benefit of such coverage would be that patients are receiving the health care that fits them best, which is the true purpose of Medicare.

  As a part of the Biden administration policy, Medicare comes with additional benefits, known as rebate dollars - additional discounts when the customer buys enough of a product. Typically, this is a marketing strategy targeted to attract and keep customers. The company is able to increase their sales "without forcing the seller to drop their price" ("Rebates vs Discounts"). However, to make use of the benefits, the customer usually must fill out extensive paperwork, which takes a lot of time, leading to customers giving up on gaining their benefits ("Pros and Cons"). Center for Medicare and Medicaid Services (CMS) aims to regulate these issues, making sure that the customers are aware of the benefits, that the benefits actually advantage the customers, are accessible, and aren't just for marketing purposes ("Biden-Harris Administration"). Also under Biden, the Inflation Reduction Act was signed and put into effect. This law "requires drug companies to pay rebates to Medicare when prices increase faster than the rate of inflation for certain drugs" (ASPA Press Office). Although just recently enforced in 2023, this law will make sure that drug companies don't take advantage of their customers. On one hand, it could deter innovation or production of key drugs if the profit per unit goes too low. On the other hand, this assistance will lower drug costs for patients under Medicare, assuring that they receive the prescription they need to live at a sensible and affordable price.

  People who are unable to support themselves consistently and over a long period of time are able to have long term care. However, the long term care plans can be very expensive and are very taxing on the provider, as they are typically expected to care for the patient for the majority of each day. Because of the demand of the job, there are limited people who are willing to devote the amount of time the job requires. The Biden administration has increased the private financial support for these providers, therefore, increasing the number of willing providers, creating more options for families in need of this support (The White House, "Executive Order"). Increasing the number of providers is important because in the absence of a professional provider, the family will likely have to take on the responsibility of caring for the individual in need, which is time consuming and tiring. If the family member is occupied with helping the individual, they will be unable to work as much for a profit and won't be able to enjoy their life fully. Because of the increase in providers, more families can be at peace knowing that their loved ones are in good hands, being taken care of by skilled professionals.

  A major focus of the Biden administration is to decrease the prices of medication, specifically drugs. These high prices, as well as drug shortages, are a product of many different issues with the drug market. Between the ingredients supplier, the manufacturer, the sponsor or

seller, and the FDA, many delays may occur. The first cause is concentrated markets (Hernandez). When very few companies make a type of drug, all sponsors (like pharmacies) will use the same active ingredient supplier to make their final product, the drug. Because of the limited ingredients suppliers, only a limited amount of an ingredient can be made at a time. Not to mention, if the supplier is unable to provide their ingredient, then all sponsors will not be able to provide the drug. Unfortunately, shortages resulting from this root issue have a very slow recovery from supply constraints. This instability in supply is only one of many possible issues. Another issue is that it's common for one manufacturer to make final products for "all generic sponsors marketing a given product" (Hernandez). This has a similar effect as the market concentration in that the limited manufacturers cause instability and a slow response, however, this issue has a more reliable fix rather than depending on the growth of unpredictable plants. Yet another issue is "logistical and regulatory complexities" that disrupt and make the process even slower (Hernandez). The regulations are put in place to ensure that the drugs are being manufactured ethically, safely, and with good quality. These are necessary measures that take time, and unfortunately, delay the process of distributing the drug to the sponsors. Lastly, an increase in price is largely due to the sponsors desire for more profit. Because the sponsors often innovate or acquire the right to drugs they wish to sell, they may price it at any way they wish.

The Biden administration has expressed that battling these drug shortage issues is one of their priorities. As mentioned earlier, one of their solutions to this issue is to prevent consolidation of drug markets. The administration worked closely with the CMS, of which the administrator Chiquita Brooks-LaSure stated that "'Today's proposals further our efforts to curb predatory marketing and inappropriate steering that distorts healthy competition among plans'" ("Biden-Harris Administration"). Pressuring and misinforming clients to make biased decisions on which health care plan or products to purchase leads to uneven competition between plans or products. When this bias occurs, the majority of the profit goes to a limited number of companies. This means that companies are increasing in revenue not because of the quality of their product, but rather, the marketing strategies by which they persuade their clients over. Because of this, strategies become more aggressive, leading to misinformed and possibly harmful decisions by the consumer. Limiting predatory marketing will relieve the consolidation at its source, leading to healthy competition between companies. This means that prices will become lower because more companies are competing with each other to attract more consumers. One of the strategies by which they do this is price reduction. To ensure honesty, the "CMS is proposing to require that Medicare Advantage plans include an expert in health equity on their utilization management committees and that the committees conduct an annual health equity analysis of the plans' prior authorization policies and procedures" ("Biden-Harris Administration"). Creating checkpoints will ensure that companies' plans are not driving drug prices out of reach for the average American, who are typically of middle income status.

Despite their efforts, there may be potential unintended consequences of limiting the consolidation of drug markets. As the prices of drugs decrease, manufacturers don't want to make drugs that have "low profitability" (Hernandez). A decrease in manufacturers means that

the market has consolidated, leading back to an increase in price of the product. The decrease of manufacturers can also lead to an increased chance of shortages, of which generic drugs are particularly impacted by (Hernandez). These shortages can vary in length, however, if severe, can last for many months, years, or even decades. A decrease in accessibility will potentially prevent neurodivergent individuals from living "normal" lives, and considering the possible lengths of these shortages, can impact an individual's life course. Never has a product been "awarded" because of its quality (Hernandez). Manufacturers are encouraged on the basis of quantity over quality to grow their profits, leading to potentially poor quality medication that can physically impact a consumer.

Although the Biden administration's policies have a clear purpose of aiding neurodiverse individuals, their impact on a larger scale has yet to be seen as it is too soon to tell how these policies will play out in the long run. However, the intended progress to achieve equality and to further increase the accessibility of aid is a big step towards improving the quality of life of neurodivergent individuals.

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Reviewing The Efficacy of FLT3 Inhibitors in Treating AML
By Shruti Balachander

Abstract

   Acute myeloid leukemia (AML) is a highly aggressive type of blood cancer that originates in the bone marrow. The standard of care primarily consists of intensive chemotherapy however prognosis is especially poor for older patients. Recent genetic and molecular testing for alterations involved in the pathogenesis of AML has shown that mutations affecting the fms-like tyrosine kinase 3 (FLT3) gene are extremely prevalent, as they make up 33% of all leukemia cases. As a result, FLT3 inhibitors were created to target various FLT3 mutations, including internal tandem duplications (ITD) and tyrosine kinase domain (TKD) mutations. There are two inhibitor generations and they are used in combination with chemotherapy and transplantations to bolster their efficacy and achieve better outcomes. Several of these drugs have been approved by the FDA for relapsed and newly diagnosed patients, including Midostaurin, Sorafenib and Quizartinib. Despite the promising results of these clinical trials, there are still several issues that have surfaced through the use of these inhibitors. Severe adverse events (e.g. cardiotoxicity, hematologic toxicities, gastrointestinal symptoms) and drug resistance are issues that need to be properly addressed as they become increasingly prevalent. As more trials are conducted for these inhibitors, they have the potential to become widespread in their administration for FLT3 mutated patients.

Keywords: acute myeloid leukemia (AML), FLT3 inhibitors, chemotherapy, internal tandem duplication (ITD), tyrosine kinase domain (TKD)

1. Introduction

   Acute myeloid leukemia (AML) is a hematological malignancy defined by an abnormal quantity of hematopoietic precursors, or immature blood cells, in the bone marrow. AML is caused by genetic and molecular alterations to normal hematopoietic stem cells (HSC), which are primitive cells that develop into various blood cells from the lymphoid and myeloid lineages. These modifications create an increased production of abnormally differentiated immature cells called myeloblasts. These progenitor cells crowd out healthy blood cells and leave the body vulnerable to anemia, infection and bleeding. Although, AML accounts for only 1% of cancers, it causes 2% of cancer-related deaths. The incidence of AML has globally increased by 15% and the proportion of AML among leukemic patients has increased by 27%. Therefore, the necessity for innovative solutions beyond standard chemotherapy should be at the forefront of research looking to reduce the morality of AML.

   Regarding the various treatment options available for AML, historically the "7+3" regimen which includes highly aggressive drugs has been utilized. This protocol is the induction phase and once remission has been achieved, the consolidation phase takes place to eliminate any remaining cancer cells. Depending on the type and aggressiveness of AML, patients can

receive other treatment modalities, including hematopoietic stem cell transplant (HSCT), that are meant to prolong remission. However, AML in particular targets older patients and a vast majority of them are either unable to tolerate the toxicity of chemotherapy or do not qualify for stem cell transplant. Recent advances made in genetic and molecular testing has led to the emergence of targeted therapy drugs that are more palatable to the average AML patient. These developments have gained momentum in recent years and have become individualized to a person's mutational status.

The most common mutations targeted by these newfound agents are FMS-like tyrosine kinase 3 (FLT3) mutations. Among the types of FLT3 mutations, approximately 25% of adults have internal tandem duplications (ITD) and 10% of adults have tyrosine kinase domain (TKD) mutations. An ITD mutation involves the DNA sequence of a gene being replicated and inserted adjacent to the original sequence. TKD mutations are point mutations affecting the tyrosine kinase domain of a FLT3 receptor. Both of these mutations are defined by their constant activation of FLT3 receptors, which initiates the proliferation of myeloblasts in the bone marrow. This creates impaired intramedullary and extramedullary apoptosis, where cell death fails to occur, and block differentiation, in which progenitor cells fail to mature into their specialized forms. FLT3 inhibitors disrupt the activity of these mutations by binding to the kinase domain of the receptor to allow for transcriptional changes and pathway activation.

This review aims to explore the treatment options available for patients diagnosed with FLT3 mutated AML. The use of FLT3 inhibitors in tandem with chemotherapy and hematopoietic stem cell transplants (HSCT) are among the more effective methods for obtaining complete remission (CR). Therefore, the primary objective of this review is to provide an overview of FLT3 inhibitors and analyze their efficacy against AML.

2. FLT3 Structure

FLT3 is a tyrosine kinase receptor (TKR) that consists of five separate regions, including the extracellular, transmembrane, juxtamembrane and tyrosine kinase domains and c-terminal tails. FLT3 receptors are encoded by genes located on chromosome 13q12 and are involved in the intracellular signaling and proliferation of hematopoietic progenitor cells. These receptors play a key role in normal hematopoiesis and are expressed through immature hematopoietic progenitors and hematopoietic stem cells. They are activated by FLT3 ligands, which are proteins responsible for the proliferation and differentiation of hematopoietic cells. Once activated, the receptors stimulate the phosphorylation of tyrosine residues to activate downstream signaling pathways that allow for the regulation of cell survival. After the ligands bind to the extracellular domain, dimerization becomes induced with a second FLT3 receptor to activate the intracellular kinase domain. Tyrosine residues in the intracellular domain undergo autophosphorylation and function as docking sites for signaling proteins that propagate their signals throughout various pathways. Those pathways include the phosphatidylinositol 3-kinase (PI3K), rat sarcoma (RAS) and signal transducer and activator of transcription (STAT) pathways. The activation of

downstream signaling cascades ultimately flows through these pathways and results in the maturation of hematopoietic cells in the peripheral blood.
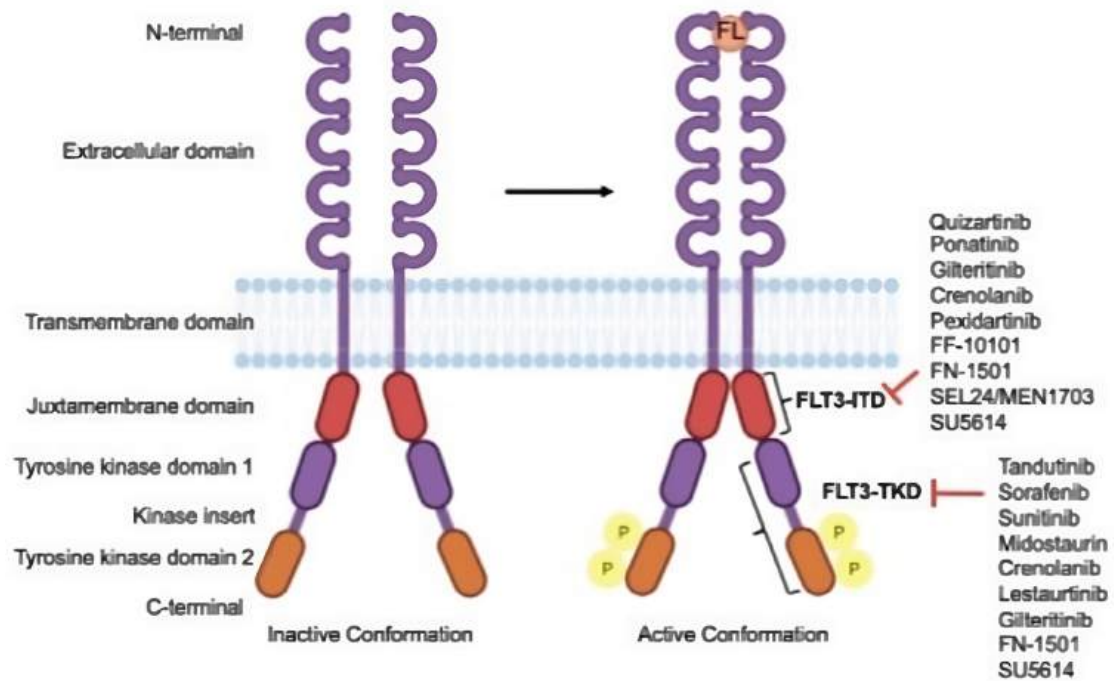
Figure 1: Components of a FLT3 receptor and the process of dimerization

Patients with AML house leukemic cells that overexpress FLT3 from FL-independent dimerization, or the process by which FLT3 receptors are combined without ligand binding. The overexpression of tyrosine kinase receptors creates the excessive production of leukemic blasts and immature hematopoietic cells that accumulate in the peripheral blood. These mutated cells inhibit signaling pathways involved in apoptosis and hematopoiesis. The most common FLT3 mutations created by FL-independent dimerization are ITD mutations, where a DNA sequence becomes duplicated in the juxtamembrane domain to disrupt a gene's normal regulatory functions. Common point mutations affecting the FLT3 gene are TKD mutations, which are also produced through dimerization and interfere with FLT3 activation loops located in the tyrosine kinase domain. TKD mutations facilitate the insertion of codon D835 or the deletion of codon I836 to create the structural distortion and continual activation of these loops.

3. FLT3 Inhibitors

Targeted therapy drugs, or inhibitors, are agents that have become increasingly implemented into combination therapy to bolster the efficacy of treatment. These inhibitors interfere with abnormal cell signals to diminish the proliferation of leukemic blasts. FLT3 inhibitors are classified as first or second generation based on their specificity and potency. First

generation, or type I inhibitors, include Midostaurin, Sorafenib, Sunitinib, Lestaurtinib and Tandutinib. These inhibitors are characterized by their ability to bind to the activated conformation of a kinase receptor, targeting the juxtamembrane and tyrosine kinase domains. Second generation, or type II inhibitors, include Gilteritinib, Quizartinib, and Crenolanib. These inhibitors are more precise, due to their ability to attach to the active ATP-binding site of a tyrosine kinase receptor.
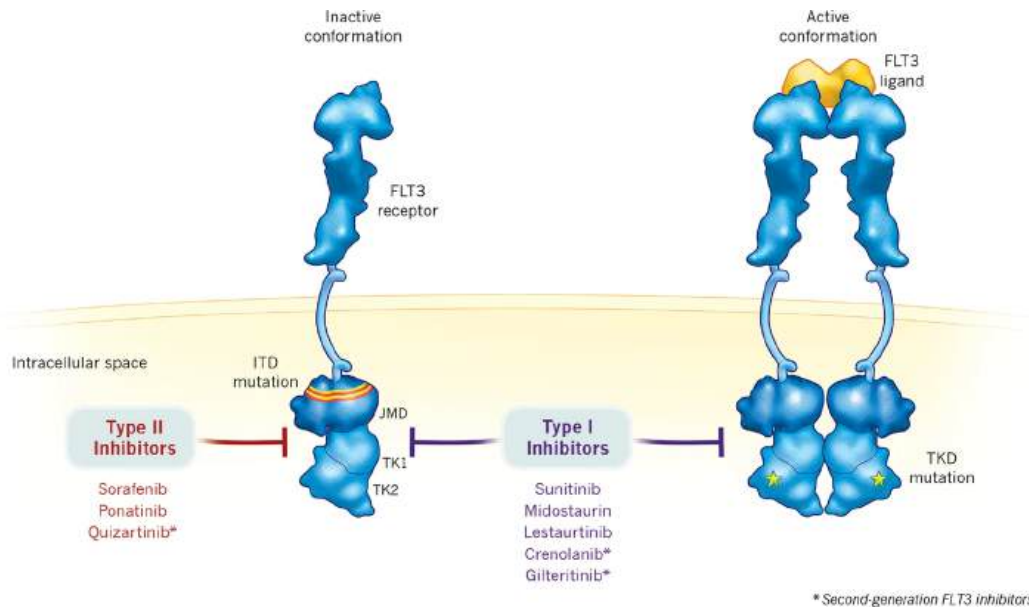
Figure 2: Inhibitory effects of a FLT3 inhibitor against various receptor conformations

Adverse events (AE) are common with FLT3 inhibitors and are an important consideration to make during their administration. First generation inhibitors yield a greater risk for hematological toxicity and gastrointestinal symptoms, including pancreatitis, dyspepsia and diarrhea. These same side effects are also caused by the second generation, with hematological toxicities present in 57.7% of all cases and gastrointestinal symptoms and cardiac toxicities present in 13.9% of all cases.

Of the inhibitors tested against AML, Midostaurin, Gilteritinib, and Quizartinib have all been approved by the FDA. The remaining inhibitors, including Sorafenib, Sunitinib, Lestaurtinib, Tandutinib, and Crenolanib, are still being studied, yet their results have been poor.

4. First Generation Inhibitors

4.1. Midostaurin

Midostaurin is a first generation, multikinase inhibitor that is highly effective against ITD and TKD mutations. It is an alkaloid derived from the Streptomyces staurosporeus bacterium. In preclinical studies, Midostaurin successfully induced cell cycle arrest and apoptosis of Ba/F3 lines expressing FLT3 by directly inhibiting the tyrosine kinases. Its efficacy extends to the

inhibition of various other protein kinases, including c-KIT, VEGFR and PDGFR-β involved in leukemogenesis. In the context of AML, Midostaurin is combined with chemotherapy to inhibit the autophosphorylation of FLT3 receptors and initiate the apoptosis of ITD and TKD mutant leukemic cells.

Midostaurin was initially studied in patients with relapsed AML and though the regimen reduced blast counts, it did not produce a complete response. Therefore, in the phase III (RATIFY) trial, FLT3 inhibitors were used in combination with standard induction and consolidation chemotherapy to prolong the survival of patients under the age of 60. These patients had either an ITD or TKD mutation. Overall survival (OS) for the Midostaurin group was 74.7 months compared to 25.6 months for the placebo group. Complete remission (CR) and median event-free survival (EFS) was 51.4% and 8.2 months for the Midostaurin group compared to 44.3% and 3.0 months for the placebo group, respectively. The superior results produced by Midostaurin led to FDA approval in 2017 and it became standard of care.

Even though the prognosis of AML has been significantly improved by transplantation, a substantial number of patients still relapse. As a result, the use of Midostaurin in maintenance therapy was analyzed by the (RADIUS) trial, utilizing patients between the ages of 18 and 70. The majority of these patients had also received an hematopoietic stem cell transplant (HSCT) prior to the study. Relapse free survival at 18 months improved by 13% for the Midostaurin group compared to the standard of care arm.

In another phase II trial (AMLSG 16-10), the efficacy of Midostaurin was examined in the treatment of R/R patients above the age of 18. Altogether, CR and complete remission with incomplete platelet recovery (CRi) was easier to achieve by taking Midostaurin with chemotherapy.

4.2. Sorafenib

Sorafenib is a first generation kinase inhibitor that is primarily used against advanced hepatocellular and renal cell cancer. It acts as a multikinase inhibitor against FLT3 by hindering the proliferation of leukemic blasts and its inhibition extends to other tyrosine receptors, including KIT, RET, VEGFR and PDGFR. When combined with chemotherapy and HSCT, it becomes extremely effective at inducing apoptosis in ITD and TKD mutated patients. Nowadays, Sorafenib is used in relapse prevention for patients who have already undergone HSCT.

In the phase II (SORAML) trial, Sorafenib was analyzed in newly diagnosed patients between the ages of 18 and 60. After a median follow-up time of 36 months, the median EFS for the Sorafenib group was 21 months, compared to 9 months for the standard of care.

In analyzing the efficacy of Sorafenib and HSCT, the phase II SORMAIN trial found that the combination of the two can function as a palliative therapy because of their curative antileukemic synergism. After its administration, the minimal residual disease (MRD) was better in those who had undergone maintenance therapy with Sorafenib compared to the placebo. These findings demonstrate that Sorafenib, as a drug used in combination with HSCT, can significantly inhibit the recurrence of ITD mutations.

Another study, based on a collection of multicenter data, found that the median relapse time was 6 days for those who took Sorafenib following HSCT, compared to 8 days for those who took the placebo. The OS rate was 51% for the Sorafenib group compared to 38% for the placebo group.

4.3. Sunitinib, Lestaurtinib, Tandutinib

Sunitinib, Lestaurtinib and Tandutinib are all multi-targeted tyrosine kinase inhibitors that hinder the proliferation of several proteins, including FLT3, KIT, VEGFR, RET and PDGFR. Sunitinib has especially been used against diseases such as renal cell carcinoma and gastrointestinal stromal. Lestaurtinib and Tandutinib are first-generation oral inhibitors that are utilized in combination with cytarabine and daunorubicin to enhance their therapeutic effects. Altogether, these inhibitors are limited and brief in their usage as a single-agent therapy drug.

In a phase I/II trial testing the efficacy of Sunitinib with chemotherapy, Sunitinib was given as part of maintenance therapy for patients experiencing activating FLT3 mutations. Across the 17 analyzed patients, the median OS, relapse free survival (RFS) and EFS rates were 1.6, 1.0 and 0.4 years respectively.

Another phase I trial analyzed the antileukemic activity of Tandutinib in ITD mutated patients. Altogether, 40% of the patients achieved CR after receiving only a capsule of 100 mg of Tandutinib twice daily by mouth.

The most promising results were from the administration of Lestaurtinib, as seen in the Cephalon 204 trial. Eligible patients were above the age of 18 and hosted either an ITD or D835 mutation. FLT3 inhibition through Lestaurtinib produced high remission and created an effective therapeutic modality for when it was used with chemotherapy. By reducing the marrow blasts found in the peripheral blood, Lestaurtinib was highly effective at targeting solid AML tumors while being tolerated by the patient.

5. Second Generation Inhibitors

5.1. Gilteritinib

Gilteritinib is a second generation, multi-targeted kinase inhibitor that selectively inhibits FLT3 and AXL receptors through its pyrazine carboxamide scaffold structure. It is able to inhibit both ITD and TKD mutations while being moderately effective against c-Kit tyrosine kinases. Across all the preclinical data available for Gilteritinib, the regimen has been highly effective at decreasing the phosphorylation of FLT3 through supporting the downstream effects of its anti-leukemic activity.

Gilteritinib has primarily been tested on R/R patients and its effectiveness was studied in the ADMIRAL trial, where patients with an ITD or D835/I836 mutation were randomly selected to receive either salvage chemotherapy or Gilteritinib. The median OS for the Gilteritinib arm was 9.3 months compared to 5.6 months for the control arm.

When analyzing the efficacy of Gilteritinib in combination with other hypomethylating agents, the LACEWING trial found that those who undertook AZA + Gilteritinib had a median OS of 9.82 months compared to 8.87 months for those who only took AZA. Although the median EFS was 0.03 months for both groups, the median time for CR in the AZA + Gilteritinib group was 116.5 days compared to 95 days for the AZA group.

In a phase III trial analyzing the effect of Gilteritinib on patients with relapsed AML, adults were randomly assigned in a 2:1 ratio to receive either salvage therapy or Gilteritinib. The median OS for the Gilteritinib arm was significantly longer; 9.3 months compared to 5.6 months for the chemotherapy arm. The median EFS for the Gilteritinib group was 2.8 months compared to 0.7 months for the chemotherapy group.

5.2. Quizartinib

Quizartinib is a second generation inhibitor with strong inhibitory activity particularly against FLT3-ITD. Its effectiveness is especially prominent in R/R patients, as the regimen demonstrates a type of selectivity against FLT3 that was previously absent in the first generation.

By combining Quizartinib with chemotherapy, the QuANTUM-First trial could analyze their combined antitumor activity against ITD mutated patients. Eligible patients were between 18-75 years in age and were given induction therapy through the standard 7+3 protocol, receiving either a placebo or Quizartinib. The continuation of Quizartinib across 3 years, with or without HSCT, yielded an OS rate of 0.4 months.

Another phase III randomized study (QuANTUM-R) was performed on ITD-mutated patients. Once Quizartinib was administered, anthracycline and cytarabine-based induction and consolidation therapy was introduced to bolster the efficacy of the treatment. The OS rate for the Quizartinib group was significantly higher than that of the chemotherapy group; 6.2 months compared to 4.7 months.

In another phase I multicenter trial of Quizartinib monotherapy (Study 2689 CL 0011), Quizartinib was used in maintenance therapy for patients who had received HSCT. The regimen was administered in a dose-escalating fashion, where dose-limiting toxicities (DLT) were analyzed in tandem with maximum-tolerated doses (MTD). Altogether, relapse was minimal once patients had received treatment and the induction of morphologic remission was quick to occur.

5.3. Crenolanib

Crenolanib is a second generation kinase inhibitor that was originally designed to inhibit the proliferation of PDGFR receptors. It is effective at suppressing both the wild-type and mutant forms of FLT3-ITD and D835. The drug targets PDGFR and FLT3 receptors to restrict their signal transduction pathways and inhibit tumor angiogenesis. Its potency differs from other inhibitors in that it can function against active and inactive point mutations. Crenolanib's high tolerability and lack of cardiotoxicity makes it an effective second generation inhibitor. Though

Crenolanib has a weaker inhibition of c-KIT, its results are more promising when it comes to yielding the myelosuppression generated by AML.

Most trials following Crenolanib have focused on using the regimen in tandem with standard 7+3 induction therapy. In a phase II trial, Crenolanib was taken orally at a dose of 100 mg, with re-induction being allowed. Although a median OS was not achieved, the rate for CR/CRi was 96% and 88% respectively.

Another trial (NCT02283177) utilized patients who had previously received induction therapy prior to the study. Due to this fact, Crenolanib could target both the active and inactive points on the FLT3 gene while limiting myelosuppression. Altogether, 90% of patients achieved CR and the majority of patients achieved low MRD-negative. EFS was 44.7 months on average.

6. Future Directions

Despite the numerous advancements made towards improving FLT3 inhibitors, they still have many flaws that hinder their overall efficacy. The main problem is cardiotoxicity, which generates various arrhythmias and alterations. Additionally, resistance to FLT3 inhibitors has become increasingly prevalent, as short-lived responses pose a significant threat. Resistance comes in two forms, primary and secondary, and their presence depends on the regimen being used for inhibition. Primary resistance is natural and occurs through the overexpression of FLT3 ligands to create an abnormal bone marrow environment vulnerable to resistance. Secondary resistance occurs from the use of an inhibitor and involves alterations made to parallel and downstream signals. These forms of resistance are accompanied by various AEs that emerge from inhibitors being used in either monotherapy or combination therapy. The most prevalent AEs include gastrointestinal symptoms and hematologic toxicities, which are all toxic to normal hematopoiesis.

The overall efficacy of FLT3 inhibitors becomes more pronounced when used in combination with other agents. In post maintenance therapy, FLT3 inhibitors are most effective when combined with HSCT and induction chemotherapy. Alternatively, hypomethylating agents, such as azacitidine and decitabine, can be used in combination with inhibitors. By reversing DNA methylation patterns, these agents allow for the re-expression of genes involved in apoptosis and hematopoiesis. Venetoclax, a BCL-2 inhibitor, is also effective at targeting pathways associated with AML pathogenesis, especially when used in combination with tyrosine kinase inhibitors. These combinations allow for better antileukemic activity, response rates and survival outcomes. Although there are tolerability issues, further research is investigating into seeing whether those issues can be resolved through a three-way combination of FLT3 inhibitors, Venetoclax and hypomethylating agents.

Several ongoing studies have also investigated the use of FLT3 inhibitors in post-maintenance therapy. In the RATIFY study, Midostaurin was used in post-maintenance therapy to treat AML patients. The study's promising results have inspired several other trials, including AMLSG-16-10, HOVON 156 AML and QuANTUM-First, to experiment with the implementation of FLT3 inhibitors in post-maintenance therapy. Sorafenib, in particular, has

graft-versus-leukemia effects in post-transplant maintenance therapy for patients with ITD mutated AML. Consequently, patients undertaking Sorafenib following HSCT saw improvements in RFS and OS, as tested through the SORMAIN and SORAML trials. Midostaurin, when evaluated through the RADIUS trial, minimally improved RFS in patients who had undergone HSCT. Limited studies have looked at the remaining inhibitors and all of them still require further research before they are implemented in maintenance therapy. Despite the lack of available studies, the future looks promising for the administration of these inhibitors in both maintenance and induction therapy.

7. Conclusion

As AML becomes an increasingly prevalent disease, the use of FLT3 inhibitors in combination therapy can dramatically improve survival rates. FLT3 inhibitors have been particularly effective against ITD and TKD mutations when used in combination with other treatments, such as chemotherapy and HSCT. More research is needed to improve on these inhibitors as the risk for AEs and resistance becomes higher. As clinical studies continue to utilize FLT3 inhibitors in monotherapy and maintenance therapy, the future looks promising for the widespread use of these inhibitors in the treatment of AML.

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Accurate News Reporting is a Public Good. Does it Follow That News Agencies Should Be Funded From Taxation? By Shengqi Yao

Abstract

BuzzFeed News, the Pulitzer Prize-winning digital news website that took the internet by storm roughly a decade ago, shuttered in April 2023[i]. CEO Jonah Peretti regretted overinvesting in BuzzFeed News which led to encountering severe financial setbacks, accepting the fact that big platforms were unable to provide the financial support for accurate journalism. Even after slashing 15% of its workforce to cut costs[ii], the company still could no longer sustain itself as a standalone organization.

In their pursuit of publishing high-quality news, BuzzFeed did not make a high enough profit to buffer itself through economic downturns. The trade-off between high-quality journalism and clickbait articles guided the discussion of how more efficient funding models can be applied to ensure the long-term sustainability of accurate news organizations.

This essay begins by identifying the fundamental characteristics of 'accurate news'. In comparison to fake news, accurate news is precious and valuable, which makes it a public good for its non-rivalrous and non-exclusive nature.[iii] Non-exclusivity allows the public to use news reports without paying for them, while the concept of non-rivalry demonstrates how the news benefits everyone without incurring marginal costs for each user.[iv] Because individuals and organizations may not always have the motivation to provide complete and truthful disclosure, accurate news reporting is considered a public good.[v]

Accurate News' Benefits

When it comes to financing, many argue that the socially beneficial nature of news necessitates public funding[vi]. Indeed, news yields positive social externalities by empowering people with precise and reliable information. In comparison, misleading or false information can encourage negative externalities like market instability and crime.[vii] The free flow of accurate information provided by verified news agencies is crucial for keeping the public well-informed, fostering civic engagement, and enabling individuals to make socially aware decisions. Evidence shows that individuals who rely on traditional news outlets, such as news websites and print, demonstrate higher levels of engagement and knowledge about political and social issues compared to those who primarily rely on unscrutinized social media.[viii] Moreover, news highlights social injustices and issues that demand collective action.[ix] Investigative journalism, for instance, exposes corruption and struggles of marginalized communities to spark public discourse and action. Such reporting can inspire and mobilize individuals to engage in advocacy, raise awareness, and contribute to positive social change.

That does not mean that these public goods should necessarily be financed by taxation. The implementation of this funding model raises several considerations. Would taxation be the primary source of funding, or would it also involve a mix of methods such as subsidies or user fees from privately owned entities? Furthermore, should taxes be levied on all citizens,

regardless of their need for or usage of news? This essay examines the merits and drawbacks of public and private funding for news agencies and explores the possibility of a hybrid funding model that synthesizes the strengths of both approaches.

The Risks Of Taxation

1. Consumers Carry Heavier Tax Burdens

Taxation refers to a method in which governments allocate a portion of tax revenue to fund and support public broadcast entities.[x] Public entities are entrusted with the responsibility of disseminating unbiased and comprehensive news. A primary source of this taxation is television license fees – a mandatory payment imposed on households who own televisions to watch the news[xi] – which are collected to fund public broadcasting organizations. The tax revenue also supports privately owned news organizations through government subsidies, ensuring that accurate journalism is accessible to a larger audience. Television license fees are considered indirect taxes imposed on news services. [xii] The impact of indirect taxation is determined by the elasticity of the goods and services. Generally, accurate news reports are considered inelastic due to the limited availability of substitutes and the high perceived importance of news to society. In this buyer's market, a higher proportion of taxation falls on news readers and less on news producers. [xiii]

2. Welfare Loss From Taxation

Nevertheless, the extra cost of production may lead to inefficient resource allocation. Higher taxes can result in the underproduction of news, diverting resources and leading to a welfare loss in the economy. [xiv] (Figure. 1)

Figure 1 demonstrates that the supply and demand curves intersect at price equilibrium (PE). An imposed tax on each unit shifts the effective supply curve (S1) up to the final supply curve (S2). The new point of intersection implies that the equilibrium price increases to Pc, and the quantity supplied reduces to Qt. The loss in market efficiency ("welfare loss") is illustrated as the triangular area (A+B).
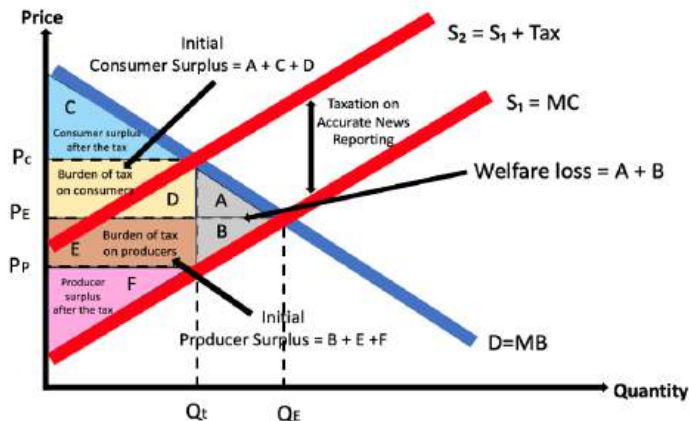
Figure 1: Impact of taxation on news agencies and consumers (Source: illustrated by author, adapted from economic theory)

3. Uncertainty in Public Funding

Moreover, financial overreliance on government spending is risky as budget fluctuations may prompt the government to prioritize emergencies over news.[xv] In this case, opportunity costs appear to undermine the degree of emphasis on journalism, leading to inconsistent funding.[xvi] This uncertainty hampers organizations' ability to plan long-term operations, pressuring them instead to seek alternative private funding that may jeopardize their objectivity. Moreover, government influence over news content raises concerns about biased representation[xvii], potentially shaping a preferred governmental narrative. This influence contributes to intangible forms of oppression, eroding public trust in accurate news reporting.[xviii]

The evidence presented illustrates that relying solely on taxation to fund news agencies is suboptimal for two primary reasons. Firstly, it results in welfare loss, thereby reducing efficiency. Secondly, it imposes an inequitable burden on television users who may not directly benefit from the news services provided. Therefore, a hybrid funding model is recommended to sustain the production of accurate reporting, involving a mix of public funding and private sources such as membership fees and donations.

The Needs and Risks of Private Funding Methods

A robust body of literature underscores the necessity of private funding for news.[xx] News reporting is considered a luxury good because, unlike basic education and healthcare, it is not essential for human survival. From the consumer perspective, accurate news from credible agencies is demanded primarily by those who are well-off and can afford such a luxury.[xxi] From the supplier's perspective, high-quality news is not universally accessible akin to freely available resources like air and water. Self-financed news agencies have responded by restructuring their business models to prioritize profitability.[xxii] This parallels the production of high-end products, where the resource-intensive nature of producing accurate news justifies the implementation of usage fees. This strategy, akin to price differentiation, charges consumers for access to higher-quality news content.[xxiii] Consequently, consumers seeking such content are required to pay, creating barriers to entry for those unable or unwilling to afford it, leading them to rely on free but potentially less reliable sources. Major news outlets such as Bloomberg[xxiv] and The New York Times[xxv] exemplify this trend with their subscription models. While basic news updates are typically available at no cost, access to in-depth analyses and specialized content requires a subscription fee.

Taken together, the 'luxury' characteristics of high-quality news, coupled with limited access, emphasize that its consumption is selective. Advocates argue that accurate news should be treated as a "billable" service[xxvi], where those who value and require it should bear the financial burden. Consequently, funding models should prioritize usage fees over universal public funding to ensure equitable access among users.

Furthermore, the positive social externalities generated by accurate news reporting necessitate significant resource investment, which is not sustainable through taxation alone, particularly given competing government expenditure priorities. [xxvii] When weighing the opportunity costs associated with allocating financial resources, governments must carefully assess whether to prioritize funding for precise information. Private funds play a crucial role in sustaining long-term support by preserving trust and credibility, enhancing public awareness, and promoting a well-informed society.[xxviii] For instance, the Washington Post is primarily funded through a combination of revenue streams, including advertising, subscriptions, and other business ventures, maintaining editorial independence to ensure journalistic integrity.[xxix] ProPublica, a nonprofit news organization, operates on a donor-funded model, allowing for diversification of funding sources to spread risks over a large number of donors, mitigating funding fluctuations.[xxx] In addition, a wide base of users strengthens the bond between ProPublica and the community, further fostering dependency and loyalty towards the agency.

In practice, membership fees and private donations serve as prominent private funding methods for news organizations. Membership fees provide a stable revenue stream essential for sustaining operations and ensuring financial independence. Typically, billed on a monthly or annual basis, these fees allow subscribers exclusive access to content and services, effectively addressing the free rider problem that can lead to market failure. However, the sustainability of member-based funding hinges on maintaining a loyal and dedicated readership, making it susceptible to revenue fluctuations.

Private donations offer an additional means of financing news reporting, bolstering editorial independence in pursuing accurate journalism. Non-profit entities like MinnPost exemplify successful models where donations, grants, and reader contributions sustain operations. [xxxi] By actively engaging stakeholders such as donors and community members, these organizations cultivate a sense of ownership and garner long-term support. Nonetheless, challenges arise in the donation process, including the potential for donor influence to lead to biased reporting and compromise the objectivity of content. [xxxii]

However, relying solely on private funding is dangerous. To maintain objectivity and combat misinformation, agencies must minimize their dependence on funding from profit-driven companies. Guided by manipulative financial objectives, private firms can disseminate news with undue bias catered towards specific target audiences. This dilutes the purpose of news reporting – serving the needs of the general population.

Moreover, heavy reliance on private funding will likely lead to market failure such as the existence of a monopoly. In the last ten years, American journalism has relied on a for-profit commercial model which made news reporting more affordable and accessible to a broader audience. This model has now failed due to the existence of the monopoly of Google, which "hoovered up" all other businesses, making newspapers no longer a thriving business. [xxxiii] This essay argues that quality information cannot be seen as an optional luxury for the well-off and should instead be regarded as an essential, like schools, roads, bridges, and clean water.

Conclusion

  This essay has identified significant variations in the effectiveness of public and private funding mechanisms for accurate news. Public funding offers crucial independence from commercial pressures, supporting journalistic integrity and serving the public interest; unfortunately, it is susceptible to political interference and budgetary constraints. Moreover, it is unfair to levy a one-size-fits-all taxation on both users and non-users. Conversely, private funding introduces innovation and agility but carries the risk of bias or sensationalism driven by profit motives. [xxxiv] Adopting hybrid funding models, which integrate elements of both public and private funding, could support the dissemination of accurate and impartial news while safeguarding journalistic independence and integrity. By blending public accountability with the dynamism of the private sector, these models effectively facilitate the production of reliable and unbiased news.

  Who should pay for accurate news? Accurate news reporting is inherently a public good with positive social externalities, necessitating continuous funding to uphold its essential societal functions. However, one should be aware that accurate news is not essential for the survival of all; fairness dictates that those who benefit directly should bear the financial responsibility. [xxxv] It is crucial to recognize that overreliance on private funding alone risks compromising objectivity, making it an impractical solution.

  What are the optimal methods for funding accurate news, considering efficacy and feasibility? Among mainstream funding methods—taxation, membership fees, and voluntary sponsorship—each has its limitations. Sole reliance on taxation proves inadequate due to budget fluctuations and potential governmental influence, which could undermine impartiality. Therefore, a hybrid approach that integrates taxation and membership fees—a blend of public and private contributions, both voluntary and obligatory—offers a well-rounded funding model. This hybrid model aims to optimize the benefits of diverse funding sources while mitigating their respective drawbacks, ensuring robust support for the sustained production of accurate news that effectively serves the broader societal good.

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The Structure of Scientific Revolutions:
How Thomas Kuhn Brought History to the Philosophy of Science By Jay Tsai

Abstract

Although Thomas Kuhn published The Structure of Scientific Revolutions in 1962 as a practicing historian of science, the work was not confined to the history of science but delved much into the philosophy thereof. Indeed, Structure was more influential upon the latter discipline than it was upon the history of science proper. This paper will trace out Structure's place in the academic developments of the history and philosophy of science. It will explain that while Kuhn's argument in Structure was indeed historical, it used the history of science to develop a philosophical conception about the nature of science, its development, and progress. Indeed, Structure shaped a newfound debate in which Kuhn and his contemporaries historically evaluated competing theories of science. And this interdisciplinary debate eventually helped bring historical evaluation a greater prominence within the philosophy of science.

Kuhn's Theory of Science

In his work, Kuhn put forth a structure of science as follows. Mature science begins with the establishment of a paradigm, or an achievement recognized by the scientific community as a model for the theoretical world-view and methodological standards of scientific research (Kuhn, Structure, 10-22). Science then consists in work under a paradigm, called normal science, which is fundamentally a puzzle-solving activity that consists in further articulating the paradigm's theory to match with observed facts and expanding the paradigm's applications (23-42). Normal science works to resolve any anomalies of fact that occur by adjusting the theory of the paradigm, but sometimes it fails to resolve an anomaly, which then turns into a crisis (52-76). This is when extraordinary science develops, with the goal of replacing the old paradigm: it consists in the relaxation of constraints of the paradigm, the debate over fundamentals and recourse to philosophical thinking, and the proliferation of new theories (77-91). Since paradigms come with their own meanings of words and their own world-view, comparison between an old paradigm and the new one generated by extraordinary science cannot be made from exactly the same set of premises and observations (92-135). Instead, the community finds that one paradigm better solves the more pressing problems, provides a more coherent theory, and/or promises a more preferable future line of normal science—when this happens, a revolution will occur and the new paradigm will be established as the guide for normal science once again (144-159). Kuhn takes the cycle to explain the success of science, which he takes as analogous to evolutionary progress—not towards some goal of ultimate truth but a improvement upon prior science: normal science, in its articulation, is efficient both in increasing the applications and accuracy of a paradigm and in recognizing when a paradigm truly fails, while revolution will by definition lead to a paradigm that scientists deem better suited for their research (160-173).

The History and Philosophy of Science

That Kuhn's Structure used the history of science to inform and help develop a philosophical conception of the nature and progress of science is clear from the first sentence of the work: "History, if viewed as a repository for more than anecdote or chronology, could produce a decisive transformation in the image of science by which we are now possessed" (1). And in the 1969 Postscript for Structure, he made this more explicit:

The preceding pages present a viewpoint of theory about the nature of science, and, like other philosophies of science, the theory has consequences for the way in which scientists should behave if their enterprise is to succeed… Conversely, one set of reasons for taking the theory seriously is that scientists, whose methods have been developed and selected for their success, do in fact behave as the theory says they should. My descriptive generalizations are evidence for the theory precisely because they can also be derived from it, whereas on other views of the nature of science they constitute anomalous behavior. (207)

In Structure, Kuhn put forth a theory of science that makes normative claims about what valid science ought to consist in, but he did so by explicitly analyzing the history of science for "descriptive generalizations" of scientific behavior. As Kuhn admitted, his method was somewhat circular, though by no means incorrectly so: he looked at the history of the mature sciences to develop a theory of valid science, which was thus supported by the fact that it accounted for much of the history of mature scientific behavior. The method is nonetheless valuable, as his theory of science, if successful, would thus give historical science, only intuitively considered mature and valid, a coherent and explicit explanation of its validity and success (207).

By using the history of science to inform his philosophical conception of science, Kuhn helped develop a newfound interdisciplinary focus on how the philosophy of science could be evaluated and informed by its history. In the decades prior to Kuhn's Structure, the history of science and the philosophy of science each had their own tight methodological constraints, entailing that to a certain extent, as Stephen Toulmin put it, "approaching the history of science with philosophical questions in mind seemed as heretical to professional historians of science in the 1950s as approaching the philosophy of science with historical questions did to most of their philosophical colleagues" (Toulmin 148). The philosophy of science, especially in the U.S., was rooted in the logical positivist movement, which had the intellectual goal of representing scientific knowledge as built up from empirical observations with purely mathematical and logical structures. Therefore the philosophy of science largely restricted its attention to problems of formal and logical justifications of knowledge, and abandoned non-formal concerns about science like those of history or the social sciences (146-147). In turn, the newly emerging discipline of the history of science had been limiting the scope of its work—in order to establish historiographical standards for the discipline, which had previously been embarrassed by simplistic analyses of the socio-economic, external contest of science—to a precise and focused

reconstruction of the developments internal to the intellectual context of scientific work (Thackray 114-120; Toulmin 148-150). And this professionalization at the time excluded philosophical questions about such scientific work (Toulmin 148). The self-imposed constraints upon the philosophy and history of science entailed that there was little interdisciplinary work between the two, and thus Kuhn's Structure marked a relatively newfound emphasis on their interdisciplinary relation.

The Debate with Popper

The interdisciplinary focus on history's role in informing the philosophy of science, taken up by Kuhn and several of his historico-philosophical contemporaries, began with how Kuhn's Structure contrasted with the work of the philosopher Karl Popper. Kuhn's historically-informed theory of science was in part, as Kuhn himself recognized, a reaction to the work of Karl Popper, a philosopher who had formulated one of the most influential theories of science in his works, The Logic of Scientific Discovery and Conjectures and Refutations (Kuhn, "Logic of Discovery" 1-24). Popper's theory, in its broadest form, stated that valid science consists in putting forth scientific theories that must be able to be falsified by empirical results (Scientific Discovery 18-20). Science is a cycle of conjecturing falsifiable theories, which must display the possible ways for it to be empirically refuted, and working to empirically refute them (Scientific Discovery 20; Lakatos, "History of Science" 111). But in Structure, Kuhn claimed that "No process yet disclosed by the historical study of scientific development at all resembles the methodological stereotype of falsification by direct comparison with nature" (77). Drawing on the history of science, including examples from Newton's Laws of Motion to Copernicus' rejection of Ptolemaic astronomy, Kuhn claimed that scientists do not refute a scientific theory as soon as an empirical or theoretical counter-instance occurs, as Popper said they should. Instead, most of normal science consists in improving the paradigm to resolve these apparent counter-instances. Only when normal science fails to resolve an anomaly, the rules of the paradigm are blurred, extraordinary science sets in, and a new theory is put forth can a paradigm be refuted: "the decision to reject one paradigm is always simultaneously the decision to accept another, and the judgment leading to that decision involves the comparison of both paradigms with nature and each other" (77-84). For example, as Kuhn noted, Newton's laws of motion seemed, during normal science under its paradigm, "very much like a purely logical statement that no amount of observation could refute," and the counter-instances to his laws merely seemed like puzzles for normal science to solve, until they led to a crisis in which Einstein put forth his own theory (78-79). And thus Kuhn used historical instances like this, which resembles Kuhnian science—specifically, its fluctuation between normal, puzzle-solving research and revolutionary change—much more than Popper's falsification theory, as a way to demonstrate the former's improvement over the latter.

The Role of History

Kuhn even explicitly conveyed how he used the history of science to compare philosophical theories of science with an enlightening analogy to his own work: just as a new scientific paradigm is comparatively stronger than the old paradigm by how well it can assimilate what had proved to be an anomaly for the old paradigm, Kuhn's theory of science is stronger than than Popper's precisely because it can assimilate the historical counter-instances to Popper's as instead fundamental truths (Structure 77). Referring to the argument represented above, Kuhn stated the following:

…they [historical reasons] were, that is, themselves counter instances to a prevalent epistemological theory [Popper's falsificationism]... By themselves they cannot and will not falsify that philosophical theory, for its defenders will do what we have already seen scientists doing when confronted by anomaly. They will devise numerous articulations and ad hoc modifications of theory in order to eliminate any apparent conflict… If, therefore, these epistemological counter-instances are to constitute more than a minor irritant, they will be because they help permit the emergence of a new and different analysis of science within which they are no longer a source of trouble. Furthermore, if a typical pattern, which we shall alter observe in scientific revolutions, is applicable here, these anomalies will then no longer seem to be simply facts. From within a new theory of scientific knowledge, they may seem instead very much tautologies, statements of situations that could not conceivably have been otherwise (77)

Kuhn's brilliant analogy helps lay out precisely how the debate of historically evaluating philosophical theories of science would ensue: just like observational counter-instances to a scientific theory, historical counter-instances alone cannot falsify a philosophical theory of science. Instead, as Kuhn used them (see the Newton example) above, historical counter-instances can be used to advance a new theory, which can assimilate them, over the old theory to which they are anomalies. Finally, Kuhn recognized that once a theory assimilates the historical-counter instances to the old theory, these historical facts nearly become tautological—in the same way that Newton's laws did—in that they demarcate or define what counts as valid science or not, and thus cannot be outright refuted; as Kuhn's theory accounted for the fact that scientists never reject a paradigm without replacing it, this became part of his demarcation of valid science: "To reject one paradigm without simultaneously substituting another is to reject science itself" (79). Ultimately, then, the debate of historically evaluating philosophical theories of science would consist in comparing how well they demarcate what in history is valid science and what is not, in the ways explained above.

This method of historical evaluation can first be elucidated by contrast to the criticism of L. Pearce Williams, a historian who somewhat misunderstood the way in which the history of science was used for philosophical theories. Williams criticized both Kuhn and Popper for basing their views on science on its history: "the history of science cannot bear such a load at this time. We simply do not know enough to permit a philosophical structure to be erected on a historical foundation" (Williams 50). He then gave an example of how each theory lacked sufficiently

robust historical evidence. For Kuhn, he pointed out that Michael Faraday, whose experimental research was typically seen as the "illustration of 'normal' science," actually revealed in his letters and notes that he was actually testing fundamental hypotheses as in Kuhn's extraordinary science (50). For Popper, in turn, he claimed that the history of spectroscopy and the work of Max Planck illustrate the value in normal, non-falsificationist problem-solving (50). What Williams failed to understand is that a philosophical theory of science, as Kuhn mentioned in his analogy above, cannot be falsified by historical-counterinstances alone. Neither Kuhn nor Popper would have dreamed or even hoped that the entirety of scientific behavior in history conformed to their theories of science: for that to be the case, their theories would have to add nothing substantial about the way valid science is done—that is, all scientific behavior would be trivially considered valid. Instead, they both strove—although Kuhn led the focus on the role of history—to find a demarcation that accounts for the inherently valid and successful scientific activity found in history. Thus any historical counter-instance presented alone, like the ones given by Williams, could simply be concerned invalid science by the whim of the philosopher. It is when, as Kuhn recognized, there is a comparison between philosophical theories that historical counter-instances gain their use (Structure 77). For example, instead of each of Williams' examples being used to criticize each of Kuhn's and Popper's theories, the work of Max Planck and the history of spectroscopy, in demonstrating the success of normal science, ought to be used to support Kuhn's theory over Popper's, while the work of Michael Faraday ought to be used vice-versa. And this is indeed how the likes of Kuhn, Popper, Lakatos, Feyerabend, and others used history of science to evaluate philosophical theories of science.

The Historical Evaluation of Competing Theories

This interdisciplinary debate took off when Popper and his contemporary Imre Lakatos led the International Colloquium of the Philosophy of Science in London, 1965, for Kuhn, themselves, and several others to explore and give opinions on the differences between the Popperian school and Kuhn's work (Hacking n17). Resulting in a set of published responses in Criticism and the Growth of Knowledge, the conference fostered, among other philosophical topics, the very debate of historically evaluating philosophical theories of science (n17). Kuhn himself further elaborated on his differences with Popper, recognizing that Popper too, in formulating his theory, looked to the history of science ("Logic of Discovery" 1). But Kuhn claimed that Popper had looked exclusively to the historical periods of extraordinary science, in which experiments played a large role in testing a theory to its limits, to formulate his falsificationist demarcation of valid science (6). Kuhn then recognized that while Popper's demarcation was historically supported by its exclusion of psychoanalysis or astrology, as the two fields did not allow for the falsification of their theories with empirical results, it failed to demarcate the activity of normal science, historically fundamental to science, as valid (8,11). Instead, under Kuhn's theory, the puzzle-solving of normal science served as a large part of his demarcation, and astrology was consequently not a valid science precisely because it did not engage in the puzzle-solving articulation of its paradigms in order to match them with

observational facts—as Kuhn's theory said normal science does. Thus Kuhn argued that his demarcation still excluded, as Popper's did, the pseudo-sciences, but improved upon Popper's by fundamentally demarcating the historically prominent and useful normal science as valid (9).

Looking at the responses to Kuhn, in turn, several others in the conference welcomed Kuhn's emphasis on normal science under a paradigm as an improvement upon basic falsificationism, in that both normal science and critical refutation (which for Kuhn is confined to periods of extraordinary science) are historically prominent and rationally needed. Margaret Masterman, a philosopher experienced in the sciences, noted a support for Kuhn that functions, although about contemporary scientists, in the same way as historical support would: "It is because Kuhn—at last—has noticed this central fact about all real science…namely that it is normally a puzzle-solving activity, not a fundamentally upheaving or falsifying activity…that actual scientists are now, increasingly reading Kuhn instead of Popper" (60). That Kuhn's work is more believable and coherent for contemporary scientists strongly suggests that the same would be true for historical ones in the same, mature fields. Lakatos, in developing his more sophisticated falsificationism, recognized that the stable periods in history point to the dogmatic attitude that Kuhn recognized in his concept of normal science, and one useful to the extent it is relinquished as normal science degenerates—a qualification rather similar to Kuhn's depiction of extraordinary science ("Falsification" 177). Paul Feyerabend, another philosopher of science, also recognized that to an extent Kuhn was right in emphasizing the normal, conservative element in science ("Consolations" 211).

While recognizing the historical and rational place of normal science as Kuhn did, several participants claimed Kuhn's theory too greatly distinguished and temporally separated normal science from extraordinary science, and thus it excluded some significant historical scientific activity. Popper, in reply to Kuhn, conceded that Kuhn's distinction of normal and extraordinary science, of which Popper had "at best been only dimly aware," pointed out "something that is of great importance," but that Kuhn has over-represented the both the distinction between the two ("Normal Science" 52). Popper pointed out that history showed—in the examples of Darwin's creative and ingenuine work in the un-revolutionary field of descriptive botany, of Boltzmann's following of Maxwell while rejecting the predominant science of his time—that there are "many gradations" between normal and extraordinary science (54). Feyerabend claimed that the theory-tenacity of normal science and theory-proliferation of extraordinary science did not "belong to successive periods of the history of science, but are always copresent" ("Consolations" 211). He cited that the three mutually incompatible paradigms of classical physics had existed in the second third of the 19th century: the paradigms of mechanics, of a phenomenological theory of heat, and of electrodynamics (207). And he claimed that it had been the proliferation and "active interaction" between these paradigms that had "brought the downfall of classical physics" (208). Thus Feyerabend argued that Kuhn was wrong in temporally separating the proliferation of multiple paradigms and the tenacity of a scientific viewpoint into temporal periods of normal and extraordinary science. Instead, as shown in his example, it is "the interplay between tenacity and proliferation" that serves as an "essential

feature of the actual development of science" (209). Feyerabend further claimed that historically, there is no reason for expecting, as Kuhn does, that the normal and extraordinary elements of science will exhibit a logical structure, as there is too much non-rational influence on scientific behavior and institutions (214).

The Adoption of History in the Philosophy of Science

Both the positive and negative evaluations of Kuhn's theory from the 1965 conference exemplified how the history of science was used to evaluate philosophical theories of science. And this philosophical role that Kuhn gave to history was greatly expanded upon by his contemporaries, including those at the 1965 conference whose work found much of its development in the debate with Kuhn. Lakatos published "History of Science and Its Rational Reconstruction" shortly after Criticism and the Growth of Knowledge, and continuing his work on scientific research programmes that began in the latter, he offered up a historical evaluation scheme rather similar to Kuhn's: "Progress in the theory of scientific rationality is marked by discoveries of novel historical facts, by the reconstruction of a growing bulk of value-impregnated history as rational" (118). Just as Kuhn had reasoned that demarcations of science can be compared by how well they account for historical instances, Lakatos proposed that theories of scientific rationality can likewise be compared by how much of history they can account for being "value-impregnated," or conforming to their standards (Structure 77; "History of Science" 116-118). Feyerabend likewise developed the ideas from his paper in Criticism in his 1975 Against Method, in which he used philosophical analysis as well as historical evaluation to develop his theory that there are no rational rules for science. As Toulmin noted, by the 1970s, most philosophers of science recognized the need for their theories to apply to actual historical science: "public debates in the philosophy of science were repeatedly turning into analysis of key episodes in the historical evolution of science; and the scholarly burden of proof had shifted so far that these historical issues had to be faced and dealt with" (152). And Kuhn no doubt played a central role in bringing historical concern to the philosophy of science.

The success of Kuhn's Structure of Scientific Revolutions is ultimately not found in its argument being widely accepted, but rather how it bore a positive influence on interdisciplinary thinking—in particular the historical evaluation of philosophical theories of science. It is telling that Kuhn's actual argument—his structure of scientific development—largely failed to provide a model for the actual research of historians of science, who found it, as Nathan Reingold succinctly wrote, "less useful as a means of organizing their findings" (Reingold 467; Settle 105-106). As this paper has attempted to show, Kuhn used a historical argument for profoundly philosophical conclusions, which were consequently avoided—whether reasonably so is another matter—for historians of science doing research solely in their own field. But especially in the philosophy of science, it is the influence of his work rather than its acceptance that marks its success. As exemplified by the 1965 colloquium, Kuhn's contemporaries in the philosophy of science had much to criticize about his theory presented in Structure—the historical evaluations above are a mere glimpse of a much wider debate and criticism. But given the occasion for their

criticism—an international colloquium of several of the leading philosophers of science—and, more importantly, the fruitfulness in the discussion, it is clear that his contemporaries found his work seminal enough to prompt a significant response to and a productive exploration of his ideas (Criticism). Stephen Toulmin even claimed that Kuhn's work has a long-term positive influence in part "because historians and philosophers have had to join forces in order to criticize his initial formulations effectively" (154). His influence on future work in the philosophy of science, in setting an example for how philosophical theories can be historically evaluated, is perhaps the strongest testament to his success. Kuhn remarked in Structure, "Is it really any wonder that the price of significant scientific advance is a commitment that runs the risk of being wrong?" (101). In his bold interdisciplinary project that was The Structure of Scientific Revolutions, Kuhn certainly ran the risk of being wrong; and the philosophy of science, in learning to remember its subject's past, has been the better for it.

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The Inadequacies of the Prison System By Siya Shokeen

Abstract

Upon analysis of the common flaws within prison systems on a global scale, the scope for change in humanising present structures employed as forms of punishment by the criminal justice system grows evident. In pursuit of greater reform within the prison system with respect to optimising processes in their original aims such as rehabilitation and deterrence, reflection upon past failures and present successes is of utmost necessity. Hence, in order to effectively complete this study, I consider present issues with a focus on the prison system of the United States and contrast it with the Halden Supermax Prison in Norway. The comparison between the treatment of prisoners within both systems and resultant outcomes when reviewing current research provides grounds to inform solutions for change. In consideration of these findings in line with reformative agendas, a clear path for evolution in generating positive change emerges for consideration. It is the fundamental objective of this paper to generate sound conclusions regarding these potential avenues for change and develop an evaluation of such pertinent processes to address the imminent flaws within the prison system.

Introduction

The criminal justice system holds a pivotal position in shaping the kind of society we live in, defining its collective moral character and values by characterising what constitutes acceptable conduct. Over the course of history, humanity as a collective has formed countless systems for the deliverance of justice, punishing a crime for both beneficent and self-serving reason. Originating from the intrinsic human desire to rationalise and ritualise necessities (Stearns), systems of punishment exist as an individual and social defence against actions considered to be damaging to the moral fibre of a society. As these systems have developed and evolved, we have reached a position in organised society where the primary form of punishment for major crimes is the stripping of individual liberty by placing individuals who violate the law in prison. In doing so, the justice system seeks to fulfil a plurality of aims, primarily revolving around deterrence, expressivism, rehabilitation, and the deliverance of retributive justice.

However, as we have progressed, the issues that arise from this system are growing increasingly apparent, especially with regards to the impact of such on the welfare of incarcerated individuals.

In this paper, I will explore the current issues with the status quo, using the American Prison system as a case study for problems that arise in a first world nation where broader socioeconomic conditions such as lack of funding do not underlie the plethora of inhuman conditions that riddle the American prison system. Following this, I will explore a series of solutions to such apparently problematic systems by evaluating abolition as a goal, and deconstructing its effectiveness and lack thereof. Furthermore, I will then examine the application reform to present conditions by a case study of the Norwegian Halden SuperMax prison, renowned for its remarkable humanity. By comparison of these systems, I hope to

demonstrate the particular shortcomings of the American prison systems and present evidence that these are capable of being remedied and not in fact a lost cause.

Current Issues with the Status Quo

It is no secret that the prison systems of America boast a wide array of problematic conditions and are set up in such a way that makes fulfilling original aims of the prison system such as rehabilitation difficult at best. These arise primarily due to the rates of mass incarcerations and subsequently abhorrent conditions experienced in prison that make rehabilitation difficult, if not impossible. There is a severe disregard for the health and wellbeing of prisoners that lends itself to a degradation of human welfare within those prisons, contributing to generally inhumane conditions. These all cumulate in concerningly high rates of recidivism and America not growing at all closer to addressing issues of crime.

Mass incarceration is a prominent issue throughout the western world, particularly in respect to the systemic over policing of minority groups and their subsequent overrepresentation in the prison system. Such rates of incarceration have a highly detrimental impact, causing overcrowding that overwhelms the system and creates more harm than good. This is particularly an issue in the United States of America which boasts the largest prison population in the world, and despite the U.S. making up only 5% of the global population, the American prison system holds approximately 20% of the world's prison population (Holder et al.). Although the number of incarcerated individuals in America has been on a slight decline since 2008 , it has seen a 500% increase since 1970 (The Sentencing Project, "Criminal Justice Facts"). Contrary to popular opinion, mass incarceration has done little to genuinely improve the safety of the public. Mass incarceration is an expensive way to achieve less public safety (Stemen), costing taxpayers in America a whopping $87 billion in 2015 for roughly the same level of public safety achieved in 1978 for $5.5 billion (Bureau of Justice Statistics, "Expenditure and Employment Data for the Criminal Justice System 1978"). Furthermore, in consideration of the myriad of other expenses of the public safety machine including but not limited to policing, court costs, and family spending to support incarcerated family members, mass incarceration costs state and federal governments and American families $182 billion each year (Wagner and Rabuy).

In addition to the funding poured into the prison yielding little results, the conditions in prison remain abhorrent. In the USA where approximately 25 percent of male inmates and 20 percent of female inmates reported being physically assaulted during their current sentence (Forum on Global Violence Prevention et al.), demonstrating the shockingly widespread nature of violence throughout prisons.

Such issues are exacerbated by managerial ignorance of such pressing issues, a prime example of which is the Alabama Department Of Corrections. Federal investigators discovered that a minimum of 30 deaths of incarcerated men were not disclosed by prison officials in Alabama, and that three homicides committed in 2017 and 2018 failed to be reported as homicides by the ADOC (Equal Justice Initiative, "Justice Department Finds Alabama Prison Conditions Unconstitutional"). In addition to evident neglect by prison officials being

detrimental to the physical safety of prisoners as threats to their safety were not brought to light, the ADOC have neglected the safety of their employees. Despite "repeated notification of the problems." the ADOC failed to take action to protect their employees against or correct the "toxic, sexualized environment that permitted staff sexual abuse and harassment" at Tutwiler Prison for Women. The Justice Department found in 2019 that the Alabama Department of Corrections had been aware of the unconstitutional conditions in its prisons far before the Justice Department's 2016 statewide investigation into the prisons, yet "little has changed" (Equal Justice Initiative, "EJI Welcomes Justice Department Challenge to Alabama Prison Conditions"). In fact, the documented violence has only gotten worse since the Justice Department announced its statewide investigation in 2016 and there is a continued failure to protect individuals from astounding levels of violence. In 2019, over the course of a single week, there were four stabbings (one that involved a death), three sexual assaults, several beatings, and one person's bed set on fire as he slept (Benner and Dewan). Unfortunately, such issues surrounding the are not isolated to the singular state and are concerningly widespread across the United States.

Even after being subjected to such instances of violence, prisoners receive astoundingly poor quality medical care, particularly in the United States. American prisons and jails often function as mechanisms of poor community health because of their disjointed internal health care systems that adversely affect the total of nearly 2 million inmates they harbour. About 80% of imprisoned individuals have been diagnosed with a chronic health condition that requires longitudinal primary care for optimal recovery and maintenance of prisoner wellbeing. Despite such pressing need for medical care in prisons, it is remarkably difficult to access a doctor through prisons. In the US, inmates must first visit a correctional officer who will decide if care is a necessity, and in the case that it is deemed to be so, they will allow the prisoner to see a nurse before they can even see a doctor.

Jumping through such hoops and going through a whole 2 people who will determine how pressing the needs of prisoners are before individuals can access adequate healthcare creates unnecessary difficulty that poses great health risk to incarcerated individuals. If at any point there is a misunderstanding concerning the state of the prisoner's health, it could be potentially fatal if they are barred from receiving the medical care they require. However this access is not only limited by administrative barriers, but financial and socioeconomic barriers as well. In a significant number of states in America, inmates are required to pay $3 or more to be seen by the prison physician. If fortunate enough to have a prison job, prisoners make $0.75 a day which equates to four days' worth of work to be able to see a physician for any sort of medical issue. That is particularly an issue for those who are imprisoned and lack any external support from family members. Additionally, many states uphold a Medicaid exclusion policy for inmates–meaning that a prisoner that is a recipient of government support to access medical care due to financial difficulty has their eligibility and coverage suspended or terminated the moment they enter prison. At the end of their sentence, they need to reactivate Medicaid and it's highly common for them to encounter problems that can block that. The medical transition from incarceration to release is neither smooth nor effective. Though it varies by state, when

individuals are released, they receive a limited supply of medications and a list of their medications. In the worst case, they are provided with nothing at all.

In addition to the severely lacking physical health care in American prisons, the mental health care is perhaps even more appalling. Mental illness is highly prevalent in the prison system, with over half of the individuals comprising the prison population of the USA experiencing some form of mental illness (Mental Health America). Prisons in remote and rural areas fail to hire and retain mental health professionals (Thompson and Eldridge), and due to a lack of such resources, misdiagnosis of serious mental health issues is more likely. And not only is the treatment of such prisoners inadequate, but false negative determinations can also make it more difficult for them to receive disability benefits or treatment once released. Referring back to Alabama as an example for some of the most deplorable prison conditions in the USA, in 2017, a federal court found Alabama's "horrendously inadequate" mental health services as having led to a "skyrocketing suicide rate" amongst their prison population (Equal Justice Initiative, "Federal Court Rules Alabama Prisons 'Horrendously Inadequate'"). The court found that prison officials do not take steps to identify individuals experiencing serious mental health issues and do not appropriately address concerns. There is extremely inadequate treatment for prisoners experiencing suicidal thoughts and tenders. And in Alabama prisons, rather than providing the required support, they discipline people with mental illness, often putting them in isolation for long periods of time.

Studies have shown time and time again that solitary confinement is highly damaging to the mental wellbeing of those who are placed there and it is highly ineffective for treating those who are afflicted by mental illness. Over 60,000 individuals are held in solitary confinement across the American prison system. They're isolated from other inmates in cramped cells for 23 hours a day, and only permitted to leave for showers, brief exercise, or medical visits, and are denied calls or visits from family members that may actually positively benefit their mental health. Studies evidently demonstrate that individuals that are held in long-term solitary confinement suffer from conditions such as anxiety, paranoia, perceptual disturbances, and deep depression. Across the entire US, suicides among those who are held in isolation account for almost 50% of all prison suicides, despite less than 8% of the prison population being in isolation. Such methods of discipline being employed in prisons is highly concerning as they are demonstrably ineffective and damaging, going so far as to only display the demerits of our current prison structures and their methodology of punishment.

Mental illness is not only left untreated by the prison system to fester on its own, but it may also be caused by placement in such systems. Common symptoms experienced amongst those released include: dependence on institution, loss of capacity/judgement; hypervigilance, distrust, suspicion; emotional over-control, alienation, and psychological distancing; social withdrawal and isolation; incorporation of exploitative norms; and diminished sense of self-worth and personal value (Forum on Global Violence Prevention et al.). In addition to this, incarcerated people who are frequently subject to inadvertently witnessing the violence that is so widespread in their environment feel helpless to protect against it can experience post-traumatic

stress symptoms — such as anxiety, depression, paranoia, and difficulty with emotional regulation — that can last years following their release from custody (Novisky and Peralta).

Of the more than 1.5 million people incarcerated in American prisons in 2019, more than 95 percent (Bureau of Justice Statistics, "Bureau of Justice Statistics Reentry Trends in the U.S.: Highlights") will be released back into the community at some point, at a rate of around 600,000 people each year (Assistant Secretary for Planning and Evaluation). These lingering aftershocks of stays in prison have ripple effects throughout communities that are proven to be of greater detriment to society than any benefit. Over 113 million Americans have had a close family member in jail or prison (Hayes), the social costs can be cataclysmic. A major factor that the prison system fails to account for is our interconnectedness as a society and how imprisonment punishes more people than just the perpetrator. For instance, over 150,000 imprisoned mothers spent the day apart from their children (Bertram and Sawyer). A child being separated from their mother, particularly at an early age, may experience adverse effects such as maternal separation trauma, especially as there is no guarantee that they have an adequate support system to bridge the gap that the absence of their mother creates. Furthermore, children who have an incarcerated parent run greater risks of health and psychological problems, lower economic well being, and decreased educational achievement (Martin). The aggravating effect of imprisonment far from one's family is evident.

The potential negative effects of the removal of an individual from their community of family and friends are evident, but unfortunately, 'corrective facilities' fail to achieve what they hope to which is rehabilitation and reformation, creating cycles of individuals spending a good portion of their life in and out of jail. A long-term study of recidivism rates in America of people released from state prisons from 2005 to 2014 found that 68 percent were arrested within three years and 83 percent were arrested within nine years following their release (Bureau of Justice Statistics, 5 out of 6 State Prisoners Were Arrested within 9 Years of Their Release). This evidence confirms the great irony of the American criminal justice system: the longer someone spends in "corrections," the less likely they are to stay out of jail or prison after their release (Pew Charitable Trusts). Despite this clear data, not nearly enough action is being taken to help rehabilitate prisoners. In Florida, which has the third largest prison system in America, there are virtually no education programs for prisoners (Maxwell), even though research shows that those programs reduce violence in prison (Pompoco et al.) and the recidivism rate for those released from prison (Mooney and Hopwood). Through severe authoritarianism, rules, and control, prisons reduce personal autonomy and increase institutional dependence. This ensures that people learn to rely upon the free room and board only a prison can offer, thus rendering them less able to cope with the economic demands of sustaining life upon release (Harding et al.).

Irrespective of such blatant evidence of the many failures of the prison system in fulfilling its aims, enacting effective, long term change is near impossible. Many state and local governments have entered into expensive long-term contracts with private prison corporations to build and sometimes operate prison facilities. Since these contracts prevent prison capacity from being changed or reduced, they effectively block meaningful criminal justice reform (Covert)

despite staunch bipartisan support (The Sentencing Project, Capitalising on Mass Incarceration U.S. Growth in Private Prisons). This is primarily due to the prison population boom of the 90s that effectively eliminated court oversight for prisons and jails as lawmakers made it significantly more difficult for incarcerated individuals to win civil rights suits (Booker).

As of present, the prison system is riddled with such flaws that with the state of the system are apparently irresolvable in the short term. It would take major overhauls and upheaval, as well as enormous amounts of planning and funding to institute any lasting change to these evidently worrisome issues regarding the welfare of incarcerated individuals. This does not, however, mean that there is an absence of hope for the future as the prospect for solutions are vast and with proper institutional support, the possibilities for improvement are near endless. Potential Solutions

All such issues posed in the prison system create a cumulative environment that renders change to be a foreign concept, as the poor administration of the prison system appears to be so deeply entrenched into the justice system that alternatives and reform are difficult. However, this has not stopped people from continuing to try to better the injustices that occur throughout the prison system. Over time, these various approaches have formed and fallen into two distinctive categories; the abolitionist agenda and the reformative agenda, within which the restorative justice approach falls.

Abolition

The abolitionist agenda seeks alternatives to the prison system, deeming the entire concept of the removal of human autonomy to be a poor execution of justice in the first place. As summarised thoroughly by Marina Bell, "The goal of abolition... is to eliminate carceral institutions, the prison industrial complex, and the criminal punishment system as a whole, and to replace them with non punitive ways of addressing harm that empower, rather than disenfranchise, vulnerable populations and communities." (Bell).

Abolition is not something that can realistically be achieved swiftly in one fell swoop. It is a process that would in theory take a number of years, perhaps even decades, to entirely overturn the prison system as we know it and remodel it entirely. Furthermore, the question of which method is best is incredibly difficult to determine when the current punitive system was once considered to be a remarkably humane system. The innate flaws with the removal of autonomy and personal liberties as a punishment may not ever be able to be remedied by making changes in a system that is perpetually flawed.

Currently, the most widespread and active abolitionist movement group in America is Critical Resistance, who cite their goals as eliminating punishment and imprisonment, policing, and surveillance and creating lasting alternatives (Critical Resistance). In their own words, they are unable to accurately picture what form abolition will tak, but whatever it may be, it will be a far cry from buildings full of cells as it is today. Another aim they describe is the unravelling of social conditions as the prison industrial complex "both feeds on and maintains oppression and inequalities through punishment, violence, and controls millions of people". As the prison

industrial complex is not an isolated system, Critical Resistance considers abolition to be a 'broad strategy'. In the vision of this group, the abolitionist view is representative of future goals, built upon practical strategies to move closer to these dreams.

However, the issue lies in the fact that this movement's actions are rooted in goals and dreams. This movement, despite being among the most widespread abolitionist agendas in America, lacks a clear vision beyond stopping the growth and expansion of the current PIC in America. After reviewing their website and understanding their achievements to date, which are to be commended considering their intensive effort, are no step closer in breaking down the current system and truly reaching a state of abolition. This is a national movement with multiple chapters across the USA but what is lacking is an ability to instil lasting change in their society. This is due to them currently lacking any power to change the system outside being a group of individuals protesting without true ability to enact the change they desire.

This is a particularly prevalent issue throughout the majority of abolitionist movements across the world. There is a fundamental lack of power possessed by them and as for those who have it, a lack of desire to truly abolish and reconstruct the punitive process of the criminal justice system.

Reform

As the prison systems of the world are lacking in many ways, a far more practical and easy to implement solution is reform. A world leader in humane prison structure and treatment is Norway, their efforts and philosophy being exemplified in Halden Maximum Security Prison. This prison employs philosophies of restorative justice and its greater appeal to the original purpose of prisons for rehabilitation, holding a "better out than in" ideology.

The restorative justice approach to prison reform prioritises the repair of harms caused by criminal behaviour and the promotion of healing and reconciliation amongst all affected parties. Unlike traditional punitive approaches, restorative justice places high emphasis upon creating a holistic, community driven approach to the reduction of crime by addressing root causes as opposed to enforcing punishment.

The Norwegian prison system developed to its progressive state over a long period of steady developments, beginning with capital punishment being banned in 1902, with the next major development being the abolishment of life sentences in 1981. Up until 1998, Norway had just about the same systems of operation in prisons as America. The Norwegian Ministry of Justice reassessed the goals of the Corrections System and shifted focus to rehabilitation by means of education, job training, and psychological treatment. After this major shift, there was a second Wave of improvement in 2007 to make reintegration a priority alongside rehabilitation. Prior to the release of inmates, the authorities in the prison would ensure that prisoners had housing and found work with steady income.

A major concern, perhaps, of those in nations such as the United States when considering the issue of prison reform is the financing of it with consideration as to the expenses of better facilities for prisoners. However, according to the Vera Institute of Justice, spending on the

Halden prison runs to more than $93,000 per inmate per year, compared to just $31,000 for prisoners in the United States. Though this seems high, being threefold the price in the US, if the United States were to reduce its rate of incarceration of its citizens to be the same low rate as Norway (75 per 100,000 residents, versus roughly 700), it could spend that much per inmate and still save more than $45 billion a year. Although, it is necessary for it to be considered that Norway's prison population sits just shy of 4,000 at 3,960 (Statista, "Norway: Prison Population 2022") in comparison to the 1.8 million held in American prisons (Statista, "Ranking: Most Prisoners per Capita by Country 2020").

Unlike many other prisons worldwide which prioritise efficiency and safety in prison design, the Halden prison has been specifically designed to "ease psychological pressures, mitigate conflict and minimise interpersonal friction" (Benko). The "prison cells" are much unlike the typical image of a grey stone room enclosed by iron bars, but rather resemble a standard student accommodation, featuring comfortable facilities of a bed, desk, and personal storage, all in a signature Scandinavian style of design features. The rooms are not intended to provide the prisoners with a sense of captivity but rather a feeling of normalcy and comfort to shift from a focus on punishment to rehabilitation. Instead, the high grey walls that line the perimeter of the prison are the only primary design feature present to intentionally remind the prisoners that they no longer have the autonomy to roam the world how they please.

Despite their inability to leave, most prisoners have free reign to move between their room, common room areas, classrooms, and the like. This is due to different form of policing the movement of prisoners known as dynamic security as opposed to the standardised image of security that is known as static security (i.e. security cameras constantly watching inmates, officers accompanying inmates when they move about, authority to physically harm inmates that misbehave, etc). Dynamic security focuses much more on establishing a relationship built on mutual trust between security and inmates. Interestingly, the offices of security guards are designed to be small and cramped to encourage them to roam around and socialise with the prisoners, often over a coffee or tea in a common room. This focus is for the primary purpose of ensuring bad intentions between the security and prisoners do not develop in the first place to address the root cause of prison violence in the first place. Because of such mutual trust, the prison does not place surveillance cameras in the classrooms, common areas, cell hallways, or cells. Furthermore, the prison is designed in such a manner that there is no focus on preventing anything that could potentially be used to cause harm such as a knife, glass, or ceramic plates, within reach of prisoners. In fact, the prisoners have easy, open access to such objects in common cooking areas and kitchen workshops to expand their skill set and sense of independence.

Though prisons inherently limit the liberties and autonomy of those they imprison, Halden prison makes a point of aiming to grow the independence of their prisoners and ensures that their autonomy does not fall below a baseline, humane standard. This care for their wellbeing and free will is shown in the integration of nature as a part of the rehabilitation process, such as a blueberry forest, for prisoners to access easily. However, Molden, one of the

prison's chief architects stated that they "don't think of it as a rehabilitation" but as a "basic part of growing up". This highlights the focus on reintegration and rehabilitation as the time in prison is not so much a period of punishment as opposed to an opportunity to learn and grow, hopefully redirecting past offenders from continuing down the path of crime and truly offering another chance.

Once prisoners are out of prison, they do not go unsupported. Those who are released are provided with a reintegration guarantee as the authorities ensure that prisoners are provided with a home, a job, and a supportive social network prior to their eventual release. Norway also has an excellent social safety net that ensures access to free/ heavily subsidised healthcare, education, and pension to offer those who are unable to meet the demands of the cost of living and education a helping hand. Such systems being in place contribute to the low recidivism rates of Norwegian prisons.

Unique social contexts that have contributed to the current processes that define the prison systems of America and Norway function respectively. It is critical to be aware that, despite the fact that these results can be attributed to the organisation and programs used by Halden Supermax prison, they are generally only able to be so effective because of the broader context of Norwegian society and overall conditions within the country. The exact conditions of any prison system can not be directly transported to an entirely different society, despite ample resources, due to the cultural factors of each nation which shape the manner with which prisoners are treated. However, there still remains an integral lesson to be learned from such prisons which centralise humanitarian ideals and restorative justice as critical values that shape their structure. In doing so, punitive consequences may lead to greater outcomes for individuals that enter the prison system and society as a whole if greater considerations are made to address the present issues with prisons.

Recommendations

Ultimately, the most realistic way to truly address the issues that perforate the prison systems, particularly those of world leaders such as the USA, is the pursuit of the reformative approach as employed by Norway. This, however, would have different applications in each country as all possess their individual struggles with mass incarceration that require reduction before there is any potential for the sheer funding required to get such a large scale overture of present systems off the ground. Such change in large countries such as these can only be enacted as highly long term plans spanning a decade at the bare minimum. This is also not in consideration of factors such as the social climate in these nations and collective political attitudes that may pose detrimental to such a movement. However, if provided enough backing, these nations are likely to be able to make significant positive change if they follow a reformative approach prior to considering anything remotely abolitionist. If I were to draw up a rough guideline of what sequence I believe such a movement would take, it would be much like this.

A foremost stage of reform would involve the development of greater social support and welfare for formerly imprisoned and at risk individuals as an essential safety net. This may come in the form of support groups at local community and religious centres or aid in finding stable employment following the completion of a prison sentence.

The following step in reform would necessitate addressing the Mass Incarceration Issue by a review of sentencing policy, which while a lengthy process, is a necessary reflection on the criminal justice system and its reflection of societal values. Such integral law reform would require a critical assessment of criminal codes such as non violent crime, reflecting on the efficacy and necessity of incarceration for particular crimes, with emphatic consideration for non-violent offenders. A following congressional discussion by lawmakers is essential for the implementation of social change as presently there is neglect towards the underlying factors that influence criminal behaviour, with primarily only reactionary measures that address the outcome in place. Furthermore, it should be noted that though the courts take measures to ensure Procedural Fairness, the notion of Procedural Justice is typically undervalued within the prison system which is a similarly critical branch of the criminal justice system and upholding it as a core value in defining criminal justice systems on a global scale will lead to better recognition of justice across such systems.

Another key area in addressing the substandard conditions experienced by imprisoned individuals would be a mass renovation of current prisons. It is essential to upgrade current outdoor and indoor areas by creating a lighter, brighter, more positive environment within the prison itself. In consideration of practical barriers in complete overhaul of an existing prison building, this would likely take place in the development of extensions to the current prisons that include common areas for safe, monitored socialisation, areas to hold workshops, and classes. Better healthcare facilities are further essential to support those who are struggling mentally and/or physically. The development of better equipped treatment facilities within prison for those with mental health concerns alongside the prison itself to address the pressing issue of mental health that is currently remedied primarily by solitary confinement which typically exacerbates the issue. In that vein, a total abolishment of solitary confinement is of high importance, instead opting for communal or individual based remedial sessions to address the root cause of the issue rather than subjecting the individual to poor treatment. It is duly noted that there are prisoners that pose genuine physical threat to those around them, however that should be considered a mental health issue and treated accordingly, with appropriate physical measures taken to monitor and address these concerns without elimination of all socialisation.

To combat aggression between prisoners and security, a switch from Static to Dynamic policing is required. Security being able to develop a level of trust with the prisoners and a standard of mutually respectful behaviour is beneficial to the enhanced safety of the prison environment. Hence, it is of greater importance that the prisoners and security develop positive relationships for ensuring a reciprocated level of decency for the safety of both parties.

The establishment of rehabilitation guarantees for prisoners awaiting release is a critical area in combating high recidivism rates by addressing the factors that hold back rehabilitation by

placing at risk individuals directly in the environment that drives them toward crime without any aid in improving their circumstances. This would entail ensuring proof of stable housing, employment, and support channels for all prisoners prior to release with aid systems being in place to ensure their provision.

Conclusion

Summatively, the prison system is not one without flaws. Currently, there is an apparent lack of regard for the welfare of prisoners, for it appears that once they are imprisoned their wellbeing is a decentralised focus of the prison system, with a rather heightened emphasis on subordination. The original aims of the prison system as a deterrent force and centre of rehabilitation for criminal behaviour are not being adequately fulfilled by present systems, with it presently only functioning as an expressive form of dissent in providing retribution for crime. This is made expressly apparent in the dismal rates of prisoner wellbeing across the board and unfortunately high recidivism rates.

These conclusions are all supported by the evidence in extensive research conducted on the widespread systematic flaws of the American prison system, a nowhere near underfunded system which remains rife with issues that cause, to an extent, irreparable harm to individuals and society on a broader level. At present, there is no shortage of research on the shortcomings of the American prison system, however there is a lack of empirical research upon the problems of prison systems globally. Though this paper is limited to the study of American prisons broadly and a singular Norwegian prison, these same issues discussed can be seen in prisons globally, the poor conditions that prisoners are subjected to are widespread internationally.

There is a pending discussion surrounding the fundamental necessity of punitive systems themselves, and if any form of punishment whatsoever. Currently there is no consensus within society upon this matter as it is deeply philosophical and subjective in many ways. Though highly relevant to this paper, this was left undiscussed due to the sheer variety in opinion and lack of objectivity, especially in the inability to reasonably conclude it without imposing personal beliefs beyond the scope of assessing such a dynamic topic.

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Addressing Limitations of Neuroimaging and Systemic Gender Disparities and Biases in Autism Research and Diagnosis by Zephyr Mukamal

Abstract

Autism Spectrum Disorder (ASD) presents a diverse and complex set of behavioral, cognitive, and social characteristics, making its definition and diagnosis challenging. While strides have been made in understanding the neurological underpinnings of autism, there is an urgent need for more inclusive and comprehensive research. Knowledge of the gender biases inherent in neuroimaging and diagnostic practices is crucial in understanding the intersectionality of autism, gender, race, culture, and individual experiences. These gender biases also lead to the underdiagnosis and misdiagnosis of non-cismale individuals with autism. This paper maintains why a more holistic, intersectional approach to autism research and diagnosis that accounts for the diverse manifestations of the condition—and that integrates social, cultural, and environmental factors—in understanding and diagnosing autism is crucially important.

Introduction

Autism Spectrum Disorder is a human neurological and developmental variant. Although much remains unknown about the complex, polylithic array of neuroanatomical, genetic, sensorimotor, cognitive, and behavioral characteristics of autism, evidence suggests that the fundamental traits distinguishing the neurology of autistic people from allistic people is found in their heightened synaptic connectivity and responsiveness (Walker, 2014). The widely accepted parameters around which autism is diagnosed are persistent so-called "deficits" in social communication and interaction and restricted, repetitive patterns of behavior, interests, or activities. The Diagnostic and Statistical Manual (DSM-V-TR) specifies that these characteristics must be present in early development "but may not become fully manifest until social demands exceed limited capacities, or may be masked by learned strategies in later life" (American Psychiatric Association [APA], 2022, p. 50). However, autism remains undiagnosed for many people, especially autistic girls and women with low support needs. The prevalence ratio is often cited as 4 diagnosed boys for every 1 diagnosed girl with autism, a phenomenon known as the male bias (Brickhill et al., 2023).

This paper begins by exploring some of the proposed endophenotypes and neurobiological mechanisms underlying ASD. It then critically examines the limitations of neuroimaging technology in capturing the complexity and diversity of autism in scientific research. Next, the paper discusses some of the gender biases present in gender neuropsychological research as a whole before addressing bias and misinformation specific to autism research. The paper finishes by discussing and providing a brief sociological explanation for the fact that certain populations are disproportionately underrepresented in autism diagnosis rates.

Despite significant advancements in understanding the neurological underpinnings of autism, current research and diagnostic practices exhibit critical limitations, primarily due to

gender biases inherent in neuroimaging and diagnostic approaches. This paper affirms that a more holistic, intersectional approach to autism research and diagnosis is crucial. Such an approach will better account for the diverse manifestations of the condition and integrate social, cultural, and environmental factors—and ultimately contribute to better support and mental health for autistic individuals.

Defining Autism Spectrum Disorder, its etiology, and endophenotypes

As a result of their heightened synaptic connectivity, autistic individuals may register more sensory and cognitive information than their allistic counterparts. The brains of most autistic individuals seem to have a bias towards information processing at the local level, which helps explain why autistic individuals tend to perform worse than allistics on tasks requiring the integration of perceptual information across time. Their subjective experiences and the impact of their sensorimotor and cognitive input may be more chaotic and intense. It has also been hypothesized that the variations of cortical connectivity underlying sensory and perception styles characteristic of autism underpin restricted and repetitive behaviors, such as stimming (stereotypy) and special interests (Baum et al., 2015). These somatosensory variations could even cascade into behavioral and social differences; that is, perceptual deficits leading to social withdrawal and challenges with top-down integration of social rules constructed by neurotypicals.

Due in large part to the heterogeneity of autism's behavioral presentations, identifying a unifying endophenotype or etiology is complex. Three leading theories that explain autistic differences in social interaction, communicative capacity, and behavioral flexibility are theory of mind deficits, weak central coherence and enhanced perceptual functioning, and executive dysfunction, respectively (Romero-Munguía, 2013).[1] These theories help explain core triadic characteristics of ASD: difficulty with communication; difficulty with reciprocal social interaction; and restricted, repetitive, and stereotyped attentional and behavioral patterns. Two other theories that attempt to explain all three core triadic symptoms are the Empathizing-Systemizing and Mnesic Imbalance theories.[2] In more recent years, other endophenotype theories have been proposed, such as dysregulated excitation-inhibition balance, aberrant cortical connectivity, and lower predictive coding and Bayesian inference

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[1] Theory of mind refers to the ability to attribute mental states to others; perceptual functioning and central coherence refers to the function and independence of auditory and visual abilities and the ability to derive overall meaning from a set of details; executive functions refer to the processes necessary for the cognitive control of behavior.

[2] Empathizing-Systemizing refers to a spectrum of trait profiles that encompass atypically and typically developing individuals, with empathizing tendencies on one end of the spectrum and systemizing tendencies on the other; mnesic imbalance is a theory that suggests, in autistic individuals, declarative memory partly replaces faulty procedural memory.

Dysregulated excitation-inhibition balance

One proposed endophenotype is the neurophysiological model of dysregulated excitation-inhibition balance. According to this model, damage to inhibitory neurons may lead to increased local connectivity, especially cortical minicolumns, which play a role in intracortical communication. In other words, atypical gamma-aminobutyric acid (GABA) levels (the chief inhibitory neurotransmitter) causes dysfunction in inhibitory neurons, which can lead to increased excitation. This imbalance manifests as intense and chaotic brain activity, particularly at the local level (local hyperreactivity). In this way, there is a kind of isolation where local networks are less influenced by the broader neural context, leading to weakened long-range connections between different brain regions. In other words, local hyperreactivity coincides with global hypo-connectivity. Recent research, however, suggests that the excitation-inhibition imbalance may not only arise from increased excitation but also from increased inhibition, contributing to the heterogeneity of ASD (Dickinson et al., 2016).

Aberrant cortical connectivity

Several studies point to the underlying cortical profiling and connectivity of autistic individuals. It has been proposed that the disruption of excitation-inhibition at the cellular level has consequences for patterns of connectivity across the cortex (Berg & Pliopis, 2012; Spence and Schneider, 2009). The synchrony of neural networks is a critical aspect of sensation, perception, and cognition, and disruption thereof has been considered to be a unifying explanation for the neural basis of disorders in neurocognition and development (Voytek & Knight, 2015). fMRI and EEG/MEG studies using connectivity measures derived from resting state measures report both under- and over-connectivity (Dinstein et al., 2011; Supekar et al., 2013), suggesting that aberrant cortical connectivity is a possible endophenotype of autism. Local dysregulation and global hypoconnectivity is characteristic of many autistic individuals. Enhanced perceptual and sensory processing mechanisms and heightened neural activation during visual processing likely contribute to the superior performance of autistic individuals in visual search, embedded-figures, which measure attention to detail and field dependency-independency. Local over-responsiveness is disruptive to the integration of sensory information into whole perceptual objects and could have implications for the downstream processing of faces and language. However, it has been suggested that there are marked individual differences (idiosyncrasies) shown by whole-brain analyses of connectivity, with ASD participants showing substantially more deviation from group-averaged patterns of inter-hemispheric connectivity. Some autistic individuals even have typical cortical connectivity patterns (Tyszka et al., 2014). Closer attention to this source of variation may resolve some of the apparent contradictions (Hahamy et al., 2015).

Lower predictive coding and Bayesian inferences

Bayesian predictive coding is a neural framework process by which prior experiences and expectations are evaluated against bottom-up sensory input to update future predictions about

sensory input. This process is involved in top-down neural processing and is useful because it allows for the filtering of extraneous stimuli and for the individual to prepare for certain outcomes. Prediction errors occur when there is a discrepancy between prior experiences and expectations and the bottom-up sensory input. When a prediction error occurs, it results in an alteration in future predictions, which helps minimize error. However, errors are maximized when predictions are too specific or not specific enough and by poor bottom-up sensory coding. When top-down regulation (filtering, selection, integration) is optimally integrating bottom-up sensory coding, the brain can accurately predict what should happen and when (Arnal & Giraud, 2012). Such a system is most efficient because it primarily processes deviations from predictions.

Electrophysiologically, predictive coding is linked to cross-frequency coupling (CFC) (Canolty & Knight, 2010). CFC is a process where interactions occur between specific brain oscillations of different frequencies, allowing for the integration and coordination of neural activity. The strength of CFC changes quickly in response to sensory, motor, and cognitive events. Higher-frequency gamma oscillations in particular are thought to play a key role in encoding prediction errors, while lower-frequency oscillations are related to top-down establishment of predictions.

Phase-amplitude coupling (PAC) is a mechanism by which a lower frequency oscillation modulates the amplitude of higher frequency oscillations in a brain region, facilitating the integration of the spatiotemporal information necessary for predictive coding. PAC metrics can offer insight into the efficiency of interactions and local processing within and between neuronal regions. Recent computational modeling of oscillatory activity suggests that PAC may be crucial in balancing excitation and inhibition and maximizing the flow of information between brain regions (Onslow et al., 2014; Peterson & Voytek, 2015).

Sensory processing differences and social interaction challenges in autistic individuals may be attributed to the predictive coding framework. Autistic individuals may have less precise—or overly rigid—predictions, making them more sensitive to incoming stimuli such as social cues but less able to integrate this information contextually (Lawson et al., 2014; Pellicano & Burr, 2012). As a result, interpreting complex or ambiguous cues and stimuli poses a challenge. The link between deficient predictive coding and CFC in autistic individuals is also associated with disruptions in excitation-inhibition balance, further contributing to sensory-cognitive variation.

Electrophysiological research shows that autistic individuals often have abnormal PAC. Phase-amplitude coupling has been associated with levels of performance on different tasks. For example, coupling between theta and gamma bands has been closely linked to changes in memory state and performance (Brooks et al., 2020). This could help explain the mnesic imbalances autistics may have. There are also differences in alpha-gamma coupling, which has been linked to visual processing (Voytek et al., 2010), leading to hyper- or hypo-sensitivity to visual input.

Discussion

Limitations of neuroimaging contributes to gender bias in autism research

Neuroimaging technology has significantly advanced our understanding of how brain functioning differs between autistic and allistic populations: it has provided compelling evidence of structural and functional brain differences that relate to various cognitive and social processes. Despite its contributions, neuroimaging research is not without limitations. Sociocognitive neuroscience should aim to increase our understanding of the specific interactions between an individual's neurobiology and the environments in which they develop and live. For example, many behavioral differences between women and men cannot be solely explained by hardwiring of their genes, hormones, or neurons, but in large part by the necessities imposed by a patriarchal society.

Neuroscience is at an impasse because the techniques used in the field have trouble observing information-processing at the level at which it actually occurs, namely, neural circuits. In the absence of methods that would let us measure information-processing at the level of neural circuits, neuroscientists must settle for second best. Many neuroscientists use blunt measures of brain activity: measuring electro- or magneto-encephalograms to try to infer the sequence of information-processing steps from their signals. The timing of these signals is good, but the spatial resolution is poor. The signal is, after all, the summation of action potential charges from thousands to millions of cells, most likely not localized to a single source. Alternatively, using functional magnetic resonance imaging, neuroscientists look at where blood flows in response to neural activity. With this technology, the spatial resolution is on the order of millimeters, but the timing is poor given that it takes several seconds for oxygenated blood to peak with neural activity. The gold standard in neuroscience remains single-unit recording. Here, the temporal and spatial resolution are excellent (Ruff & Huettel, 2014). Yet, understanding information-processing architecture will require an analysis of the sequence and interplay of excitation, inhibition, and neuromodulation at the level of interneuronal network circuits and intraneuronal dendritic circuits, which analysis of one neuron offers scant insight into (Tse, 2013).

Neuroimaging technology holds transformative potential in autism research, but these technological limitations may help explain limitations in gender neuropsychology. Current critical neuroscience research, and diagnostic models, subsequently, overlook the nuanced ways in which the cognitive and behavioral manifestations of autism interact with an individual's unique experience of gender identity, sex, race, culture, class, education, upbringing, and even diagnosis status. Neuroimaging often reduces complex human experiences to generalized patterns. This homogenizing approach can obscure the rich diversity of intersecting individual experiences, creating normative benchmarks that perpetuate exclusionary cycles in diagnosis.

To address these challenges and avoid undue gender binarization, neuroimaging must be approached from a non-cisnormative, non-male-centric stance that acknowledges and centers feminine genders and trans/non-binary genders. Qualitative research, such as case studies and ethnography, can provide the necessary depth and detail of the ways in which autistic individuals

of intersecting identity present neuroanatomically, cognitively, and behaviorally. It is crucial to integrate neuroimaging with interdisciplinary research that considers both the intersecting contexts shaping neurological development and the broader social and cultural implications of neurological research.

Gender biases and limitations in gender neuropsychological research

Biological determinism is a framework positing that cognitive and behavioral differences across genders, sexes, and even sexualities can be attributed largely to genetics or hormones (Spanier, 1995). However, our traditional conceptualization of what makes a brain 'male' or 'female' is swayed by many extraneous factors. There is a huge scope for social and cultural factors to potentially impinge on brains—the actual impact of sex on differences in the brain must therefore be reconsidered. Any hypothesis about sex differences being "supported" by brain imaging and analysis must take social and experiential factors into account, which many studies completely overlook.

The overstatement of biological factors in gender psychology

Neuroplasticity, the remarkable ability of the brain to adapt and change over time, is a concept that has long fascinated researchers, but its significant role in shaping our understanding of gender has been overlooked. Few behavioral and cognitive tendencies are "hardwired" into our brains. There are multiple social categories such as race, ethnic background, and cultural contexts that give rise to diverse patterns of behavior and mental processes. Cultural factors influence both perception, cognition, and reasoning, and emotional experience, expression, and regulation (Kastanakis and Voyer, 2014). Some other factors that change brain structure and function are level of education, socioeconomic status, and occupation (Hackman et al., 2010). These social and cultural factors form an array that intersects with itself to shape an individual's unique experiences of gender and sexuality. While it is true that certain genders are more likely to have certain occupations, for instance, correlation is not causation, and sex alone is not a sufficient basis for predicting a person's occupation.

In addition to sex, another biological factor whose importance is overestimated are hormones. The brain organization theory was conceptualized in 1959 by William Young and his colleagues after studying mating behavior in guinea pigs. The theory posits that a variety of physiological and behavioral traits are shaped by prenatal hormones (Wallen, 2009). The theory has since been extrapolated to human behavioral psychology. Researchers such as Simon Baron-Cohen have claimed that hormones are directly responsible for neurological sexual dimorphism and therefore determinative of specific cognitive and emotional characteristics (Baron-Cohen et al, 2011). Even recently, psychologists continue to see the effect of hormones on brain development as fixed and permanent. For example, some contemporary research emphasizes how prenatal and early postnatal hormone exposure influences gender-specific cognitive abilities such as spatial and verbal abilities (Núñez et al., 2019). In reality, development is dependent on context; the world and its social contexts start steering the brains of children in

different directions from a very early age. The effects that the factors listed above—sex assigned at birth and hormones—actually have on the brain are much more minimal. The assumption that human behavior and cognition is hardwired into a fixed cognitive structure is losing credibility, whereas there is growing evidence supporting the idea that a person's behavior and their perceptions of it is a function of how those around them expect them to behave. The developing individual creates their personality in response to "nature" and the demands of their "nurture" (though, of course, they are not completely defined by either of them). Behavioral and even cognitive differences may be better explained not by biological predisposition, but by the gender norms necessitated and ingrained in humans from the moment of birth.

Besides gross misunderstandings and overemphases on the relationship between sex and supposedly innate cognitive and behavioral traits, gender psychology research is alarmingly ridden with methodological errors. For example, many studies about sex differences in behavior look at extreme, deliberately caused hormone imbalances in gonadectomized *animals*, instead of making use of natural and/or accidental hormonal imbalances in *humans* (Rippon, 2019). Even the supposed relationship between potency of fetal testosterone in amniotic fluid and male aggression is undergoing reconsideration. Not only are these limitations rarely properly accounted for, but the extreme imbalances are certainly untrue to life. When findings are appropriated and applied to humans, the conclusions will simply be false. Furthermore, researchers often examine various behavioral characteristics but selectively choose to focus on the specific characteristics that are the most sexually dimorphic, rather than investigating an area where relevant activity might be predicted beforehand. In biopsychological research, researchers should report an effect size, which is a quantitative measure of the strength of the relationship between two variables in a population. However, effect size is often unreported. For instance, there is a general consensus that women and men have better verbal and visuospatial abilities respectively, but these differences are in fact quite small, not "profound" or "robust."

Much of gender psychological research stems from the assumption that a certain behavioral profile is different between women and men in the first place. This affects the objectivity of methodology and data creation, as well as data collection and interpretation, such as the interpretation of voxel-based morphometric analysis. While the objectivity of psychometric numerical data is comforting, the numbers are dependent on many extraneous factors—such as the expectations of the experimenters themselves (Rippon, 2019). Psychologists have been quick to assert absolute truths about the nature of women (Weisstein, 1968); therefore, neuroimaging and neuroanalysis must be backed by behavioral data. Unfortunately there are limitations to self-report behavioral data. Behavioral psychologists tend to listen to self-reported data insofar as it is consistent with itself. But the reality is that the very inconsistencies themselves are important pieces of information (Rippon, 2019). One's opinions of oneself and one's responses to certain questions will change depending on how the questions are framed, as types of priming are present, such as stereotype threat. Patterns of behavior are inherently inconsistent and this inconsistency must be treated as valid, important information.

Autism-specific gender biases

Over the years, many scholars have proposed explanations for the preponderance of autistic males over females. Some explanations, including the "female protective effect" (which assumes a positive correlation between autistic etiology and autistic behavioral traits) (Dougherty et al., 2022), the Extreme Male Brain theory (Baron-Cohen, 2002), and the Gender Incoherence theory (James and Grech, 2020), propose different perspectives on how sex-related processes interact with ASD risk genes.

Baron-Cohen's 'fetal androgen theory' (Baron-Cohen et al., 2011) proposes that behaviors seen in autistic individuals are an exaggeration of behavioral differences between allistic females and allistic females. In his book *Prenatal Testosterone in Mind*, Baron-Cohen proposes the prenatal sex steroid theory of autism (Knickmeyer et al., 2004) to explain why autism is more frequently diagnosed in males. He performed a longitudinal study of the children of women who had undergone amniocentesis in pregnancy, who he followed postnatally. The study showed that variations in amniotic prenatal testosterone levels correlated with differences in typical postnatal brain and behavioral development. It was found in typical children that the amount of eye contact, rate of speech development, quality of social relationships, theory of mind performance, and scores on the empathy quotient were inversely correlated with fetal testosterone levels—whereas scores on the systemizing quotient (SQ) and measures of restricted interests were positively correlated (Auyeung et al., 2009). Based on these findings, Baron-Cohen proposed the Extreme Male Brain (EMB) theory of autism. In essence, the EMB theory proposes that sex differences of autism are caused by the hyper-masculinization of typical sexually dimorphic characteristics of neural structure, cognition, and behavior. Such hyper-masculinization can, in turn, be explained by the brain-organizing effects of fetal testosterone (Baron-Cohen et al., 2011). While he acknowledges that "culture and socialisation play a role in determining if you develop a male brain (stronger interest in systems) or female brain (stronger interest in empathy) (Baron-Cohen, 2002)," he emphasizes biological influences.

Another idea that attempts to explain the male preponderance of autism diagnoses is the "female protective effect." The term refers to the observation that females need a greater burden of genetic or environmental risk factors to develop ASD. Females with ASD genes and risk factors may seem to exhibit less "severe" symptoms and are thus less likely to be diagnosed. Some studies claim that males are more "severely" affected by autism. However, the concept of female protective effects and male vulnerability is simply an extension of the EMB theory. In reality, girls, on average, had to have more externalization behaviors and more intellectual disabilities than boys to receive a diagnosis of autism (Hull et al., 2020; Szalavitz, 2016).

The EMB theory wrongly assumes that gender lies on a binary female-male continuum and that there is such a thing as a "female brain" or "male brain." An idea that effectively combats the existence of a distinctly female or male brain is Daphna Joel's Mosaic Hypothesis. The hypothesis posits that most sex differences are multimorphic, not dimorphic. The female-male continuum may be useful for describing the distributions on a single brain feature for women and men, but fails when several brain regions or the brain as a whole are considered

together. Brains are composed of a unique mosaic of features, some on the 'female end' of the continuum, and others on the 'male end (Joel, 2011).' The existence, direction, and extent of sex differences in these features depend on environmental events and normal development. Sex-related differences in the direction of changes in the brain following specific environmental events may be attributed to sex-related differences in neuropsychiatric disorders, and the likelihood of their development (Joel, 2011).

Autistic individuals with low support needs are frequently undiagnosed or misdiagnosed

Many factors may prevent autistic people from ever reaching the door of the diagnostician's clinic, such as diagnosis stigma and caregiver awareness. Another set of factors after that point prevent the definitive diagnosis from being made, such as social camouflaging behaviors (McCrossin, 2022).

Some autistic people, especially those with low support needs, utilize certain strategies and behaviors that help them cope with everyday social interactions, such as camouflaging their autistic differences and difficulties. For example, an autistic person may suppress self stimulatory behaviors, mimic the behavior of those around them, such as copying non-verbal behaviors and rehearsing complex social scripts before an interaction. These strategies may help an autistic individual gain access to employment and education, develop and maintain friendships and relationships, and avoid bullying, alienation, discrimination, and stigmatization (National Autistic Society [NAS], n.d.). Camouflaging strategies are not exclusive to autistics, but compared to most neurotypical people, autistic people are more likely to experience a mismatch between their natural way of being and the demands of their social environment. They can be seen as a compensatory mechanism for less precise or overly rigid Bayesian inferences. Especially in autistic people who are diagnosed in adolescence and adulthood, these strategies are often more ingrained and subconscious. They may begin using masking strategies for stigma management as an unconscious response to social trauma before they have even grasped their differences (Miller et al., 2021). Over time, especially after a self-diagnosis or official diagnosis, they may become more aware of their own camouflaging behaviors. Age-related changes in camouflaging can also be attributed to, for example, cognitive development, age-dependent social demands and constructs, and mental health (Cook et al., 2021).

Of course, the lack of attention directed toward assessing camouflaging behaviors is not the only barrier to diagnosis. Other impeding factors include racial, ethnic, and gender bias; reliance on outdated information; misattribution to other conditions; and professional lack in knowledge and training in recognizing the diverse presentations of autism, especially in those with low support needs. A substantial portion of autistic individuals, particularly those with low support needs, remain undiagnosed due primarily to these biases in recognition and diagnosis.

Non-cismales are disproportionately undiagnosed or misdiagnosed

The diagnostic term "autism" was first introduced in 1943 by Leo Kanner. In 1944, Hans Asperger coined the term "Asperger's Syndrome" after studying young boys in Vienna, Austria. To this day, there is minimal research on autistic women/women-aligned people and

transgender/gender-nonconforming people. Various studies suggest that the ratio of autistic males to females ranges from 2:1 to 16:1 (National Autistic Society [NAS], n.d.), but the proportion of females whose autism diagnosis is missed is unknown. McCrossin's mathematical projections, which take into account diagnostic bias, estimate that the true male-to-female ratio is 3:4, with about eighty percent of non-cismales remaining undiagnosed at age 18 (McCrossin, 2022). Researchers point to both sociological and biological explanations for the male bias in autism.

Scholars have attempted to explain gender/sex disparities in diagnosis rates with biological and neurophysiological differences between autistic girls and boys, with men being more compatible with the autism phenotype. Autistic girls are instead often labeled as 'cute' or 'quirky' because of their purported shyness and their having special interests that blend in culturally (e.g., humanitarianism, animals/people, pop culture). Recently, discussions have begun to address camouflaging behaviors. For example, due to sex-related differences in cognitive profiles, autistic females may have an enhanced ability to camouflage compared to autistic males[46] (Lehnhardt et al., 2016). Compared to autistic cismen, autistic transgenders and women/people of feminine genders may also experience more pressure to fit in socially via camouflaging because of socialization experiences and gender-based societal expectations (Kreiser & White, 2014; Pearson & Rose, 2021).

Harmful consequences of the social contexts of psychiatry

In a way, the DSM could be seen as an ethnographic study—an account of how human beings are responding to the state and conditions of the world. In one era, conditions related to slavery, homosexuality and transgenderism, and gendered conditions such as hysteria, may be featured more prominently. In another era, conditions such as depression, social anxiety, and screen dependency disorder might dominate.

Furthermore, the history of psychiatry is contingent on social context and can be traced from its association with gynecology to the pervasive overrepresentation of women in mental hospitals to the 1960s where studies concluded mental illness was found more often in women than men. In her 1985 book *The Female Malady: Women, Madness, and English Culture, 1830-1980*, Showalter points to the "dual images of female insanity—madness as one of the wrongs of woman; madness as the essential feminine nature unveiling itself before scientific male rationality" (Showalter, 1987). "Biographies and letters of gifted women who suffered mental breakdowns have suggested that madness is the price women artists have to pay for the exercise of their creativity in a male-dominated culture" (Showalter, 1987). As 19th-century Europe industrialized, cases of hysteria—a common medical diagnosis for women—spiked. It was and continues to be seen as a personal fault of women because of the lack of discourse on how social factors contribute to psychiatric disturbances. In the same way, the current lack of research about the sociological contexts of psychiatry explains why comorbidities are exacerbated and contributes to their underdiagnosis, especially among autistic non-cismales. They are instead stereotyped and stigmatized as shy, quirky, or crazy.

Similarly, current shortcomings of autism research, especially regarding autistic non-cismales, contribute to the exacerbation of comorbidities and mental trauma. Traumatic events are not the only source of trauma: "There are forms of 'silent' trauma that have to do with the violation of an entire demographic of people via cultural structures" (Nerenberg, 2020). Based on current research, it has been estimated that approximately 60 out of every 1,000 women are autistic, yet only 12 are diagnosed by the age of 18, leaving 48 undiagnosed (McCrossin, 2022). Emerging research points to the possibility that transgender and genderqueer people are even more likely to remain formally undiagnosed (Warrier et al., 2020). This significant diagnostic gap profoundly impacts the mental health of non-cismen. Childhood, adolescence, and early adulthood are very difficult for women and transgenders with undiagnosed autism: constant mental trauma is very common in autistic people without a diagnosis altogether, or worse, with an alphabet soup of incorrect diagnoses. This may result in the exacerbation of a number of co-occurring conditions, especially anxiety, social anxiety disorder, depression (Martini et al., 2022), disordered eating (Barnett et al., 2021), borderline personality disorder, PTSD, bipolar disorder, schizophrenia, schizoid personality disorder, sensory processing disorder, suicidality and self-harm (Culpin et al., 2018; Moseley et al., 2020), co-occurring health disorders, panic disorder, and agoraphobia. Autistic women and genderqueer people are also much more likely to experience victimization or intimate partner violence and have PTSD (Weiss & Fardella, 2018). Unless the upstream causal factor of autism is identified, it is unlikely that the individual will never fully comprehend their condition (McCrossin, 2022).

Limitations

This paper is not a systematic review, and its findings are constrained by the available research. Notably, there is a lack of comprehensive data on gender disparities in autism diagnosis, particularly among individuals with medium to high support needs. This gap in the literature highlights the need for more inclusive and expansive research to fully understand these disparities. Procedural biases and neuroimaging limitations underscores the need for more nuanced and inclusive approaches to autism research and diagnosis processes, in order to ensure a more comprehensive understanding of the diverse manifestations of autism across different populations of individuals with unique intersecting identities.

Conclusion

Neuroimaging technology has paved the way for significant advances in knowledge about the neurobiological, cognitive, and behavioral endophenotypes of ASD. At the same time, systematic and systemic limitations and biases persist, particularly concerning diagnostic disparities across different genders.

This paper affirms that there is a present gap and a critical need in understanding gender-specific symptomatology and psychiatric comorbidity patterns. Professionals diagnosing autism or providing accommodations must be educated in sociocultural psychology and

development, and have a strong understanding of gender-specific symptomatology patterns in order to avoid misdiagnosis where diagnosis is due.

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Determining the Potability of Water using Random Forest Classification By Isaiah Park

Abstract

Potable water is a guideline set by different countries to signify whether the water is safe for consumption. Although the majority of the world has access to potable water, there are still around 771 million people who do have no access to safe drinking water. In this paper, I use machine learning, specifically random forest classification, to predict the potability of water. First, a binary tree is created using data which follows a path of yes or no questions to determine the result. Then, the average of a forest of many different binary trees is used to find the result. The model has a 72.02% accuracy in predicting the potability of water. Of the non-potable samples, 71.90% are classified correctly, while 72.41% of the potable samples are classified correctly. Although this model is fairly accurate in determining whether or not it is not potable, its accuracy in determining potability is quite low and can cause many water sources to be wasted when they are drinkable. This model can be improved, however, through the use of more data to train the model more and achieve better results.

Introduction

Approximately every day, five thousand people die due to drinking unsafe water. Due to the high rate of death, many projects have been started to help bring access to potable water to more people. However, it is important that the water sources that are created are safe and will cause no diseases. With the rise of machine learning, classifying water's potability has become easier with many methods such as neural networks and random forest classification. In this paper, random forest classification is used to effectively determine the potability of water.

Literature Review: Water Potability

Water potability determines whether a water source is safe for direct consumption and cooking. Access to potable water is very important for sanitation and helps stop the transmission of many diseases such as cholera, diarrhea, dysentery, hepatitis A, typhoid and polio. These diseases caused by water are responsible for more than one million deaths per year. Additionally, a lack of safe water can worsen issues that those people already face, like malnutrition and growth stunting. Unfortunately, many people do not have access to clean water, with approximately two billion people unable to access clean drinking water. Furthermore, of those 2 billion, 1.7 billion people are confirmed to use a water source contaminated with feces. Rates of progress in increasing access to potable water has slowed down too, with rates needing to increase fourfold to reach universal coverage by 2030.

Constant water monitoring is necessary to verify current water sources along with finding new ones. Additionally, the total number of available water sources decreases as time goes on, so efficient methods of determining water potability need to be used. In developed areas, water contamination could happen through fertilizer, pesticide, and other chemicals. In developing areas however, the main cause of contamination is through sewer and waste. By checking for

potability in water sources, people will be able to determine the general location of where the contamination occurs. For a basic, simple method, water quality test strips can give a general idea of water potability. However, to get a more detailed analysis of the water, they must do a coliform bacteria test to see if the water is safe. Coliform bacteria is an indicator of whether the water is of low quality so it is often tested for. However, coliform bacteria tests do take a bit of time to obtain the results as it is often necessary to incubate a test sample to verify the presence of coliform bacteria. Therefore, a machine learning model could be able to predict the potability quicker.

Literature Review: Machine Learning and Random Forest Classifier

For machine learning, there are two main methods: supervised learning and unsupervised learning. In unsupervised learning, the data does not have labels, whereas in supervised learning the data is labeled. This paper focuses on supervised learning, so we specify more on supervised learning here. The goal of this method is to find an approximated function that can map features to labels. The features are the information that the model first gets which it then uses to try to predict the label. The model eventually learns over time and creates a model that is able to predict the label accurately based on what it knows about the features.

There are two phases of supervised learning: training and testing. In the training phase, the model looks at the features and the resulting labels and creates a function that is able to predict the labels. Then, the function is tested for accuracy in the testing phase by comparing the predicted labels to the actual labels in the test set. Usually, around 70-90% of data is used for training while the other 10-30% is used for testing. There are two main methods in supervised learning: classification and regression. Regression has the label as a continuous value that is not put into groups, while classification puts each element of the dataset into a specific discrete group.

Finally, the paper focuses on the supervised learning method known as the random forest classifier. The random forest classifier is a method which uses an ensemble of decision trees based on the features to predict the labels. Decision trees are a series of binary questions which repeatedly split the data, eventually leading to the classification of the elements in the dataset. The splits are determined by optimizing for the lowest entropy created by a split. The purity of a split decreases as the entropy of a split increases so it is best to optimize for the lowest entropy. Decision trees are powerful, but they are prone to overfitting, which is when a function fits too closely with the data, making it less applicable to the general data. Random forests solve this by making a collection of these decision trees where the average of all the decision trees is used for the prediction.

Methods

My machine learning model uses an online dataset that contains water quality metrics for 3276 water samples. The elements in this dataset are as follows: pH value, hardness, solids, chloramines, sulfate, conductivity, organic carbon, trihalomethanes, and turbidity. The pH value

describes the H+/OH- concentration of the water and represents the acid-base balance of the water. The hardness is the amount of dissolved calcium and magnesium in the water. Solids is the amount of dissolved solids in the water. Chloramines are a disinfectant in water that could be harmful if they have too high of a concentration in water. Sulfates are naturally occurring substances that are found in minerals, soils, and rocks. Conductivity is the measure of a solution's ability to conduct electricity. Organic carbon is the amount of carbon from organic compounds in the water. Trihalomethanes are found in water that has been treated with chlorine. Turbidity is based on the amount of particles that are in the water such as dust or sand. Finally, the label the model is looking for is potability, which describes whether the water is safe to drink or not.

To create the model, I use the python libraries pandas and sklearn. Pandas is used to format the dataset and clean it for any unnecessary elements of the data set. sklearn is a package with several machine learning tools, used in this project for a myriad of functions that all deal with the random forest method. The fit function is used to create the random forest function that maps features to labels.The grid search is used for hyperparameter tuning. To help better fit the random forest function to a model, hyperparameter tuning is used to find the best hyperparameters. Once this is done, the feature importance variable is used to determine the most valuable features in determining potability, and the confusion matrix function is used to see how accurate classifications were for different labels. The hyperparameters that are tested for here are max_features, min_samples_split, min_samples_leaf, criterion, bootstrap. Max_features is the maximum features used to create a split, The tuning tests for either "sqrt" which is the square root of the amount of features or "log$_2$" which is the log2 value of the amount of features.. Min_samples_split is the amount of samples needed to split a node. The tuning tests for the values two through four. Min_samples_leaf is the amount needed in a leaf node which is the node at the end of a branch. The tuning tests for the values one through four. Criterion is what is used to measure that quality of a split. The tuning tests for "log_loss", "entropy", or "gini" which are all different equations used to measure the quality of a split. Bootstrap is a method that uses random sampling with replacement if turned on. The tuning either tests for True which turns it on or False which leaves it off.

Results

For the feature importance variable function, Figure 1 shows the various features and their importances in decreasing order.

Feature	Feature Importance
Sulfate	0.148875
pH	0.139233
Solids	0.113727
Hardness	0.112649
Chloramines	0.110360
Trihalomethanes	0.095988
Conductivity	0.094600
Turbidity	0.092371
Organic_Carbon	0.092198

Fig 1: Feature importance chart.

The Confusion matrix function creates Figure 2.
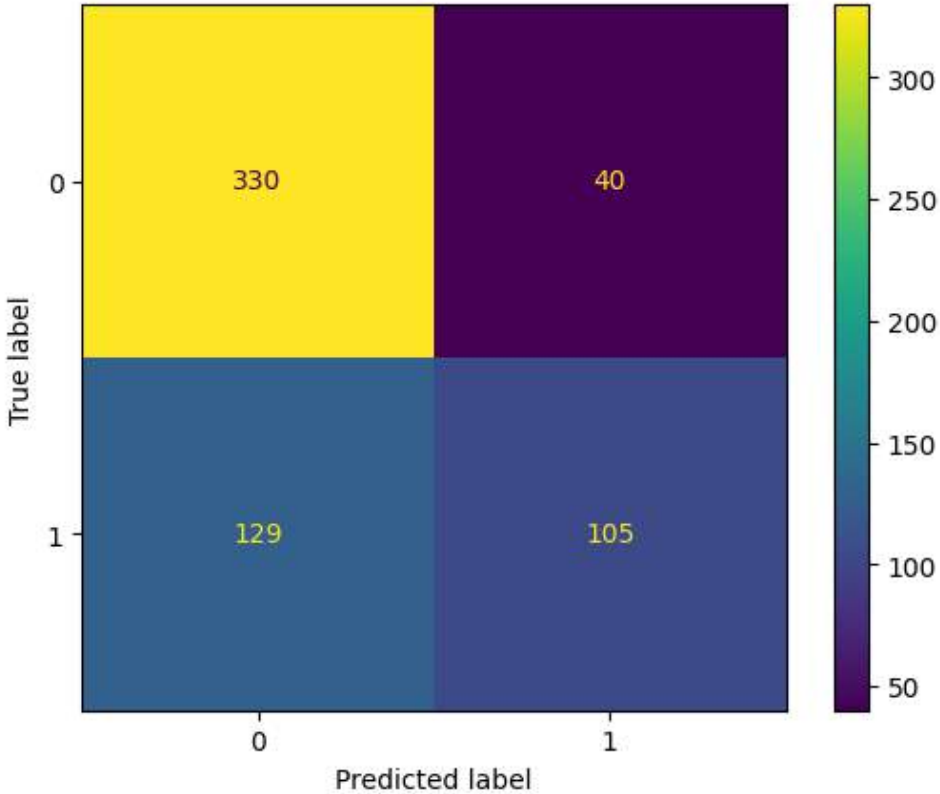
Fig 2: Confusion matrix of the best model.

Figure 3 shows the best values for each value found by the grid search function:

Hyperparameter	Best Value
max_features	"log$_2$"
min_samples_leaf	2
min_samples_split	3
criterion	"gini"
bootstrap	False

Fig 3: Hyperparameters from the Best Model

Discussion

Looking at the feature importance variable chart, turbidity and organic carbon concentration are the least important features from this dataset in determining potability. To save time, measurements of the least important features can be skipped in favor of the most important ones such as pH or sulfate concentration.

Looking at the confusion matrix, the model has around the same accuracy with both potable or non-potable sources. For non-potable sources, it has a 71.90% accuracy and for potable sources, it has a 72.41% accuracy. The confusion matrix shows that the model predicts samples as both potable and non-potable, and does not simply classify all examples as one category or the other. Although it is somewhat accurate in determining potability, more testing would need to be done to verify that the water source is potable.

Conclusion

In this study, a machine learning model, specifically random forest classification has been used to predict water potability. While creating this, many insights have been made in important features for determining water potability or what features are used to split the data. As issues over water sanitation continue to rise with the decreasing water supply, it is necessary that humans start to put more effort into finding new potable water sources.

With our model, we have been able to obtain a 72.02% accuracy in predicting water potability. Although this needs further refinement in order to obtain a suitable accuracy, this is a good first step, and the model can improve with further work. For future work, more datasets can be incorporated in order to further train the model and give it a greater range of water sources. Additionally, if the random forest classification shows no sign of improvement, different models such as neural networks can be used to better predict the potability of water sources.

In conclusion, this model is a good first step in quickly predicting the potability of any water source. However, it highlights the need for further work in order to ensure that new water sources can always be found to replenish the constantly decreasing water supply.

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Why Do Modern People Identify as Being "Spiritual but Not Religious"? By Hong Ma

In the modern world, being spiritual is one of the most prevailing identifications. As a 2023 new Pew Research Center survey suggests, 70% of U.S. adults describe themselves as spiritual in some way; intriguingly, 22% of them identify as "spiritual but not religious" (Pew Research Center). Similarly, another survey finds many East Asians identify as unaffiliated but believe in unseen beings, venerate ancestors' spirits, and engage in ritual practices (Lesage). Does the data suggest that religion is becoming less important? Is there a clear line to draw between "religious" and "spiritual"? What exactly does it mean when people say they are spiritual but not religious?

This essay would argue that the rigidity of religion naturally makes its coexistence with other ideologies very unlikely, leading to the unease that people unwish; meanwhile, the emergence of the secular age brings "spirituality" as a more inclusive choice that enables people to achieve personal ultimacy. Therefore, being spiritual but not religious has become a popular choice in the secular world.

Before discussing people's choice between religion and spirituality, it is necessary to look at the common reason for people to identify with either one, that is, having ultimate concern. Ultimate concern, according to Tillich, is a concern that qualifies all other concerns as preliminary and inherently answers our questions about the meaning of life. In his time when the definition of religion was controversial, Tillich coined this term to describe religion as "the state of being grasped by an ultimate concern" (Tillich,4). Similarly, with the trend of identifying as spiritual instead of religious in recent years, spirituality has also been discussed as related to ultimate concern. For example, spirituality has been defined as "involving ultimate and personal truths" (Wong, 364) and an expression and practice of ultimate concern at a personal level (Emmons, 4). In all, the involvement of ultimate concern, which is a common goal of human flourishing, is an essential feature of both religion and spirituality.

To meet this human need for ultimate meaning, religious devotion and dependence on biblical teachings constitute the obvious path as the law of God always "revives the soul", "makes wise the mind", "rejoices the heart" and "enlightens the eyes" (NRSV Bible Psalm. 19.7-8). Nevertheless, the rigidity of many religions often excludes the possibility of simultaneously subscribing to other religious systems or non-religious ideologies. Such intolerances often result in personal discomfort, social unrest, and even worse, violence. The following argument will focus on some examples of the exclusiveness of religion and how politicized religion usually manifests and intensifies the exclusiveness.

First, before the sixteenth century, the rigidity of religion in Europe was shown as the absolute intolerance of non-Christian religions or even the intolerance between different denominations of Christianity. As religion intertwined tightly with economics, public life, culture, and most essentially, politics (Armstrong) at that time, the Church was dominant over all aspects. When politics was involved in the conflicts between religions, violence became the inevitable result. The authorized Church therefore often started wars for both religious passion

and political ambition. For instance, Pope Urban II initiated the Crusades (1096-1291) not only to protect the Holy Land from Muslim control for the sake of the sacred Jesus but also for the expansion of territory and papal monarchical control over East Europe. Centuries later, the French Wars of Religion (1562-1598) was initiated by the conflicts between Protestants and Catholics and was catalyzed by the threat that regional noble families had on governmental authority. However, the mass destructions and slaughters in these European wars to some extent revealed "the violent essence inherent in religion" (Armstrong). Therefore, the religious bloodbaths led by the Church triggered thinkers and civilians to advocate for religious tolerance or harshly criticize organized religion (Keddie, 17).

Second, the fundamentalists' backlash of the secularization process often showed the intolerance of traditional religion. After Western countries started their journey of secularization because the princes in newly separated European countries aspired to their own absolute control over politics, anti-secular ideologies followed unsurprisingly. These fundamentalist backlashes not only gave the public a negative impression of religion but even disturbed social peace. For example, their opposition to Enlightenment ideas and resistance to secular education in school greatly hinder the development of science. The debate between creationism and Darwinian evolutionism projected how religion denied rational thinking that deviate from Biblical implications. As religion exists upon faith in spite of evidence (Berra, 130), humans as rational beings cannot resist the more reasonable scientific evidence or persuade themselves to be fully devoted to religion.

Sometimes, fundamentalists go even beyond vocal resistance to the point of extreme violence. This can be seen clearly in some Muslim countries where Western secularization was imitated and had a similar result of backlash (Keddie, 21). The conflict between the Islamist party, the Islamic Salvation Front (FIS), and the Algerian government in the 1992 elections escalated into a civil war (Keddie, 24). Killings and torture by both armed Islamist groups and governmental military forces caused over 200,000 casualties. More recently, the frequent terrorist attacks orchestrated by Islamic extremists such as ISIS and Al-Qaeda, aiming at purifying the Islamic world and protecting the Sharia law, also showed the religion's intolerance of modern ideologies of economic and technological development. Their aggressive reaction raised the public's alertness to fundamentalism and elicited a global fear of and repugnance against religion.

Last but not least, there was hardly a peaceful coexistence of personal belief and religious tradition, facilitating the trend of negative perception of religion. Before the secular age, when the Church took political control, the clergy decided what Christians should believe. Any personal understanding that deviates from the orthodox was prohibited. Even under the current secular state where politics and religion are officially separated, this religious intolerance of personal ideologies can still be seen in the right-wing evangelical policies. Some human rights policies regarding abortion and homosexual marriage are referential to orthodox religion, provoking raging social debates and unrest. What biblical teachings emphasize on the sanctity of human life and men-women marriage becomes increasingly incompatible with modern liberalism

and humanism. Thus, for people who advocate for human rights, their aversion to religion is rooted in an "unease with the association between religion and conservative politics" (Putnam and Campbell, 3).

Given the examples showing how exclusive religion is, people consciously stay away from religion. Besides the inherent exclusiveness of religion, the changed human self-understanding in the modern world further facilitates the social trend of being religiously unaffiliated. According to Charles Taylor, a famous philosopher who delves deep into the research of the secular age, modern individuals perceive themselves as self-sufficient beings and feel separated from the external world. Rather than finding our place in the cosmos that is fully controlled by God, a buffered self "constructs its own order within the universe" (Taylor, 114). In other words, Taylor's concept of "buffered self" suggests that the self is autonomous and possesses inner depth and strong personal will. The settlement of ultimate concern no longer appeals to God but appeals to the innermost power of humans. Hence, the sharp discrepancy between humanistic modern needs and what religion proposes finally leads to the decreasing identification as religious.

However, it is too sudden for humans to realize that "God is dead" in a previously self-explanatory world where orders are maintained by God. People lost direction and meaning in life without religion to shape their morality and ethics. A post-God era followed. People wondered "What festivals of atonement, what sacred games shall we have to invent?" (Nietzsche,181) Still, new moral standards and cosmic order that support people to find meaning in ultimate concern are required for society to recover from total skepticism and nihilism.

The later development of secularization worldwide helps fill the gap by suggesting alternatives. Pluralism, one of the most salient features of modern secularism, promotes the change in conditions of belief. As Peter L. Berger suggests, the modern kind of pluralism "involves the coexistence of the secular discourse with all of these religious discourses" (Berger). It is to say that modern pluralism changes society from where belief in God is unchallenged and unproblematic to one in which it is understood to be one option among others (Taylor, 3). "Spirituality", then, is the ideology that includes all these options. Within spirituality, people can identify as religious, agnostic, atheistic, or, with considerations of the drawbacks of religion and the innermost need to achieve personal flourishing discussed before, as spiritual but not religious.

The abundant choices, or "spirituality" I would call it, provide an effective alternative to religion to help humans "live meaningfully with ultimacy" (Bregman & Thierman, 149). Specifically, spirituality can rescue humans from a universal existential crisis in a more personal way than that of religion. For example, loneliness, loss of purpose, and grief are common challenges in human lives. Urgent epistemic quests, such as "What would happen after death", can't be adequately explained by science but can rather be met by spirituality. Biological decay of organisms may explain the finitude of human life but the awareness and fear of death are never easy to confront. For cancer patients, spirituality as "an active-passive process of relating to and often wrestling with 'reality-as-it-is'" (Yang et al. 57) can help them find peace and relief

under the anxious confrontation to the liminal situation. A more realistic example is how spirituality was applied to cope with the trauma of a loved one's death during the COVID-19 Pandemic. The funeral ritual which was lacking during the time was seen as a formal farewell among Italians (Biancalani et al.); in East Asia, religiously unaffiliated adults burned incense to take care of lost families and release their grief spiritually (Pew Research Center); attempt in meditation and continuation in connection with the loved one were also widely used. Different from religion, these spiritual practices do not necessarily resort to the transcendent world but offer hope and condolences much needed. Therefore, being spiritual is the preferred way among modern people to struggle the existential challenges when religion is not easy to embrace anymore.

Moreover, besides the effectiveness of spirituality in resolving universal challenges, another key role it plays in ultimate concern is that it helps achieve individual uniqueness. According to Taylor, this unique ultimate concern refers to situating "the place of fullness" where "life is fuller, richer, deeper, more worthwhile, more admirable, more what it should be" (Taylor, 4). In other words, each individual would have his/her own sense of the shape of the ideal life, and being spiritual is an alternative way or a better way than being religious to get to "the place of fullness" in the secular age. Being religious, people need to at their expense win the favor of a God because religions such as Christianity and Islam often suggest that only by renunciating individual goals but being fully devoted to God can humans achieve a greater fullness granted by God. However, spirituality which pluralism provides frees people from this sacrificing path to fullness and offers opportunities to personally choose ways that are customized to their own imagined shape of life and get to the place of fullness.

In all, the politicized religion gradually lost its rigidity and our loyalty because of the frequent violence and social unrest it causes in history and in modern times. When the society was suffering from the loss of meaning and undergoing a collective existential crisis, the development of the secular age brought pluralism which promoted a better alternative for religion: spirituality. It is as helpful as religion in guiding people through obstacles and hardships and even more helpful than religion in helping humans achieve individual fullness. In a word, spirituality and religion both reflect human's shared ultimate concern; being spiritual but not religious is one of the ways for humans to support their ultimate concern; but after evaluation, it seems to be a more effective and more favored one in the secular age compared with being religious.

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A Comprehensive Review of CRISPR-Cas Systems and Their Industrial Applications By Akshay Bhalla

Abstract

CRISPR-Cas systems were originally discovered as a natural immune defence mechanism in prokaryotes. Recently, this technology has been engineered to be an efficient and accurate genetic engineering tool to precisely edit DNA, which has caused the rapid growth of this field within genetics. These systems have been used in a wide range of industrial applications such as medicine, agriculture, and biofuel production. In medicine, this technology benefits by enabling precise alterations to treat genetic disorders, which offers the potential for novel therapies and cures. In agriculture, the CRISPR systems play important roles in developing crops with improved traits such as higher yield, resistance to pests and diseases, and improved nutritional value. In addition, CRISPR-based approaches are used in biofuel production by targeting the genes involved in the metabolic pathways, which results in more efficient biomass conversion in microorganisms. Herein, this review paper highlights the fundamental principles of CRISPR-Cas systems, examines the various types of systems and their functions across diverse industrial applications, and discusses the challenges along with the potential ethical and regulatory issues related to their widespread use. The impact of the CRISPR-Cas systems underscores its significance as a cornerstone of modern biotechnology.

Keywords: CRISPR-Cas9, Medicine, Genetic disorders, Agriculture, Food security, Biofuels

Introduction

Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) and its associated Cas proteins (like Cas9) together represent an important genome editing tool in the field of biotechnology. The CRISPR technology was discovered in the genomes of bacteria and archaea by Yoshizumi Ishino and colleagues at Osaka University in Japan in 1987(Gostimskaya, "CRISPR–Cas9: A History of Its Discovery and Ethical Considerations of Its Use in Genome Editing"). However, the importance of the CRISPR was not fully understood at the time. In 2012, Jennifer Duodna and Emmanuelle Charpentier made an important contribution to the improvement of the CRISPR-Cas9 gene editing technology, winning a Nobel prize for their discovery of CRISPR as genetic scissors(Van Erp et al.; Jinek et al.). Structurally, CRISPR-Cas9 consists of two main parts: CRISPR and Cas9. CRISPR is a part of the bacterial immune system, while Cas9 is an enzyme and acts as molecular scissors to cut/snip specific sequences of DNA(Redman et al.; Uyhazi and Bennett). This CRISPR technology has significantly impacted genetic engineering due to its precision, efficiency, and range of uses across a wide range of applications such as agriculture, biotechnology, industrial synthesis, vaccine development, and medicine(Cho et al.). These range of applications show the importance of CRISPR technology beyond basic research to use in substantial industrial applications. For example, this technology can be used in the medical field to treat certain genetic diseases (e.g., sickle cell anaemia and

beta-thalassemia) or cancers (e.g., chronic myeloid leukaemia in hematopoietic stem cells)(Frangoul et al.; Vuelta, García-Tuñón, et al., "Future Approaches for Treating Chronic Myeloid Leukemia: CRISPR Therapy"). CRISPR-Cas technology is also used for the development of vaccines that makes immune cells more responsive and effective against particular viral species, leading to the improvement of the immune system in the body (Tavakoli et al.). Moreover, in agriculture, CRISPR is used to improve nutritional profiles of crops, to increase their resistance to pests and diseases, and to make better tolerance to environmental factors such as drought and salinity. These result in changes in the shape, size, texture, shelf life, flavour, and nutritional value of crops, highlighting how genetic modification can lead to significant improvements in efficiency, sustainability, and profitability in agriculture field (Q. Liu et al., "Application of CRISPR/Cas9 in Crop Quality Improvement"; S. Zhang et al.; "The Impact of Genetically Engineered Crops on Farm Sustainability in the United States"; "Use of Genetic Engineering: Benefits and Health Concerns"). These advances also contribute to improvement of food security and reduction of agriculture's environmental footprint (Muha-Ud-Din et al.).

Herein, this review paper aims to explore the recent advances in CRISPR applications in biotechnology, with a specific focus on its industrial applications. This article also highlights the transformative impact of CRISPR technology on various industries and its potential to drive future biotechnological innovations. Lastly, this review focuses on ethical, regulatory, and technical challenges that accompany its widespread adoption.

1. Mechanism of CRISPR-Cas System

CRISPR technology is a revolutionary tool that allows for precise genetic alterations and the CRISPR-Cas9 system is the core of this technology (Xu and Li). This system is inspired by a bacterial defence mechanism against viruses and utilizes short sequences of RNA to direct the Cas9 enzyme to specific DNA sequences, where it triggers targeted double-strand breaks (Hossain). Notably, different types of Cas proteins have different targeting/cutting mechanisms.

The CRISPR region is a length of DNA within the organism's genome, characterized by the presence of nucleotide repeats and spacers. Nucleotides are the base units of DNA. Spacers are derived from DNA segments of viruses that have previously invaded the bacteria and are embedded between the nucleotide repeats. These spacers act as a genetic memory that enables the bacteria cell to easily fight against subsequent infections when attacked by the same or similar viruses (Liao et al.). After the viral genetic material is released into the cell, if it matches with an existing spacer in the CRISPR DNA from a previous viral infection, the spacer and a nucleotide repeat is transcribed to produce CRISPR RNA (crRNA)(Vidyasagar). This crRNA is complementary to the target (viral) DNA, and it and trans-activated crRNA (tracrRNA) bind to the Cas enzyme, guiding the Cas enzyme to the viral DNA in the bacterial cell. The Cas enzyme then uses endonuclease sites to cut the viral DNA complementary to the crRNA.

The CRISPR-Cas9 system works in genetic engineering by utilizing a guide RNA (gRNA) molecule that is designed to match a specific DNA region within the target genome.

Guide RNA is essentially a lab-made combination of crRNA and tracrRNA. As shown in Figure 1, this gRNA co-works with the Cas9 nuclease, directing it to the exact location of the target DNA sequence. Cas9 causes a double-strand break in the DNA. However, before snipping the DNA, the Cas structure must see a PAM (Protospacer Adjacent Motifs) DNA sequence. These are located directly adjacent to the target site to act as identifiers for the Cas9 protein to know that the nearby length of DNA is the viral code. As such, the CRISPR Cas system works efficiently and accurately, cutting only the DNA that is complementary to crRNA(Vidyasagar).
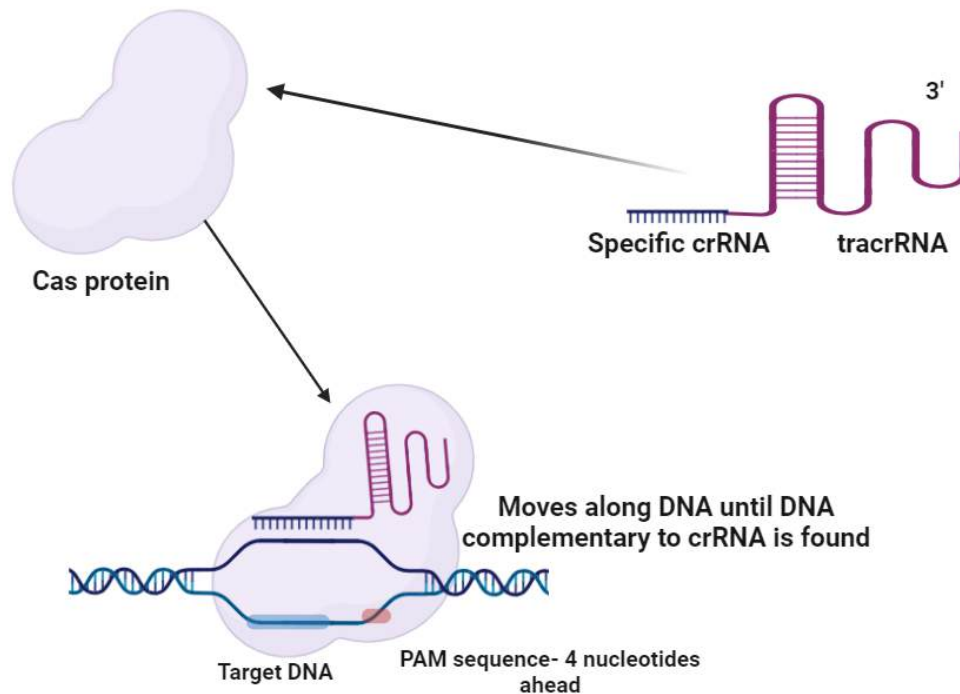
Figure 1. Illustration of CRISPR-Cas mechanism.

This figure shows gRNA that binds to the Cas protein and then uses the crRNA component to scan the DNA code of the organism until it finds a sequence that is complementary to the crRNA. This crRNA is identical to the target DNA (using RNA nucleotides instead of DNA). There is a PAM sequence (4-6 nucleotides, located 4 nucleotides ahead of the target sequence) that is necessary for the Cas protein to make cuts in the DNA. crRNA: CRISPR RNA. gRNA: guide RNA. PAM: protospacer adjacent motif.

Mechanistically, action of CRISPR-Cas systems hinges on the ability to induce site-specific DNA double-strand breaks (Figure 2). First, one has to create a 20 base-pair length of DNA identical to the target gene and then, a complementary strand of RNA is constructed and acts as a guide RNA that guides the Cas9 to cut the DNA (Vidyasagar). After being cut, the cell's natural repair system is responsible for fixing the damage to the DNA. There are two main ways this happens: homology-directed repair and non-homologous end joining. Homology-directed repair (HDR) involves a DNA recombinase pairing with homologous DNA to replicate the DNA

to repair the broken strands. The homologous DNA can be taken from within the cell's chromosomes itself or can be provided by a scientist, often taken from another species or another organism of the same species(Sun et al.). This approach allows specific genes to be inputted in a process known as a gene knock-in since the previously present gene is replaced with one that was not present in the locus(Eggermont). Non-homologous end joining (NHEJ) uses enzymes to first capture both the broken ends of the DNA, construct a molecular bridge to bring them together, and then catalyse the re-ligation of the molecule. This is a crude method of repair and causes errors due to nucleotides being accidentally deleted or added, causing unintended mutations(Weterings and Chen).
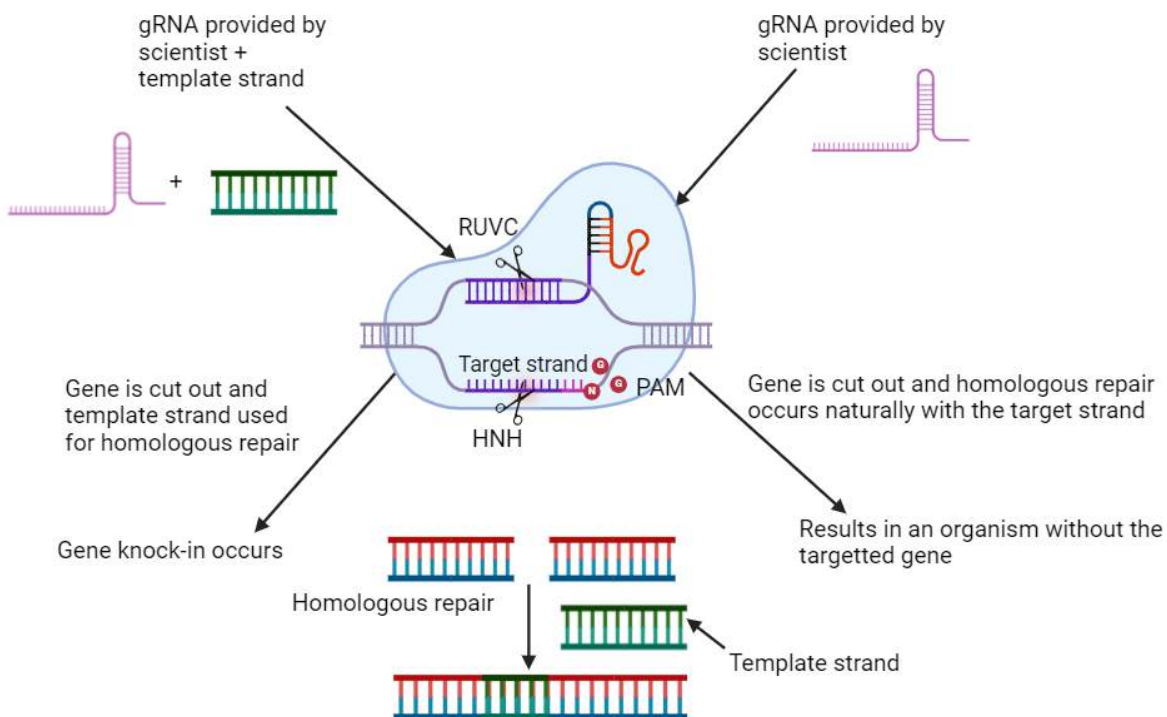
Figure 2. The biomolecular functioning of the Cas9 structure.

The gRNA is used to identify the target strand as shown in figure 1, then the two endonuclease sites (RUVC and HNH) cut the DNA in both the strands, causing a double-stranded break. This is then repaired through natural mechanisms, either using the template strand provided by the scientist- thus causing that gene to be incorporated into the genome- or by another sequence- thus allowing the targeted gene to be removed.

2. Variants of CRISPR-Cas System

Beyond the widely known CRISPR-Cas9 system, there are several variants of the CRISPR-Cas systems that are identified and engineered with unique capabilities and advantages for different applications. The CRISPR-Cas systems are separated into six types from 1 to 6,

based on both structural and functional differences. These types are then clubbed into two sub-groups: Class 1 has type 1, 3, and 4; while Class 2 includes type 2, 5, and 6 (Table 1). Class 1 type proteins have multiple different Cas proteins within multi-subunit complexes, while Class 2 type proteins have only one protein. Importantly, different types of CRISPR-Cas systems are capable of altering different molecules. For example, type I, II, and V systems only detect and cleave DNA, whereas type VI alters RNA. Type III can recognize and cleave both RNA and DNA. Type IV system is newly discovered and it is unknown how it works(Mohanraju et al.). So, depending on the different Class and type that a Cas protein falls into, its properties and thus functions can vary greatly.

Each CRISPR type is represented by several Cas proteins, contributing to increased diversity of different CRISPR-Cas systems, including CRISPR-Cas9, CRISPR-Cas12a, CRISPR-Cas3, CRISPR-Cas13, and CRISPR-Cas10 (Table 1)(G. Liu et al.). These Cas proteins show different functions in the presence of different nuclease domains that are responsible for the cleavage of single or double stranded DNA(Akey and Berger). Taken together, these Cas variants can improve the versatility of CRISPR technology and increase its application across a wide spectrum of genetic engineering challenges.

Table 1: Different CAS types and their characteristics

CRISPR System	Class	Type	Key Protein Domains	PAM Sequence	Targeting Mechanism	Applications
CRISPR-Cas3	1	I (Nayeem ul Bari and Hatoum-Aslan)	HD-type nuclease, SF2 helicase domains(Gong et al.)	N/A	DNA degradation(Sinku nas et al.)	Gene knockouts and knock-ins (e.g., exon-skipping in Duchenne muscular dystrophy genes)
CRISPR-Cas9	2	II	RuvC and HNH endonuclease domains(Babu et al.)	5'-NGG-3' (N is any base) (Karvelis et al.)	Double-stranded break in DNA	Treating genetic diseases, bioethanol production etc. Treating cancer/Duchenne muscular dystrophy(Williams and Warman).
CRISPR-Cas 12a	2	V	RuvC-like domain with a Nuc domain for cleavage(Jeon et al.)	5'-TTTV-3' (V is A, C, or G) (Paul and Montoya)	RNA-guided double-stranded DNA break(Paul and Montoya)	Degrading DNA scaffold of DNA hydrogel. To engineer rat models mimicking human atherosclerosis(Paul and Montoya)
CRISPR-Cas 13	2	VI	Single site- formed by 2 higher eukaryote and prokaryote nucleotide binding (HEPN) RNase domains(Bot et al.; Kavuri et al., "Applications of CRISPR/Cas13-Bas ed RNA Editing in Plants")	3' A/U/C (not required by all variants)	RNA cleavage (Tong et al.)	Protection against viruses for yeast/plants(Tong et al.). Bioethanol production

3. Current Advancements in CRISPR Applications

The improvements in CRISPR technology have contributed to transformative impacts on various fields, including therapeutic applications, agriculture, food security, and biofuel production. Below, we discussed the recent progress within these areas.

3.1. CRISPR Technology in Therapeutic Applications

CRISPR has the potential to play a major role in medicine as it is highly effective in combating some genetic disorders, including amyotrophic lateral sclerosis (ALS), Parkinson's disease, and cystic fibrosis, all of which are difficult to treat due to their causes being genetic mutations. For instance, the CRISPR-Cas9 system has been used to target the mutant SOD1 gene in a mouse model of ALS. These mice, carrying approximately 25 repeats of the hSOD1^{G93A} transgene, exhibit many aspects of ALS with its symptoms, including loss of muscle control, spasticity, weakness, inability to perform basic functions (Gaj et al.). Using an adeno-associated viral vector to deliver the CRISPR-Cas system, there was a significant reduction in expression levels of mutant protein SOD1 in mice, resulting in alleviated symptoms of ALS and improved motor function [51,52]. Moreover, mutations in the SNCA gene leads to Parkinson's disease (PD), a neurodegenerative condition caused by degeneration of dopamine-producing cells, causing slowness, tremor and muscle stiffness and more symptoms(Deng and Yuan; Heisters).In PD studies, , CRISPR-Cas9 system effectively reduces the level of SNCA protein and disease-related markers in vitro, while enhancing cell viability (Qu et al.). This has been tested using animal models, primarily PD rat models. These models overexpressed the SNCA gene but resulting from a knock-out of one using CRISPR-Cas9, a significant recovery of the overexpression of α -synuclein, reactive astrogliosis, the degradation of neurons responsible for dopamine responses, and the overall loss of motor function due to Parkinson's was observed[40]. Cystic fibrosis is controlled by the CFTR gene located at 7q31.2(Marangi and Pistritto). The most common mutation is the 'F508del' mutation, making up 66% of mutations, which is a deletion of a base triplet codon for phenylalanine in position 508 on chromosome 7(Balushi et al.; Hodson et al.; Marangi and Pistritto). There are 6 classes of CFTR mutations, with 3 considered severe and 3 mild depending on the influence on the resultant protein (which plays a role in the Cl- gated ion channel). One of them is F508del that leads to a class II mutation (defective processing). Normative results were obtained when CRISPR-Cas9, using where donor fibroblasts from a CF patient's skin biopsy were reprogrammed to induced-pluripotent stem cells (iPSCs). These were then treated with the CRISPR-Cas9 system. Following the integration, a low efficiency of 16.7% was acquired, paired with correction of the CFTR gene. The positive iPSCs were differentiated into proximal airway epithelial cells and their prosperity tested (Colemeadow et al.).The results indicated significant improvement as they were capable of undergoing the necessary conformational changes required for cell membrane translocation(Colemeadow et al.). Overall, CRISPR has the ability to correct genetic mutations, which when transcribed can cause several different diseases, thus alleviating the symptoms and perhaps providing a full cure, by treating the disease at the source- the erroneous genes.

Cancer is a metabolic disease that is difficult to prevent or to treat due to its ability to regenerate and resist treatment. Cancer cells uncontrollably grow due to epigenetic factors, causing tumour growth and malignance, or spread to other tissues. They often evade the body's defences too, making them hard to cure(Luzzatto and Pandolfi). Development of cancer is widely and heavily influenced by tumour suppressor genes such as RAS, WNT, MYC, ERK, TRK etc(Lewis; Weinberg). Although traditional treatments such as chemotherapy and radiotherapy are actively used, there are some limitations in their use due to the undesirable secondary consequences like DNA damage(Lomax et al.; Lindley et al.; Di Fiore and Van Cutsem; Lyman). CRISPR technology promises an alternative therapy for some cancer types such as chronic myeloid leukaemia(Khan et al.). Chronic myeloid leukaemia (CML) is a type of blood cancer that is caused by the BCR/ALB1 gene fusion, resulting from parts of chromosomes 9 and 22 being switched in a process known as reciprocal translocation(Definition of BCR-ABL Fusion Gene - NCI Dictionary of Cancer Terms - NCI). A study in 2020 reported that CRISPR-Cas9 exhibited the ability to stop tumour development in CML by targeting potentially cancerous hematopoietic stem cells (adult stem cells and are responsible for the production of blood). This CRISPR-Cas9 system effectively eradicates the oncogene and prevents cell replication by destroying the BCR/ALB1 gene fusion in both mouse models and xenografts (Vuelta, Ordoñez, et al.). Recent studies have followed similar procedures and have exposed more cells to the CRISPR system, using different delivery systems like lentiviral vectors. This shows its possible application on different types of cell and animal models(Vuelta, García-Tuñón, et al., "Future Approaches for Treating Chronic Myeloid Leukemia: CRISPR Therapy"; García-Tuñón et al.). Unfortunately, despite the success in a laboratory setting, there are currently no clinical trials going on. This lack of clinical trials underscores a cautious approach toward this innovative therapy in patients for the future use.

3.2. CRISPR Applications in Agriculture and Food Security

A demand for increased food production becomes more important with the rapidly growing global population. CRISPR has been used to modify plants to develop genetically modified organisms (GMO) with enhanced disease resistance, yield, and resource efficiency in agriculture since 2013(Q. Liu et al., "Application of CRISPR/Cas9 in Crop Quality Improvement"). Importantly, to improve food production, yields (the production of food) and disease resistance (the ability of a plant to survive diseases that would reduce yield) need to be enhanced(Khalid; Stuthman et al.).

The application of the CRISPR system in boosting plant disease resistance was notably shown by Ji et al., who applied this technology for creating GMOs with remarkably enhanced resistance to Geminivirus(Ricroch et al.). In essence, the CRISPR system is used to either remove or insert a gene that, when transcribed, produces mRNA and a subsequent polypeptide that either helps fight the infection or inhibits resistance. The Geminivirus is a type of virus that is a threat to crops (e.g., chili, tomatoes, beans) and causes economic losses (Ruhel and Chakraborty). By analysing 43 candidate sites of the BSCTV (beet severe curly top virus)

genome and selecting two sites for gene editing/integration, viral resistance was achieved through targeted use of Cas9 expressing plasmid vectors to knockout a gene (Ji et al.). Moreover, CRISPR-Cas9 has shown promise in improving agricultural yields. Jhang et al. has also shown that generation of several new rice variants by altering three homeologs of the CytP450 family and OsBADH2results in increased 1000-grain weight (GWT) and grain size when compared to the wild variety, indicating higher yields (Usman et al.). These applications contribute to increased food production and environmental benefits by decreasing the need for resources while offering social advantages through more accessible food and enhanced nutritional quality.

In addition to CRISPR-Cas9, other CRISPR-Cas systems such as CRISPR-Cas13 offer further versatility in agriculture applications. This system targets RNA instead of DNA and can be utilized to make virus-resistant plants. The use of LshCas13 in the CRISPR-Cas system to enhance the viral resistance of Nicotiana benthamiana against Turnip Mosaic virus by targeting the virus's helper component proteinase is a case in point, showing the potential of CRISPR to produce   virus-resistant plants (Kavuri et al., "Applications of CRISPR/Cas13-Based RNA Editing in Plants"). This difference among the CRISPR-Cas systems is useful to distinguish the target site being different for DNA with Cas9 and for RNA with Cas13. These diverse applications of different CRISPR-Cas systems highlight their role in shaping the future of sustainable agriculture and food security.

3.3. CRISPR Applications in Biofuels

Recently, fuel demand has steadily increased for energy and transportation due to population growth and developmental advancements. This increase in fossil fuel usage has markedly alleviated carbon emissions, exacerbating the greenhouse effect (Wuebbles and Jain). Thus, sustainable energy has become an area of focus to combat the harmful greenhouse effects, with biofuels like bioethanol and biodiesel emerging as promising alternatives, because of genetic engineering(Khan).

Biofuels can be produced from both plant sources such as sugarcane, and microorganisms, including bacteria. For instance, sugarcane is often used with yeast to produce bioethanol. The yeast Saccharomyces cerevisiae processes efficient conversion of ethanol from glucose, which is a highly efficient pathway to produce ethanol. However, this yeast also generates glycerol as a by-product during reaction, which can reduce ethanol production rates(Ruchala et al.). Previous studies have shown that glycerol output can be decreased, and ethanol production improved by deleting three genes (GPD2, FPS1, and ADH2) associated with glycerol production, indicating less stress on the yeast(Ruchala et al.; Kong et al.). SCGFA, one particular engineered strain of Saccharomyces. cerevisiae, produces the highest ethanol yield following the deletion of these genes. This strain results in 23.1g/L ethanol production compared to 19.6g/L by the wild type, without compromising the stability of ethanol production. There is also a decrease in glycerol synthesis by 22.7% compared to the wild type(Yang et al.). CRISPR-Cas9 was effectively used to delete these genes in this strain, enabling precise modifications for optimized ethanol production. In addition, these engineered strains show lower

production of lactate, acetic acid, and succinic acid production while reducing CO_2 emission(Yang et al.). Lastly, the engineered strains did not show significant changes in glucose consumption or cell growth, indicating some areas for improvement(Yang et al.).

Application of CRISPR technology in biofuel production offers substantial economic, environmental, and social benefits, improving the efficiency and sustainability of ethanol production. This has the benefit of enabling highly efficient ethanol production and, due to the increased ethanol tolerance, less harm to the microorganisms. Therefore, the fuel industry would benefit as increased sales of these fuels would provide economic benefits. There would also be less pollution, more fossil fuels for future generations, and better global health(Economics of Biofuels | US EPA). Overall, while other genetic engineering techniques present useful tools to address the problems of sustainable energy production, CRISPR's precision and efficiency highly contributes to improvement of biofuel biosynthesis in industry.

4. Ethical Considerations, Technical Challenges and Future Perspectives

CRISPR has been proven to be efficient and precise, enabling it to be useful in numerous applications. Increased research into this field could enable therapeutic practises using the technology to replace the preliminary experiments going on and perhaps benefit the people afflicted with the conditions. For the future, CRISPR's potential as a transformative medical tool is undeniable. It has promise to perfectly treat or cure diseases by altering the DNA sequences responsible for them, with extremely high accuracy and precision(Li et al.). For instance, CRISPR may be used to solve genetic conditions like Down Syndrome by inactivating the extra chromosome 21(Tafazoli et al.). There are some genetic disorders such as Duchenne muscular dystrophy and sickle-cell anemia that could be cured using the CRISPR-Cas9 gene editing system. Next, some human organs could be produced using animal blastocysts by deactivating organ development in the host with CRISPR, allowing organ transplants to be less dependent on donors and consequently being cheaper and more readily available. In the future, the CRISPR-Cas9 system may also potentially be used to revive extinct species or make new ones through chimeras by integrating DNA from different species (Nidhi et al.). An example of its potential- Casgevy and Lyfgenia- are genetic treatments that have been approved for medical use for curing sickle-cell anaemia(Leonard and Tisdale). To begin with, these are the first genetic treatments that have been approved for medical use, but not only that, Casgevy makes use of the CRISPR-Cas9 system (FDA Approves First Gene Therapies to Treat Patients with Sickle Cell Disease | FDA). This is a massive step in the field of genetic therapies and acts as an indicator of the future use in healthcare.

Due to its recent discovery, CRISPR technology is associated with several shortcomings and challenges to its successful application. The most prominent of these challenges is the ethical considerations. The heritability of edited genes and modification of human embryos are important ethical concerns. In particular, the possibility of errors due to DNA similarities may cause safety concerns. For instance, while a particular transgene may be useful for a parent, the child may suffer due to it. Another ethical issue is that of altering human embryos as even a

slight error or inaccuracy in the use of this technology (possibly due to DNA strands similar to the target site) could be harmful and result in undesired changes in cells and humans (Gostimskaya, "CRISPR–Cas9: A History of Its Discovery and Ethical Considerations of Its Use in Genome Editing"). Another ethical concern is about financial differences that would provide a challenge with CRISPR-based therapies being equitably distributed, including synthesized organs and cures to life-threatening diseases. This would increase the gap between the rich and poor and prevent people in lower socioeconomic classes from benefiting from the same treatments compared to the higher socioeconomic classes. Due to these ethical issues, research on the effect of CRISPR gene editing on embryos has been limited with most of the research being done on animal models instead. To minimize these challenges for future, the meeting of the Second International Summit on Human Genome Editing occurred, resulting in a general consensus that performing germline editing for scientific reasons is permissible, but altered embryo implantation is prohibited (The Second International Summit on Human Gene Editing | National Academies). Until the impact of a CRISPR-Cas system being used on an embryo can be better controlled and predicted accurately, germline editing (if followed by implantation) using the technology is prohibited by the international ethics community. So, evidently, increased research on different delivery systems, long-term effects, and stronger databases of the influence of certain edited genomes is necessary to bring forth the required assurance that could lead to the allowance of implantation. (Knoppers and Kleiderman). In general, the laws and regulation differ greatly between countries, including the USA having no federal opposition to the use of CRISPR on human DNA while other countries such as Canada have prohibitive laws (Knoppers and Kleiderman).

Within the CRISPR-Cas9 system there are significant issues like off-target alteration which could cause undesired issues as the target DNA code would be altered, but so would another site of DNA similar to the target, possibly resulting in crucial genes being mutated(X. H. Zhang et al.). While this is dangerous, it is very rare due to the accuracy of CRISPR-Cas systems. Numerous strategies have been developed to engineer Cas systems that do not have off-target impacts. Firstly, several online tools are available that detect possible off-target impacts beforehand. These websites use sgRNA sequences to predict sgRNA-dependent off-target effects. While they are easily accessible, and generally quite sensitive, they also are biased towards sgRNA dependent off-target effects, require high sequencing coverage, and can sometimes be expensive(Guo et al.). Other strategies include developing Cas mutants that have reduced nonspecific DNA binding; in particular engineered strains had notably fewer off-target sites amongst three mutants compared to 134 off-target sites by one sgRNA with SpCas9 (Guo et al.). An example of a very accurate strain is hypaCas9, with only 18 off-target sites. This strain importantly has an engineered proof-reading mechanism with reduced nonspecific DNA binding (Guo et al.). While numerous different Cas proteins and modified CRISPR-Cas systems exist, future research will likely focus on development of more precise systems. These advancements are crucial for the commercial use of gene therapies and to enable us to fully realize CRISPR's transformative promise. Taken together, these strategies highlight how the new developments

will be useful to prevent or minimize these off-target alterations associated with use of CRISPR system while resulting in higher efficacy.

Delivery systems for the CRISPR-Cas9 system is also an issue as multiple different systems are generally used together to deliver the system to cells as opposed to one all-purpose delivery method (Lino et al.). These methods include electroporation and microinjection. Electroporation involves the use of electric fields to increase the porousness of cell membranes, allowing the CRISPR-Cas systems to easily translocate in. This process can be applied on all cells/cell types, allows many types of CRISPR systems to translocate in, and is efficient. However, strong electric fields could lead to cell death and loss of cell stemness(Sokołowska and Błachnio-Zabielska). Microinjection is extremely efficient and accurate and leads to reduced off-target sites. However, it is a slow and manual process as each cell must be injected individually so is unsuitable for large-scale processes. Other methods include viral vectors, in which edited viruses transfer and inject the CRISPR system into the cell. It is efficient and can be done on a large scale. These delivery systems give rise to issues with in vivo applications of CRISPR systems. For one, viral vectors are problematic due to their insufficient targeting ability and possibility for immune toxicity issues, possible carcinogenesis, or undesired mutations(Cheng et al.). To solve these problems, increased research into the long-term consequences of viral vectors and experimental integration of viral vectors into animal-models is essential. Another improvement could include the use of ribonucleoproteins (instead of DNA or messenger RNA), as this enables gene editing with the fewest off-target changes to occur. However, few delivery methods are suited for this large molecule(Cheng et al.). Thus, researching and developing delivery systems suited for ribonucleoproteins would help mitigate the risk and challenges. For the future, exploring and developing new delivery systems would help make this technology deliverable into new organisms, as well as more reliable for human use.

CRISPR systems have been actively used in industry and in laboratories for about the last two decades. As such, long-term consequences of CRISPR-enhanced products or procedures are unknown to us. This is amplified by the limited knowledge about the effect of delivery systems that remain in the body(Lino et al.). This includes the influence of deactivated viruses and nanoparticles used in microinjections. Long-term experiments with a large sample size and multiple different delivery methods, products/experiments would be ideal to provide information on how future generations are affected too. Therefore, further research and experimentation with the CRISPR-Cas9 system is crucial to understand how to mitigate the challenges to its widespread use as well as large scale scientific discussions to better understand ethical problems centred around the technology.

5. Conclusion

CRISPR-Cas technology is a relatively new field in genetic engineering, but it has already revolutionized with its applications . Its applications are widespread, indicating a dynamic and swiftly growing field by providing innovative and sustainable solutions. This

review has highlighted the potential benefits of CRISPR systems in current application fields such as biofuel production, agriculture, and medicine, while challenges remain. In summary, CRISPR is a rapidly developing field which has massive room for development. The coming decades will be marked with continued developments in CRISPR technology and biotechnological applications, resulting in valuable economic, social, and environmental benefits.

The base mechanism of CRISPR systems in any application is described too- the different components work together in order to interact with DNA found in an organism, allowing a gene to be knocked-out, inserted, transferred etc. This leads to changes in the proteins synthesis pathway, and thus phenotypic expression.

6. Acknowledgements

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Comparing the Impact of Screen Time Modes on Body Image for Men and Women
By Natalie Zhou

Abstract

People spend more time today online than ever before. However, spending more time online may be linked to decreased self-esteem and increased body dissatisfaction, eating disorders, and body dysmorphic disorders. This paper examines how screen time affects the body image of men and women. A literature review was conducted comparing popular modes of screen time such as social media, television viewing, and gaming with their effects on the body image of men and women. We found that for both men and women, there was generally a negative correlation between screen time on social media and body image, while there was no significant correlation for screen time playing video games and body image. Television viewing appeared to negatively affect the body image of women only and not men. To better understand how screen time affects the body image, self image, and mental health of men and women, more extensive research can be done including more diverse demographics and modes of online platforms.

Introduction

Average screen usage in our modern world has increased considerably from the early last decade, with people now averaging 6 hours and 58 minutes of screen time a day, a 13% increase since 2013 (1). Following the COVID-19 pandemic, the stay-at-home measures and online learning protocols throughout the US were correlated with a drastic swelling of over an hour of daily screen time for children, a spurt which persisted even after these social restrictions were lifted (2). Although the COVID-19 pandemic was only temporary, the increase in usage of screen time it has caused appears to be long-lasting.

With this upsurge of screen time comes both benefits and drawbacks. On one hand, increased screen usage allows for people to connect with people from all over the globe, establishing connections that would never have been able to exist otherwise (3). A study in China concluded that increased screen usage can also improve connectedness with family members and friends, decreasing feelings of loneliness as a result (4). Social media platforms can also keep people informed about news and current events or crises such as natural disasters in real-time, increasing safety in the face of danger (5).

On the other hand, rising screen usage has also placed an increased emphasis on beauty standards. Users of social media may consume hundreds of pictures each day, including those of fitness models, celebrities, and other public figures. Many people who post on social media only post their best photos, which leads to unrealistic photos that men and women may be comparing themselves to (6). As an example, after celebrity Kim Kardashian was rumored to have buttocks injections in 2014, online searches for 'butt implants' rose by 100% (7). Additionally, following Kylie Jenner's announcement of having undergone lip augmentation procedures, Google searches for 'lip fillers' rose by 3233% (7). The culture of comparison fueled by social media

and its resulting inadequate feelings among individuals often results in excessive use of cosmetic procedures and surgeries in attempts to achieve the beauty standard (8). The surge of social media usage worldwide has also brought about an increase in mental health issues such as depression and anxiety (9, 10).

The rise in social media consumption has also led to worsening body image issues, or exacerbated dissatisfaction with one's body shape and weight, with a 2019 Mental Health Foundation report finding that 31% of teenagers and 35% of adults feel ashamed about their body image (11). For example, studies of teens in Australia and Belgium found that Facebook users experienced heightened body image concerns (12, 13). Correlations between screen time and poor body image are not due to social media alone, with other sources of media contributing to negative impacts on body image such as gaming (14), handheld viewing (15) and online viewing (15). From the results of self-reported studies, women's negative body satisfaction seemed to be positively correlated with more screen time.

Interestingly enough, different modes of screen time seem to have different strengths of association with developing negative body image. A study conducted in Iceland in 2022 on a cohort of 152 girls and boys studied at 15 and 17 years old showcased that excessive screen time, particularly gaming, was associated with lower body image scores in girls, but not boys (14). This growing trend in body image issues has also manifested itself in many different impacts and disorders. For example, a larger-scale study in 2022 involving 7,300 women found associations between handheld and online viewing and body dissatisfaction, as well as downloaded viewing and overeating behaviors (15). The study also found that recorded, online, and downloaded viewing were associated with disordered weight control behaviors (DWCB) among women (15). A 2022 study amongst female and male 16-18 year olds concluded that there is a concerning rise in body dysmorphia, or obsessions with flaws in one's own appearance, amongst adolescents (16). A 2023 study among 2538 Canadians 16-30 years old found that among women, video chatting was most strongly associated with symptoms of muscle dysmorphia (MD), a body dysmorphic disorder in which people are obsessively concerned with their muscularity and leanness (17, 18). With women, associations between specific viewing modes and poorer body image in addition to disordered weight control behaviors are apparent.

Of course, women alone are not the only ones whose body image may be affected by the rise in screen time. In the same 2023 Canadian study, no associations were found between any viewing mode and DWCB in men, but associations between viewing mode and body dissatisfaction signs were still apparent (15). The study examined 3,466 men to find that more online viewing exhibited greater body dissatisfaction, while more downloaded viewing led to increased odds of developing overeating habits (15). In addition, a 2023 study among 2,538 English-speaking Canadians aged 16-30 highlighted a positive relationship between screen time and symptoms of muscle dysmorphia in men. Social media specifically appeared to exhibit a stronger association with MD symptoms than other modes of screen viewing (17).

As screen time and digital device usage increases, it's important to understand the impact of different screen viewing modes on body image. Common screen viewing modes such as social

media, TV or broadcast viewing, and gaming may have significant impacts on body image for both men and women, but can be mitigated when better recognized and understood. This paper sought to figure out whether a rise in different types of screen time consumption modes correlate with a rise in body image issues for men compared to women.

Methods

The PubMed database was reviewed from December 2023 to June 2024 for recent reviews and systematic reviews published from January 2013 to December 2023. The search included terms such as body image, body weight, eating disorder, video games, social media, screen time, and consumption of TV. The search focused on reviews that measured the amount of screen time exposure across multiple modes (social media, TV or broadcast, video gaming) and its effects on body image through measures of disordered weight control behavior, symptoms of muscle dysmorphia, or self-reported body dissatisfaction. The reviews were mostly cross-sectional but had some longitudinal studies. The demographic was adolescent girls and boys ages 12-18 years old and men and women 18 years old and older. International studies were also included. The search reviewed only freely available studies and were examined for content related to body image and screen time. All examined studies were available in English.

Data from these studies was mostly collected through online surveys and sometimes advertised with raffle incentives at targeted high schools or Instagram and Snapchat advertisements. Any survey participants who had missing information were excluded from these studies. For the Eisenberg et al. study, surveys were used to find the 25 favorite TV shows among 2793 Minnesota adolescents to analyze weight-related teasing incidents on these TV shows (19). Surveys asked participants to share the average time they spent on screen viewing modes as well as indicate on a point-scale how much statements relating to body image satisfaction applied to them (19).

Body image was measured based on preexisting scales for each study. The Hrafnkelsdottir et al. study used five questions of the Body and Self-Image subscale of the Offer Self-Image Questionnaire in which each answer to the five questions were given a point value from 1 to 4 and totaled after the survey. The Ganson et al. study used a similar survey and point-distribution method to measure the Muscle Dysmorphic Disorder Inventory, while the Vuong et al. study used the Body-Esteem Scale for Adolescents and Adults (BESAA) body dissatisfaction subscale's score to measure individuals' body dissatisfaction (17, 19). All studies had scales that were internally consistent, with analyses performed separately for men and women.

To examine associations between each mode of screen viewing and body dissatisfaction outcomes, multiple linear regression models were run for many studies (6, 17, 19), and chi-square tests were also used in the Ganson et al. and Vuong et al. studies to test for non-normality. Stata 15.1 (21), Stata 17 (17), SPSS 26 (19), and Mplus 8.0 (19) were used to conduct data analyses. All studies considered data statistically significant if it had a p value lower than 0.05.

Results

Table 1. Associations between different modes of screen viewing and worse body image for men and women

Modes of viewing	Men (12+ years of age)	Women (12+ years of age)
Social Media	More than 5 hours daily of social media use correlated with an increase in self-reported body weight dissatisfaction: **p<0.01** (21) Frequency on Snapchat and Instagram correlated with a higher body dissatisfaction index (BESAA subscale scores): **p<0.05** (19) Hours of daily social media use correlated with a higher Muscle Dysmorphic Disorder Inventory score: **p<0.001** (17)	More than 5 hours daily of social media use correlated with an increase in self-reported body weight dissatisfaction: **p<0.01** (21) Frequency on Snapchat and Instagram correlated with a higher body dissatisfaction index (BESAA subscale scores): **p<0.01** (19) Hours of daily social media use correlated with a higher Muscle Dysmorphic Disorder Inventory score: p=0.087 (17)
Television Broadcast	Number of exposures to weight-related teasing from favorite three TV shows correlated with a lower self-reported body satisfaction score: p=0.336 (19) Hours of daily TV watched correlated with a higher Muscle Dysmorphic Disorder Inventory score: p=0.880 (17) Hours of daily TV/DVD/internet material watched correlated with a lower self-reported body image score: p<0.47 (14)	Number of exposures to weight-related teasing from favorite three TV shows correlated with a lower self-reported body satisfaction score: **p=0.008** (19) Hours of daily TV watched correlated with a higher Muscle Dysmorphic Disorder Inventory score: **p=0.040** (17) hours of daily TV/DVD/internet material watched correlated with a lower self-reported body image score: **p<0.03** (14)
Gaming	Hours of daily game playing correlated with a lower self-reported body image score: p<0.99 (14) Hours of daily game playing correlated with a higher Muscle Dysmorphic Disorder Inventory score: p=-0.196 (17)	Hours of daily game playing correlated with a lower self-reported body image score: **p<0.03** (14) Hours of daily game playing correlated with a higher Muscle Dysmorphic Disorder Inventory score: p=0.444 (17)

Table 1: The table above contains the p values of correlations collected from multiple studies to depict the relationship between a form of screen viewing consumption (social media, television, or gaming) and worse body image for men and women. Statistically significant associations with a p value of less than 0.05 are bolded.

Social Media Impact

In several studies, social media was shown to have a strong impact on body image regardless of sex (6, 19). For men, greater social media use was also correlated with a greater likelihood of developing muscle dysmorphia, but for women, there was no significant relationship between greater social media use and the likelihood of developing muscle dysmorphia (17).

Television Broadcast Impact

Among men, TV and broadcast viewing showed no significant correlation with body dissatisfaction (14, 17, 19). However, among women, these same reviews highlighted a significant relationship between consuming TV content and body dissatisfaction. Among women, more exposure to weight-related teasing in their favorite TV shows was correlated with lower body dissatisfaction (19). This data was collected through analyzing participants' favorite 25 tv shows and their own body satisfaction.

For men, there was a correlation with social media and worse body image, but not a statistically significant correlation with TV. For women, there was a statistically significant correlation with both social media and TV.

Gaming Impact

For both men and women, there is not much statistically significant data supporting that more time spent gaming negatively impacts body image. The exception was a single study that found that more time spent gaming was correlated with worse body image for women but not men (14). For women, this is unlike social media and TV, which had data to support a correlation between gaming and worse body image.

Discussion

For women, most articles highlighted a correlation between more screen time hours and worse body image. However, for men, much of the data did not support a significant correlation between more screen time hours and worse body image, with an exception in the social media category which did have data to support a significant correlation (17, 20, 21).

Social Media

The correlation of developing muscle dysmorphia from viewing social media for men but not women could be explained by the tendency of men to consume content with more emphasis on muscularity, while women might consume content with less emphasis on muscularity and

more emphasis on thinness. These data also may not have seen a correlation due to a lessened tendency for women to develop muscle dysmorphia. For example, a 2020 article that explored the emphasis of men and women with body dysmorphia found that women tended to focus on legs, while men emphasized muscularity more than women (22).

A possible explanation for social media impacting body image for both men and women is the setting that social media sites create which emphasizes body aesthetics and comparison. Many people only post their best photos on social media, which could lead to unrealistic photos that men and women may be comparing themselves to, causing worse body image (6).

Television Broadcast

A possible explanation for TV and broadcast viewing only showing a significant correlation with body dissatisfaction for women but not men is that there are more inclusive body types for men vs women on TV shows. For example, popular TV shows such as Family Guy, The Simpsons, and Modern Family feature more male characters who are not the ideal body type, while female characters across these shows are not plus size. This could lead women who don't see their body type represented on TV to feel self-conscious while watching, thus lowering their body image.

Gaming

A possible explanation for gaming not having as much statistically significant data for men or women is that people might consume it with the expectation that it is a form of entertainment and not a reflection of reality, which leads to them being less conscious of body types displayed on the screen.

Although TV impacts men and women differently, for gaming there might not be much impact on the body images of men or women because of the different portrayal of bodies in the video games men or women choose to consume. For example, women may choose not to play video games where the women are portrayed with unrealistic or sexualized bodies, while men tend to consume games catering towards the male gaze (23). This allows both men and women to not have their body image negatively impacted by the video games they choose to play.

Limitations

This review does have a few limitations, as it does not describe the effects of screen time on body image for the elderly as there was no information found for adults aged 65 years and older. Additionally, some data was collected through a sampling method with incentives, which may have increased selection bias for participants. As the data collected was self-reported in all of the studies examined, biases may have been present leading to reduced validity of data. The study by Ganson et al. on Muscle Dysmorphia was only measured for subjects 16 years to 30 years old (17). There are some differences in social media consumption across ages. 71% of adults aged 18-29 say they have used Instagram before, while only 29% of adults aged 50-64 say they have used Instagram before (24). Since Instagram is widely considered a more photo-based

media platform than others, this may mean younger adults' body image are affected by social media consumption disproportionately compared to older adults.

Conclusion

In today's age, there has been a substantial increase in screen time. The increase in screen time in this decade is also correlated with a prevalence of body image issues. Indeed, for both men and women, evidence supports a significant correlation between time spent on social media and worse body image, with men also showing a higher likelihood of developing muscle dysmorphia. With TV consumption, there was data to support an association between consuming TV content and worse body image for women but not men. For both men and women, there was little statistically significant data supporting that gaming had any impact on body image.

In the future, more extensive research needs to be done on people under 18 for the gaming mode of screen time, as they are among its most popular consumers. Furthermore, future studies can review the effects of image-based platforms such as Instagram compared with video-based platforms such as TikTok or Instagram reels on body image for girls, boys, men, and women.

On a societal level, declining body image for adolescents can be solved by limiting their screen time with more accessible parental controls. Parental controls should be the default setting for adolescents' devices. It is also worth limiting ads on the internet about diet-promoting goods or services to diverge from diet culture-promoting disordered weight control behaviors.

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Are Beliefs Voluntary? By Steven Zhen-Ting Li

Introduction

Beliefs serve as the foundational building blocks upon which our understanding of the world is constructed. In essence, beliefs shape our identity as human beings, being defined as an "idea that we hold as being correct, an acceptance that something exists or is true" (Gurteen, 2009). However, this raises the question: do we truly possess autonomy over the formation of our beliefs? If so, is it possible for us to adopt a belief based solely on conscious choice, or in other words, voluntarily?

In this essay, I will contend that the beliefs human beings hold are voluntary to an extent, as they follow a nuanced trajectory throughout human lives, influenced by various power dynamics. During early stages of life or when individuals occupy subordinate positions of power, the volitional aspect of belief formation is significantly diminished, with external factors, such as socialization and authority, playing a significant role in shaping beliefs during these formative periods. However, as individuals mature and gain the capacity and resources to assert independence over their beliefs and moral systems, the potential for conscious choice emerges.

Throughout our lives, power relations can engender conditions that limit the choices of beliefs available to individuals. The social structures stemming from these skewed dynamics such as economic inequality or hierarchies of knowledge restrict access to the diverse perspectives, information, and resources necessary to critically evaluate and construct beliefs. As such, individuals may find themselves constrained within the boundaries of societal norms and what is endorsed by those in positions of power.

Although this essay will argue in favor of the progressively voluntaristic formation of beliefs with age, it must be acknowledged that complete voluntarism remains elusive. While individuals possess the ability to weigh evidence gathered and make autonomous decisions, a variety of uncontrollable hidden factors lurk beneath the surface, compromising the extent to which the adoption of beliefs is entirely voluntary. One such factor is confirmation bias, which inherently predisposes individuals to favor beliefs and courses of action that aligns with their preconceived opinion (Nikolopoulou, 2022) Thus, even when engaging in a voluntary exploration of beliefs, many people cannot fully extricate themselves from the sway of subconscious biases. However, appropriate educational interventions and provisions of resources can do a great deal to increase the extent to which individuals overcome the limitations imposed upon them by external factors or pre-existing beliefs.

Childhood

During infancy, the cognitive capabilities necessary for intricate belief formation are still nascent, limiting our comprehension of rudimentary sensory perceptions and preventing us from engaging in reasoning, abstraction, or critical thinking. This concept of "tabula rasa", or a, "supposed condition that empiricists have attributed to the human mind before ideas have been

imprinted on it by the reaction of the senses to the external world of objects" (Britannica, 1998), conceptualizes newborns as having minds comparable to blank canvases. In this early phase, children rely extensively on external influences to formulate their understanding of the world. Parents, caregivers, and the immediate environment assume crucial roles in this developmental process. Through keen observation and emulation, children gradually internalize the behaviors, attitudes, and values exhibited by those around them and so as they mature, their beliefs become increasingly shaped by the prevailing social and cultural norms practised by their community.

The early stages of socialization and education exert a profound influence on the development of a child's beliefs about and outlooks on the world, given their limited cognitive abilities to form independent opinions. A notable demonstration of this can be observed in American schools, in which the practice of reciting the Pledge of Allegiance every morning serves as a vehicle for instilling patriotism; many children become accustomed to this ritual and engage in it without much thought. However, as children age, they begin to question the reason for reciting the Pledge, while some refuse to do so, due to the fear of condemnation by their classmates and even instructors (Etzler, 2016). This decision to discontinue the recital of the Pledge reflects an individual's evolving beliefs and values, as they learn to critically evaluate the notions that were previously instilled in them involuntarily. Similarly, few children actively select which religion to follow; in fact, religion is frequently imposed upon the members of the younger generations as a way to perpetuate religious practice and traditions.

These early belief formations can be further attributed to the hierarchical nature of children's relationships with their elders or caretakers. In the context of the family unit, parents or caregivers typically occupy the positions of power, assuming care-taking responsibilities, and children's survival depends entirely on these parental figures to take care of them. This hierarchical dynamic generates a power imbalance whereby children are obligated to comply with the beliefs, values, and rules established by their elders.

Children are also embedded in broader social communities such as schools, religious institutions, and cultural groups, in which teachers, religious leaders, or community elders assume positions of authority and influence. On the other hand, the children, being in a position of relative powerlessness, tend to obey the authority of their elders due to the fear of actual or perceived punishment. Children seek acceptance, validation, and a sense of belonging from and within their families and communities (Young, 2021); thus as a result, they are more inclined to adopt the beliefs and values upheld by those in power as a means of conforming and fitting into their social environment.

Extending upon this, the power held by adults in these hierarchical relationships can also manifest in the form of social rewards and punishments. Children receive praise, approval, or materialistic rewards when they accord themselves with the beliefs and behaviors endorsed by their elders. Conversely, they receive criticism, disapproval, or reprimands when their beliefs deviate from those of their caregivers or community leaders. Such external factors are what further strengthen the influence of power dynamics on children's internalization of beliefs.

It is important to note that power dynamics within these hierarchical relationships are not to be seen as purely negative or coercive. Adults, as figures of authority, have the responsibility to guide and protect children, imparting the knowledge and skills essential in the service of healthy development. The transmission of beliefs within such hierarchical relationships is not necessarily an act of manipulation, but rather a means of socializing children into their culture, providing them with a framework of understanding the world to assist their integration into society.

Adulthood

As children enter adulthood, the extent to which individuals can voluntarily adopt beliefs increases. With the maturation of cognitive abilities, individuals gain the capacity to engage in independent introspection and critical analysis of their own belief systems and moral compass. This is evidenced through Jean Piaget's theory of cognitive development, which theorizes that children pass through distinct stages, acquiring new cognitive abilities and ways of comprehending the world (Main, 2022), where, as they transition from concrete to abstract thinking, the resolution of their beliefs become more intricate and nuanced. Similarly, Lawrence Kohlberg's theory of moral development posits that individuals progress through stages of moral reasoning, beginning with a focus on obedience and gradually incorporating principles of justice and ethical considerations (Mcleod, 2008). This progression suggests that our beliefs about moral dilemmas evolve as we mature and become capable of engaging in more complex reasoning.

As we age, not only do our cognitive capabilities increase, but so does our accumulation of both tangible and intangible resources. The acquisition of physical assets like wealth and /or non-physical assets like experiences and skills further enables individuals to assert their autonomy over shaping their own belief systems. This is particularly the case as access to a diverse range of resources, including educational opportunities and new information, empowers individuals with a broader worldview and thus the privilege to exercise educated judgements in determining their beliefs. For example, while children in religious households often adopt their parents' religion initially, a notable number of them gradually transition to agnosticism or atheism as they mature. In the United States, of the young American adults who actively participated in Protestant churches for at least a year during their teenage years, 66% reported a subsequent period of disengagement lasting at least a year between ages 18 and 22 (Earls, 2021). The cognitive transformations that come with age are highlighted here, as individuals pursue education, gaining access to various sources of knowledge, and adopt a more open-minded attitude. It reinforces the notion that as individuals expand their understanding of the world and encounter diverse perspectives, they may reassess their convictions and adopt alternative philosophical or even non-religious worldviews.

As such, it is evident that children face inherent challenges when it comes to the formation and assertion of their beliefs, which are at this stage completely involuntary, mainly due to factors such as their basic cognitive development and limited autonomy. With their cognitive abilities still undergoing development, children possess neither the necessary

knowledge nor experience to critically assess and evaluate complex belief systems. As we mature into adulthood, however, humans develop volition, gaining the capacity to seek out diverse sources of information, engage in critical thinking, and explore different belief systems. This accumulation of knowledge and resources enables adults to weigh perceived evidence and make informed decisions about their values.

Power

While it is certainly the case that adults have more volition over their beliefs than children, there are nevertheless limits on the ability of even adults to form and express their own views as a result of power dynamics. French philosopher Michel Foucalt argued that power operates through social institutions and discourses to shape and regulate individuals beliefs (Gaventa, 2003). Foucalt emphasizes the role of power-knowledge, proposing that knowledge and power are inseparable (Fruhling, 2022). Power structures shape what is deemed legitimate knowledge, while knowledge, in turn, reinforces and justifies existing power structures. This interplay between power and knowledge perpetuates dominant belief systems and limits alternative perspectives from emerging. Consider the highly restrictive context of North Korea, for instance, where a tightly controlled political system and pervasive ideological indoctrination severely limit individual freedoms to shape the social landscape. Despite potential advantages such as age or resources, the overarching dictatorial political structure impedes the formulation and expression of independent beliefs. The regime's stranglehold on information, freedom of speech, and constant surveillance curtail opportunities for dissent and open expression of diverse viewpoints and discourses.

The social and political context in North Korea promotes a collectivist mindset that prioritizes conformity and loyalty to the ruling regime. Dissent or expression of independent beliefs is viewed as a threat to the stability and power of the regime, making it virtually impossible for individuals to openly assert their own convictions. Under such power imbalances, even adults find themselves unable to exercise autonomy in shaping their beliefs.

Conclusion

Ultimately, the formation of beliefs is a complex, multi-faceted process which is involuntary throughout childhood, due to cognitive limitations and social dynamics. The formation of beliefs, however, becomes progressively more voluntary with age as we possess greater volition to critically evaluate and shape our own beliefs. However, it is essential to recognize that complete autonomy in belief formation may be impossible due to the pervasiveness of power dynamics. In understanding the complexities of the voluntary or involuntary nature of beliefs and limitations imposed by external factors, our understanding of the nuanced nature of human belief formation is heightened.

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Exploring the Evolution and Impact of Microfinance in India: Developing Credit Scoring Models for the underbanked/unbanked By Kabir Dhawan

Abstract

This paper explores the evolution and impact of microfinance in India and discusses the development of credit-scoring models for the underbanked and unbanked populations. It examines the historical progress of microfinance, highlighting significant initiatives like the Self-Help Group (SHG)-Bank Linkage Programme and Joint Liability Group (JLG) models that have been pivotal in extending financial services to marginalized communities. The adaptability of microfinance institutions (MFIs) in addressing diverse socio-economic challenges is emphasized. Despite significant advancements, the paper identifies ongoing challenges, including limited access to capital, regulatory constraints, and inconsistent investment validation methods. Addressing these challenges requires coordinated efforts from policymakers, financial institutions, and MFIs to foster a supportive environment for the sector's growth and sustainability. The study also underscores the critical need for robust credit scoring models tailored to the unique needs of the underbanked and unbanked. These models are essential for assessing creditworthiness accurately, managing risks, and ensuring the sustainable growth of MFIs.

 Introduction

Financial inclusion and socioeconomic development are some of the foundational pillars for achieving equitable economic growth and addressing the inequalities that exist in any nation. However, there is a significant disparity between urban and rural areas in India, and it has existed for thousands of years. However, with the latter facing insurmountable barriers to accessing formal financial services and economic opportunities, Microfinance institutions (MFIs) have emerged as transformative services to bridge this gap. By providing individually tailored solutions to modern problems, they effectively empower marginalized groups in the rural population, stimulating socioeconomic progress in the process.[1]

In the pursuit of inclusive development, India has made significant strides in recent years, with notable economic growth and progress in various sectors. However, this growth has not been uniform across the country. Rural areas continue to face numerous challenges related to poverty, unemployment, and lack of access to basic services.[2] The situation is exacerbated by limited access to formal financial services, leaving a large segment of the rural population excluded from the mainstream financial system.[3] Lack of access to credit and savings facilities hampers entrepreneurship, investment in livelihood activities, and resilience to economic shocks in the rural Indian community.

It is in this context that microfinance has gained prominence as a potential solution to address financial exclusion and uplift rural communities. Microfinance is a financial innovation that provides small loans, savings, and other financial services to poor and low-income individuals who are excluded from the traditional banking system.[4] The concept of microfinance

emerged subsequent to the launch of institutions such as Grameen Bank[5] in Bangladesh, founded by Muhammad Yunus.[6] Inspired by the success stories of microfinance, various organizations and institutions have established MFIs in India, all with the aim to empower the rural poor and catalyze sustainable development.

The impact of microfinance on poverty alleviation, women empowerment, and rural development has been a subject of extensive research and debate. Numerous studies have sought to evaluate the effectiveness of microfinance interventions in improving the livelihoods of the poor and fostering inclusive growth.[7] [8] While some researchers emphasize the positive effects of microfinance on income generation, entrepreneurship, and empowerment, others caution against potential mission drift, over-indebtedness, and the need for careful monitoring to ensure the positive impact. [9] [10]

Despite the successes of microfinance, the sector faces significant challenges in accurately assessing the creditworthiness of potential borrowers. Traditional credit scoring models, which rely heavily on formal financial histories, are often inadequate for evaluating the risk profiles of individuals with limited or no banking records. This paper explores the evolution and impact of microfinance in India, focusing on developing innovative credit-scoring models that leverage alternative data sources to assess the creditworthiness of the underbanked and unbanked. By examining various approaches and their implications, this research aims to contribute to the ongoing efforts to enhance financial inclusion and ensure the sustainable growth of the microfinance sector in India.

Evolution and Current State of Microfinance in India

Historically, the world has seen several ways of issuance of loans to destitute populations. "Montes pieties", or mounts of piety, were a series of medieval Christian credit institutions that were formed in Italy to provide funds to support the poor in their difficult times.[11] The system was gradually exported out of Italy and expanded to all of Europe laying the foundations for modern-day Banking. The first mutualist financial institution in the form of a savings and loan cooperative opened in 1879 in Germany, serving the working population by providing them with access to credit. However, nothing was sufficient to inhibit the growth of poverty and the so-called "third world." It was here, in the third world, that the expression "microcredit", which evolved to microfinance, as we know it today, took birth as the brainchild of the Bangladeshi economist Muhammed Yunus.[12] He realised by personally funding the business of a group of forty-two women making bamboo furniture for a living, that small loans made a disproportionate difference in the life of the poor, and if given a just chance, the small loan would always be repaid, sowing the seed for an idea of a viable business model. His idea of Microfinancing received a lukewarm reception from the traditional banking system, so in 1983, he founded the Grameen Bank (bank for the poor), which recorded stellar growth in years to come and earned him a Nobel Prize in 2006.[13]

Micro-financing includes simple financial services, such as small loans, savings accounts, funds transfers, and insurance on financial services, such as business training. The unique feature

of microfinance is the assistance of people who are living in poverty and who don't usually qualify for regular banking services because of a lack of identification or collateral for securing loans.

In India, until the nineties, people experiencing poverty were deemed "unbankable", largely due to the lack of collateral which was required for any form of formal finance. The poor were in a vicious cycle of breeding more poverty. However, with the emergence of the idea of Microfinancing and its uniqueness of not needing collateral, India looked at it optimistically as a possible tool to get its poor out of their vicious cycle of poverty. Before Microfinancing, the poor could only look at commercial lenders, landlords, or traders, who had formed the informal, easy-access option to get finance, but this was marred by exorbitantly high interest rates. There were regional rural banks and some rural development programmes (Integrated Rural Development Program) which lent money through heavily subsidised schemes; however, they were often siphoned off by the local people in power. Needless to say, that these schemes brought heavy losses to the banks due to high arrears and default rates. [14]

The Informal lenders were well placed to have a lot of information about the needy households and could enforce repayments by effective, sometimes unlawful means but were limited in resources. In contrast, the formal lenders, like the state-owned banks, had plenty of resources but limited to no information about the clients, and hence could not effectively enforce repayment mechanisms in the absence of collateral.

Microfinance began to be seen as a way to find the best of the formal and informal options above, namely, access to information and strength of resources. This came for India at a time when the Indian government's boost towards alleviation of poverty was picking up pace, and Microfinancing was looked at as a means to achieve that. Over time, Microfinancing has been linked with the following objectives:

- Promotion of social and economic development amongst the weaker sections of the society
- Strengthen self-help groups and use them as a tool to steer economic development.
- Promotion of women empowerment, financial liberation of women, and support of women entrepreneurs.

The first microcredit summit was held in 1997 in Washington, and the G8 outlined the principles of microfinance in 2004. The year 2005 was named "International Year of Microcredit" by the UN.[15]

Since its advent, the microfinance sector has been instrumental in creating opportunities by providing credit access to over 64 million borrowers who had been beyond the reach of traditional banking services. A few significant features of Microfinance may be listed as follows:[16]

- Borrowers are from low-income backgrounds.
- Loan amounts are small (microloans)
- Loan tenure is short.
- There is no/minimal requirement for collateral.

- The repayment is at a higher frequency.
- The purpose of the loan is usually income generation.

Microfinance Models

A few models of Microfinance have been prevalent to fulfil the Microfinancing needs in the Indian subcontinent. These are discussed below.[17] [18] [19]

Associations Model

In the association model, the target community forms an association through which microfinance and other activities are initiated for themselves. The associations may be formed by a group of women, cultural or religious groups and create support for work-based issues. The association gathers capital and intermediates between banks, MFIs and its members. An example of the association model is the self-help groups. The NABARD -Self Help Group- Bank Linkage Programme (SHG-BLP) is being spoken of as the largest such in the world.[20]

Community Banking Model

Members of the community join together to pool capital resources to lend to members. The transparency of practice is very high in this model, and guarantees are provided by social collateral as services are distributed through member groups where each member's eligibility for a loan is based on their peer's performance. Royal Bank of Scotland (RBS) Foundation India[21] is a successful example of a community banking model.

Cooperatives Model

The cooperative model is very similar in structure to the associations and community banks model. However, their ownership structure differs because it does not include the poor. The cooperative is formed by a group of middle or upper-class individuals who then offer Microfinance services to the poor. These members are shareholders and have their share in equity capital and also share the profit. The Cooperative Development Forum Hyderabad is an example of the cooperative model. Grameen Bank (Bangladesh)[22], Self-Employed Women's Association (SEWA) Bank[23](India) and K-Rep Bank (Kenya)[24] are all well-known examples of MFIs based on the Cooperative Model.

Credit Unions Model

In a credit union, members of the community pool their money together and offer loans to one another at a low interest rate. While their structure is similar to community banks, they differ in their size, being substantially smaller, and are not profit-oriented. Their interest rates are just enough to allow the sustainability of the credit union. SACCOs (Savings and Credit Cooperative Organizations) in Kenya are a prominent form of credit union where members pool in their resources to provide loans and other financial services to each other. [25]

Non- Governmental Organisation Based Microfinancing

The activities of NGOs include offering microfinancing services, improving the credit rating of the poor, and providing training, education, and research. The NGOs also acted in as intermediaries between the poor and donor agencies. BRAC (Bangladesh Rural Advancement Committee) is one of the largest NGOs in the world and operates a comprehensive microfinance program in Bangladesh. It provides small loans to the poor, especially women, to start or expand small businesses. BRAC's approach combines microfinance with other development programs in education, health, and social development to create a holistic impact.[26]

For-Profit Banks

Specialised microfinance banks, or even commercial banks today, also offer various financial services to the poor based on their creditworthiness, but their primary purpose may be to ensure a high return on investment. Banco Compartamos (Mexico) is one of the largest microfinance institutions in Latin America. Initially starting as an NGO, it transformed into a for-profit commercial bank to scale its operations. Compartamos focuses on providing small loans to micro-entrepreneurs, particularly women, to help them grow their businesses.[27] On the other hand, Equity Bank (Kenya) is a commercial bank in Kenya that has successfully integrated microfinance into its operations. It offers a range of microfinance products, including microloans, savings accounts, and insurance services, targeting low-income individuals and small businesses. Equity Bank's innovative approach has significantly contributed to financial inclusion in Kenya.[28]

In the Indian subcontinent, Bandhan Bank started as a microfinance institution and transitioned into a full-fledged commercial bank in 2015. It focuses on providing micro-loans to the underbanked and unbanked populations in India, primarily targeting women entrepreneurs and small businesses. Bandhan Bank has a strong presence in rural and semi-urban areas, offering a range of financial products and services.[29]

Rotating Savings and Credit Associations (ROSCA's)

Informal associations formed to save and simultaneously borrow, commonly known as a "kitty" amongst women and "chit" amongst the micro, small and medium businesses (MSMEs), are numerous in India. It is essentially a group of individuals, usually women for the kitty groups, who form a group and make regular cyclical contributions to a common fund, which is given as a lump sum to one member in each cycle.[30] ROSCAs have become a vital tool for communities to access credit. They help individuals finance education[31] and health services,[32] as well as acquire vehicles, housing,[33] land, livestock, and other means of production.[34] Additionally, ROSCAs support the purchase of non-capital goods and facilitate social and cultural events.[35] This mechanism provides a broad range of financial solutions to meet diverse needs within the community.[36] CredRight is a fintech platform using alternate data to underwrite loans for the small business that are part of the chit fund who need funds but did not win the chit prize in a given month.[37] [38]

The four pillars of the microfinance credit system are supply, demand for finance, intermediation, and regulation. Irrespective of the model of microfinance, the ultimate goal is the accessibility of finance to the poor population.
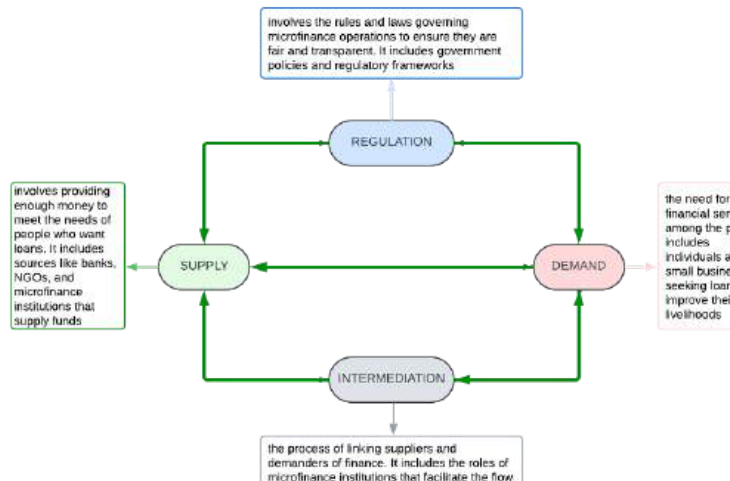
FIGURE 1: THE PILLARS OF MICROFINANCE [39]

Financial Inclusion and MFIs

Financial inclusion is the extension of financial services to large, uncertain populations to promote their growth potential and is the key enabler to reducing poverty and boosting prosperity.[40]Financial inclusion is a priority for the government of India, which initiated the National Mission for Financial Inclusion (NMFI) called the Pradhan Mantri Jan Dhan Yojna (PHJDY)[41] in 2014 to "provide banking services to every unbanked household, guided by the principles of "banking, the unbacked, securing the unsecured, funding, the unfunded, and solving the answer, then underserved areas."[42] In 2018, the aim shifted its focus from every unbanked household to every unbanked adult.[43]

Before the concept of Microfinancing, mainstream banks were reluctant to offer financial services to the poor. They considered these clients high-risk due to a lack of collateral and perceived inability to repay loans. Additionally, reaching rural and suburban areas involved high costs, and the low number and scale of operations translated to low transaction values, making it unprofitable for banks. Consequently, the poor were often left without access to essential financial services.[45]

Microcredit helps people like vegetable vendors, artisans, farmers, rickshaw pullers, and fishermen get loans to improve their lives. It aims to lift people out of poverty by providing financial resources. Microfinance Institutions (MFIs) are growing fast, reaching many small borrowers.

In India, microfinance began with the Self-Help Group-Bank Linkage model by NABARD in 1992. This model has evolved, with significant penetration into the market by 2019. The Reserve Bank of India (RBI) regulates MFIs and supports them through Self-Regulatory Organizations (SROs) like MFIN and Sa-Dhan. These SROs help ensure

responsible lending and growth while preventing borrower over-indebtedness. The RBI's regulations and policies, such as increasing lending caps, support the sector's expansion.[46] Microfinance primarily benefits women, who make up 99% of the borrowers. The models have shifted from paper guarantees to social guarantees, emphasizing community support to ensure loan repayment.

The NABARD report on microfinance in India for 2022-23 provides a comprehensive overview of the sector's growth and impact. The report highlights significant progress in financial inclusion, with increased outreach and loan disbursements to marginalized communities. Key initiatives, such as the Self-Help Group (SHG)-Bank Linkage program and the Joint Liability Group (JLG) model, have been instrumental in empowering rural populations, especially women. NABARD's Self Help Group-Bank Linkage Programme, the largest microfinance initiative globally, impacts 16.2 crore households through over 134 lakh SHGs. These groups collectively hold deposits exceeding ₹58,893 crore, with an annual loan offtake surpassing ₹1,45,200 crore, and outstanding loans amounting to over ₹1,88,079 crore. This program highlights NABARD's significant role in promoting financial inclusion and economic empowerment for rural communities in India.[47]

The report also addresses challenges like over-indebtedness and the need for better regulatory frameworks. It emphasizes the role of technology in enhancing service delivery and recommends policy measures to ensure sustainable growth.

According to the Equifax Microfinance India Report 2023, the microfinance sector in India has become a key player in financial inclusion, empowering economically vulnerable groups. Microfinance Institutions (MFIs) have shown significant growth, disbursing numerous loans and improving the financial well-being of millions. Non-Banking Financial Companies specializing in Microfinance (NBFC-MFIs) have a notable presence, accounting for 41% of loans disbursed and outstanding portfolios. As of JAS 2023, MFIs have disbursed 205 lakh loans. West Bengal is a notable hub for economic inclusion, with private sector banks leading in loan disbursement, providing 5,145,416 loans worth INR 23,160 crores from July-August -September 2022 to July-August-September 2023.[48]

Socio-economic and Transformative development and MFIs

MFIs provide rural households access to credit, savings and insurance products. This financial inclusion empowers people to stand or expand small businesses, invest in their agricultural needs and cope with emergencies with improved. Financial access comes with increased income generation which is then used to improve the quality of life. The Self-Employed Women's Association Bank (SEWA) is an MFI focused on empowering women in the rural communities of Gujrat. SEWA provides financial services to female entrepreneurs and agricultural workers, promoting income generation and financial inclusion. A study by NHBC, witness to assessing the women's self-help group program, found that more than 78% of respondents reported improved economic and social status and improved access to credit. About 30% of the respondents of the low-income group migrated to higher income levels after joining

the WSHG program. Interestingly, 66% of the WSHGs in Himachal Pradesh reported the creation of personal assets, 73% reported an increase in access to microfinance, 74% reported an increase in monthly income, 78% reported an increase in support during an economic crisis, and 79% reported an increase in financial literacy.[49]

Some MFIs offer financial products that are specifically tailored for education, such as school fee loans and educational materials. This empowers parents to invest in their children's education and break the cycle of illiteracy, allowing the younger generation to be equally equipped and capable of making use of newer opportunities. Another aspect where MFIs help in socio-economic development is by providing health insurance products. Communities can access quality healthcare services without fear of catastrophic expenses, which improves healthcare outcomes.

Assessing the Impact of MFIs

Whether an MFI is able to serve as many clients as possible and keep its costs under control can be measured by the efficiency ratio. Gross loan portfolio to total assets is another efficiency indicator that measures the extent of the assets that an MFI allocates towards loans.

The Outreach performance indicator is used to assess the MFI in its ability to expand the width and depth of its client base. It includes the geographical spread of the MFI and the needs of clients assessed by poverty level, place of residence, and gender. The outreach concept covers six diverse dimensions that include the size of the client base, the poverty level of the clients, the cost to the clients to access the service, the perceived value of the microfinance product indicating its worth, the scope of the products which reflect the diversity, and the sustainable and timely provision of the service.[50] [51]

Challenges and Criticism

It is now being questioned whether the microfinance companies and the non-banking financial companies in India even trying to facilitate the Sustainable Development Goals or national policies that target the reduction of poverty and empowerment of women. These MFIs and NBFCs have been called a big curse or a big wolf because of their unlawful and exorbitant interest rates levied on poor borrowers, plunging entire families into the bottomless pit of debt.[52]

One of the major challenges faced by the NBFC establishments in India includes overborrowing. The average microfinance loan size has significantly increased, which is compounded by borrowing from more than one lender in tandem by the borrower. Besides this, the NBFCs have also found it difficult to retain investor support. Additionally, banks have also started venturing into the microfinance space, some even partnering with MFIs strategically. Vice versa, many microfinance institutions have converted themselves into smaller finance banks, allowing them to increase their interest-rate interest rates.[53]

The client's lack of literacy and financial education

Many people in India do not have any grasp on the basics of finance, and their awareness of the financial services available to them is minimal.[54] The lack of financial literacy among households and individuals with limited intellectual skills poses significant challenges for microfinance institutions (MFIs) in India. These individuals struggle with managing daily expenses, financial transactions, and assets. As noted by researchers and policymakers globally, financial literacy is crucial for integrating this vulnerable population into the formal banking system. Studies, primarily in developed countries, show a strong link between financial knowledge and improved financial behaviours, leading to better income generation and living standards. Enhancing financial literacy is essential to prevent debt traps and ensure the economic upliftment of the poor in developing nations like India.[55]

High expense of the outreach

MFIs provide small loans to the urban poor and those underbanked in distant locations, which involves logistical, human resource, and fuel costs associated with the outreach. Consequently, margins are reducing, necessitating the digitization and automation of processes or levying of higher interest rates.

Self-help group (SHG) growth

The SHG or the joint liability Group (JLG) model used by many MFIs increases the possibility of the borrower taking more debt than they can handle. The robust government engagement in supporting the SHGs has resulted in their widespread and rapid expansion, putting strain on the MFIs and their profitability and viability.

High Interest Rates

MFIs have been charging higher interest rates than Banks since inception, although there was a cap of 7.89% on the interest rate of the small loans enforced by the RBI in 2021. However, in 2022, the RBI issued new directives for microfinance lending and has included all entities - banks, NBFCs, and MFIs, under the same purview of law, subjecting them to the same regulations for microfinance and, at the same time, redefined the borrower limits from a family income of Rs 1,20,000 pa to 3,00,000 pa and lifted the interest rate cap allowing the MFIs to decide their own interest rate. This has resulted in borrowers facing higher interest from MFIs.[56]

While this new directive allows for an expansion of market opportunity, the interest-rate cap removal promotes risk-based underwriting. This will also encourage healthy competition and harmonize the regulatory framework for different types of lenders, enabling the customers to make an informed choice about their credit needs. Above all, with strong governance architecture, the new framework may help scale the industry further, ensuring better and wider financial inclusion.[57]

Lack of Validation of Investment

Access to information for appraisal and the quality and quantity of information available to build investment decisions cannot be validated because of a lack of any consistent and trustworthy valuation methods. This constraint hinders their ability to access market data necessary for accurate investment appraisal. The absence of consistent and trustworthy valuation methods prevents MFI management teams from effectively utilizing the information they possess to make sound investment decisions and impact the financial stability of the MFI. Inadequate investment validation can lead to suboptimal allocation of resources, increased financial risks, and potential losses, which ultimately hamper the development and effectiveness of MFIs in fulfilling their mission of providing financial services to underserved populations.[58]

MFI dependence on the Banking system

Consistent access to capital remains a significant challenge for India's microfinance sector, which relies heavily on banks and financial institutions. Since MFIs depend on borrowing from banks rather than raising debt from the capital market, larger NBFC MFIs face higher borrowing costs. Large and mid-sized MFIs primarily borrow from private and foreign banks, while smaller MFIs rely on private banks and apex lenders.

Many MFIs in India rely on funding from commercial and private banks, who, in turn, charge them high borrowing rates. Around 80% of MFIs came from commercial banks, and majority of them are registered as NGOs relying on banks for stable funding for their microfinancing activities.[59]

Over-indebtedness of Clients and Loan Default

With ineffective risk management and substantially increased borrowings, microfinance institutions report late payments on a large percentage of their loans.[60] This, in addition to the lack of any collateral, is a source of over-indebtedness and an increased risk of default and bad debts. [61]Also, over 35% of borrowers have had access to more than one lender in 2018-2019, consequent to overborrowing and aggressive lending, raising concerns around control of NPAs.[62]
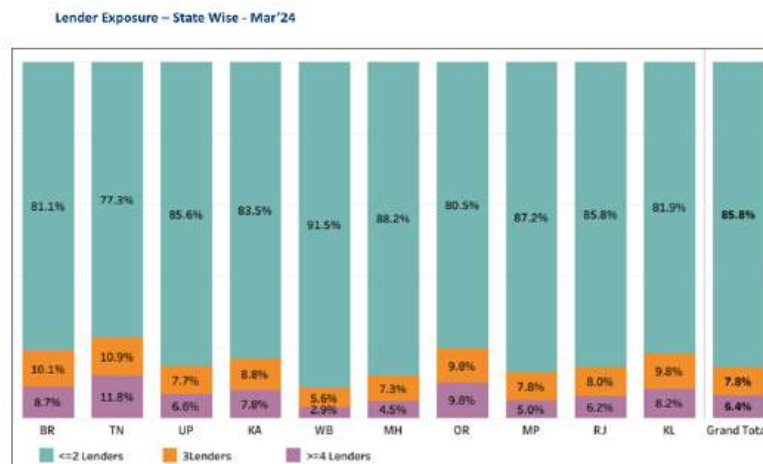
FIGURE 2: OVERBORROWING PATTERNS IN MICROLOANS IN INDIA[63]

Lack of Diversified and Innovative Products

Most of India's MFIs have yet to offer the diverse range of products that are included in microfinancing, like working capital loans, insurance, and savings loans, amongst others. This results in a very limited operation of the MFI, which also overlooks the low-wage worker in particular.[64]

Addressing these challenges

India has the fastest-growing microfinance sector in the world. However, regulatory constraints, such as complex licensing requirements, limit the growth and expansion of MFIs. Hence, a balanced approach to a policy that ensures consumer protection while allowing a conducive regulatory environment to encourage innovation and healthy and responsible lending practices becomes necessary.

The borrowers need financial literacy to address over-indebtedness. Policymakers must look at addressing the information gap and devise regulations that promote transparency and client protection. The presence of informal lenders that pose severe competition in remote areas also needs addressing by creating awareness about the advantages and disadvantages of micro financial services.[65]

The Joint Liability Group (JLG) model has allowed MFIs to grow at a phenomenal rate by enabling doorstep access to financial services to the underserved population, a large percentage of it being women. The Pradhan Mantri Jan-Dhan Yojana (PMJDY) has been pivotal in providing millions of Indians with access to banking services. The scheme is enhanced by the Jan-Dhan Aadhaar-Mobile (JAM) trinity, which links bank accounts, Aadhaar cards, and mobile numbers, facilitating greater financial inclusion.

Additionally, India Stack, with its paperless, cashless, and consent layers, enables lenders and Fintech companies to develop customer-centric products. The widespread adoption of Aadhaar has further transformed the traditional banking system into a digital model, offering electronic Know Your Customer (eKYC) and authentication services, streamlining financial operations and improving accessibility.

Due to the above initiatives, microfinance is proliferating in India; however, the current High Touch Model (HTM) of borrower engagement, which involves high interaction between loan officers and borrowers, faces challenges. Unlike the Low-Touch Model (LTM), HTM increases operational costs and leads to high staff turnover. Also, it does not provide enough incentive for borrowers to attend group meetings or maintain group dynamics after adopting cashless collections (KPMG 2021).[66]

This has led microfinance institutions to adopt the more efficient Tech-Touch Model (TTM), which combines the efficiency of LTM with the personal engagement of HTM. TTM uses automation and self-service tools while maintaining customer support, helping lenders move towards digital microfinance.

Credit Scoring Methods: Traditional vs. Alternative

The start of modern credit scoring may be dated back to the 1950s judgemental approach to determining the creditworthiness of an individual.[67] [68]Commonly called the 5C's approach, it included the assessment of the 5C's: Character, Capital, Collateral, Capacity and Condition:

· Character: determined by familiarity with the borrower or their family
· Capital: the amount of loan requested
· Collateral: assets offered as security by the borrower
· Capacity: judged by the borrower's ability to repay
· Condition: an assessment of the current market conditions

The 5C's approach couldn't handle a large volume of applications daily, leading to the development of scorecards. These scorecards, in use to date, make consistent and unbiased decisions, ensuring fair treatment for all borrowers. They generate a score that quantifies the risk of lending money.

When someone applies for a loan at a bank, the bank collects information about them. This includes personal details like the number of people they support, how long they've lived at their current address, and how long they've been at their current job. The bank also gets information from local credit bureaus, such as how many times the person has applied for credit, any court judgments against them, and if they have missed any payments.

Once people are approved for loans, the bank tracks their repayment history over time, and based on their payment behaviour, the bank labels them as either good or bad borrowers. If they have fewer than a certain number of missed payments, they are marked as good borrowers; otherwise, they are marked as bad borrowers.

Using this information, the bank creates a scorecard. This scorecard gives each borrower a score that helps predict if they are likely to be a good or bad borrower. The cut-off score, determined by a statistical method, is the point that best separates the good borrowers from the bad ones. If a borrower's score is equal to or higher than the cut-off score, they are predicted to be a good borrower; otherwise, they are predicted to be a bad borrower. The scorecard is also used to assess people who were initially rejected for loans to predict their reliability. This combined data from both accepted and rejected borrowers helps the bank build a final scorecard to make better loan decisions.

Scorecards have not been limited to assessing creditworthiness; they also serve various functions beyond that. An Application Scorecard helps banks decide whether to grant credit to new applicants by analyzing their credit history, income, employment details, debts, and other financial information. It produces a score that predicts the likelihood of the applicant defaulting on the loan. For example, someone with a stable job and a good credit history would likely get a high score, indicating low risk.

A Behavioural Scorecard monitors existing customers' credit usage and behaviour over time to adjust credit limits and terms. It uses data such as payment history, credit utilization, account balances, and changes in financial status to produce a score reflecting the current credit risk posed by the customer. Consistently on-time payments and low balances result in a high score, suggesting a low risk for future credit.

A Collection Scorecard helps prioritize and manage delinquent accounts by assessing the likelihood of repayment. It evaluates information on overdue payments, account age, historical payment behaviour, and customer communication responses to produce a score indicating the probability of recovering the owed amount. A high collection score suggests a higher chance of successful collection based on factors like previous partial payments or responsive communication.[69]

There are various mathematical methods to predict risk scores, such as logistic regression, neural networks, and decision trees. The probability scores from the modelling process assist business managers in decision-making, but converting these scores into a point-based scorecard is beneficial. It makes the scores easier for business users to understand and simplifies the calculation process through simple addition. Score points, calculated using a defined minimum/maximum scale with a specified odds ratio and rate of change of odds, provide an alternative way to represent the scorecard without affecting its predictive power.

For high-risk applicants, several strategies can be implemented: rejecting the loan proposal if the risk is excessively high, charging a higher interest rate for those with medium risk, requiring a larger down payment or deposit, imposing higher premiums on insurance policies, offering prepaid services instead of postpaid or blocking international calls in the telecommunications industry, and conducting a greater number of checks before loan approval.

On an ongoing basis, scorecards can be used for various purposes: identifying good clients for upselling and cross-selling, increasing credit limits on credit cards and lines of credit, deciding whether to grant a top-up loan or reissue an expired credit card, directing high-risk accounts to stricter collection methods or outsourcing them to a collection agency, determining when and from whom to repossess assets like automobiles, expensive goods, or houses, and placing an account on a watch list for potential fraudulent activity.

Such traditional credit scoring models, like the FICO, VantageScore, etc, rely heavily on credit histories and financial data from credit bureaus. While these models are effective for those with established credit histories, they fail to evaluate individuals without formal financial records, often excluding the unbankable and the credit-invisible populations.

Gen Z and Millennials, who now have significant buying power, handle finances differently from previous generations. This change is due to various factors like the 2008 recession, the housing crisis, high debt levels, the gig economy, and the rise of digital banking. These factors have made it harder for them to access financing, highlighting the need for new solutions.[70]

The Alternative Credit scoring models, on the other hand, use non-traditional data sources like social media profiles, online behaviour, online shopping, mobile usage, asset ownership, etc. These factors are then used to accurately determine credit risk. Unlike the scorecards of the traditional credit scoring method, machine learning algorithms are used to analyze the alternate data to identify trends and patterns that may signal risk. [71]Alternative credit scoring gathers reliable data from various sources to determine whether an applicant can and intends to repay a loan. A customer's online presence, known as their digital footprint, serves as

valuable alternative data for credit scoring models. This footprint confirms the person's existence and legitimacy while providing insights into their financial stability.

In addition to profiling a customer's social accounts, various types of data can be used to assess creditworthiness. With internet usage increasing worldwide, including in underbanked markets, online activity provides valuable insights into customers. For example, device fingerprinting reveals a lot of digital information about the phone, computer, or tablet borrowers use to connect to a lending website; using private mode or an emulator suggests they might not be who they claim to be. Email profiling can identify if a customer's email address is non-existent or from a suspicious or disposable domain, indicating potential untrustworthiness. Phone analysis can reveal clues about financial stability, as using cheaper mobile carriers in some regions may suggest lower financial stability, while fake phone numbers suggest fraud. Additionally, analyzing location data helps identify applications from high-risk areas, filtering out customers likely to default or commit fraud.

In the Indian scenario, it is useful, especially for the blue-collar workers who are unbanked or underbanked. Consider the example of Ms Manju (fictitious), who moved from a village to Mumbai for a job. She lives in a shared accommodation and works as a domestic helper, receiving her wages in cash. Now, she wants to purchase a moped for commuting, has saved half the amount, and requires a loan for the rest. Traditional lenders are unlikely to grant her a loan for several reasons: lack of bank statements as proof of income, no credit history, no formal rent agreement, and lack of collateral. However, what they miss is that Ms Manju is a responsible and hardworking individual. She carefully manages her expenses, regularly sends money to her family, and has a stable job record. With her skills and dedication, the likelihood of her being unemployed for an extended period is low. The gap between lenders and borrowers like Ms Manju can be bridged using alternative data and analytics to create an alternate credit score.

Machine learning enhances predictive analytics in banking for credit scoring by combining and analyzing data more effectively. For example, in Ms Manju's case, geo-data from Google's API could be used to gather details about her current residence and the places she has visited over the past few weeks. Machine learning can calculate her employability index to assess her job opportunities. Additionally, ML algorithms can be used to evaluate her willingness to repay the loan by analyzing her responses to various tests. These are just a few possibilities, and the scope is vast. ML can handle micro-segmentation from thousands of segments and detect micro-patterns on a frequently updated basis.

As digital touchpoints continue to grow rapidly, the use of alternative data is expected to increase.

A new type of psychometric credit scoring methodology is being increasingly popularized. One such credit scoring methodology developed by EFL Global as a part of the financial inclusion initiative assesses the creditworthiness of an individual by gamifying the credit application process. A credit risk score is created through a dynamic psychometric assessment aimed at analyzing character traits that have a relationship to credit risk. This approach is designed for applicants who do not have a credit history and, therefore, cannot be

scored using traditional credit scoring methods. Besides their easy reachability to underserved populations, gamification and survey methodologies are also fun ways that are also backed by rigorous scientific evidence. They also are low-cost screening tools and fit for emerging markets as they address information asymmetry.

This psychometric testing targets the 2 billion people globally who are unbanked and have no banking relationship and another 1.3 billion who, although have access to banks but have no credit history.[72] Empowering more consumer access to credit will add fuel to the economic growth of the nations.[73] An example of a model using alternative data to create consumer credit profiles is the FICO Score XD2, which not only brings new customers into the system but also provides clarity on the consumers who are credit retired, that is, they have not used credit in the last six months, and also for consumers who have negative information in their files. This new system incorporates public records and property data and supplements it with credit file data and public registry information.[74]

Björkegren & Grissen (2020), in their research paper, critically examined the use of mobile phone data to improve credit scoring for individuals in a middle-income South American country with limited access to traditional banking services. In this country, only 34% of adults have bank accounts, but 89% of households have mobile phones.
The study focuses on a telecom company transitioning customers from prepaid to postpaid plans and evaluates how behavioural indicators from mobile phone usage can predict creditworthiness. By analyzing call detail records (CDR) and financial histories from a credit bureau, the study identifies patterns in phone usage that correlate with repayment behaviour. For instance, individuals with regular monthly usage patterns and strong social connections were more likely to repay their bills on time.

The study's approach to deriving behavioural indicators is significant because it uses data intuitively linked to creditworthiness, making it more acceptable to implementation partners wary of 'black box' methods. This method involved extracting approximately 5,500 indicators from raw transaction records, focusing on aspects like call frequency, social interactions, and geographic mobility. The telecom provided data on 7,068 subscribers, of whom 11% defaulted on their postpaid plans. These insights suggest that phone usage data can quantify behaviours traditionally considered 'soft,' making them measurable and useful for formal credit assessments.

The broader implication of the study highlights how mobile phone data can extend credit access to the unbanked population. As traditional credit bureau models fail with sparse financial histories, the mobile phone-based method maintains consistent performance across different levels of user engagement. This approach offers a low-cost, scalable solution for screening potential borrowers, enabling digital credit services without the need for physical interactions.

The paper identifies several challenges in implementing mobile phone data for credit scoring. First, privacy concerns are paramount, as data must be anonymized, and consumers must opt-in for their data to be used. Second, data manipulation risks arise if subscribers can game the system to improve their scores, necessitating robust and less susceptible indicators.

Third, phone sharing complicates credit assessments, as shared accounts produce a single score reflecting multiple users' behaviours. Finally, multiple accounts per user dilute data accuracy, as usage spread across different networks can lead to incomplete activity profiles.[75]

There are many straightforward indicators of behaviour that Björkegren & Grissen (2020) found plausibly related to the repayment of credit. For example, a responsible borrower may carefully manage their balance over time, so usage is smoother. An individual whose usage repeats on a monthly cycle may be more likely to have a salaried income. Or, an individual whose calls to others are returned may have stronger social connections that allow them to better follow through on entrepreneurial opportunities.

A study by Berg et al. (2019) examined the potential of digital footprints—data trails left by online activities—to predict consumer default. Using over 250,000 observations, the research demonstrates that digital footprint variables can match the predictive power of traditional credit bureau scores. Furthermore, the combination of both data sources improves lending decisions, reducing default rates and expanding credit access for individuals with positive digital footprints while limiting access for those with negative footprints.

The findings suggest that digital footprints can significantly enhance financial inclusion, potentially benefiting the approximately 2 billion unbanked adults globally. However, the study also acknowledges the Lucas critique, suggesting that individuals may alter their online behaviour if they know it influences credit decisions, akin to wearing an expensive suit to impress a bank. This behavioural change could have pervasive effects on daily life.

Regulatory scrutiny is another critical consideration, as the use of digital footprints must comply with fair lending laws to prevent discrimination. The potential for traditional financial institutions to lobby against the use of digital footprints due to competitive threats is also noted, highlighting the complex interplay between innovation, regulation, and market dynamics.[76]

Use of Technology and Data Analytics in Credit Scoring

The integration of big data and machine learning (ML) has fundamentally transformed credit scoring by enabling the accurate analysis of vast and diverse datasets. This process begins with the collection of data from various sources, including transaction records, social media interactions, and mobile usage patterns.[77] Once the data is aggregated, feature engineering identifies and selects the most relevant features that influence credit risk. Subsequently, ML algorithms such as logistic regression, decision trees, and neural networks are employed to train predictive models.[78] These models are continually updated with new data, enhancing their accuracy and adapting to evolving consumer behaviours. This dynamic approach ensures that credit scoring remains precise and relevant, leveraging the latest information to make informed lending decisions.

Digital Microfinance and FinTech

Fintech companies have revolutionized the financial services industry by leveraging technology to create more inclusive credit scoring models. One of the key innovations is the

development of mobile banking platforms, which not only provide financial services but also collect a wealth of user data that can be used to build comprehensive credit profiles. These platforms enable even those without traditional credit histories to be evaluated for creditworthiness based on their financial behaviour and transaction patterns observed through their mobile interactions. Additionally, the integration of blockchain technology has introduced a new level of security and transparency in maintaining credit histories. Blockchain ensures that all credit-related transactions are securely recorded and immutable, which helps build trustworthy and verifiable credit records. Furthermore, fintech companies are harnessing the power of artificial intelligence (AI) to drive dynamic risk assessments. AI algorithms analyze vast amounts of data to evaluate risk in real time and provide personalized credit solutions tailored to individual borrower profiles. This dynamic approach not only improves the accuracy of credit assessments but also allows for more customized financial products that meet the unique needs of each borrower. Through these technological advancements, fintech companies are making significant strides in democratizing access to credit and enhancing financial inclusion.[79]

The Digital India initiative, coupled with rising internet penetration, has boosted India's digital population to over 751 million active users as of January 2024. Mobile internet users primarily drive this growth in the world's second-largest internet market.
Fintech stands for financial technology and refers to innovative financial services or products delivered through technology. According to PwC, it involves tech-focused startups and new market players creating new products and services that challenge those offered by traditional financial institutions. Jad and Issa (2017) describe fintech as a movement towards the digitization, decentralization, and removal of middlemen in economic transactions, driven by technologies like peer-to-peer networking, big data analytics, machine learning, blockchain technology, and open APIs.[80]
Specific banking segments vulnerable to fintech disruption include retail banking, payment solutions, and consumer credit, with FinTechs offering innovative, cost-effective alternatives. Payment solutions, in particular, are experiencing significant investment and innovation. Crowdfunding and P2P lending are emerging as solutions for SMEs, addressing gaps in traditional funding. Wealth management is also a potential area for fintech disruption, provided regulatory challenges are addressed.

Customer segments most susceptible to fintech disruption include millennials, small businesses, and the underbanked, who value cost efficiency and digital experiences. Fintechs are well-positioned to cater to these groups through innovative products and services, potentially filling gaps left by traditional banks. For millennials, fintech offers the digital convenience they prefer, while SMEs and the underbanked benefit from alternative funding solutions and financial inclusion efforts.[81]

The paper "Psychometrics as a Tool to Improve Screening and Access to Credit"[82] explores how psychometric assessments can enhance credit screening and expand access to credit, particularly for small business owners in Peru. The study focuses on the Entrepreneurial Finance Lab (EFL) tool, which uses psychometric tests to evaluate the personality traits,

intelligence, and integrity of potential borrowers. This approach provides an alternative method for assessing creditworthiness, especially useful for individuals lacking traditional credit histories.

For already banked entrepreneurs, the psychometric tool acted as a secondary screening mechanism, complementing traditional credit assessments. For unbanked entrepreneurs lacking credit histories, the tool served as the primary method to gauge their creditworthiness. The EFL tool incorporated various psychometric tests that measured personality traits, intelligence, and integrity, which are significant indicators of an individual's loan repayment likelihood. By analyzing the responses, the tool provided deeper insights into borrowers' behavioural patterns, effectively supplementing traditional credit scoring methods.

The main takeaways from the study highlighted several significant findings. The use of psychometric assessments was found to reduce the risk of loan portfolios. For banked entrepreneurs, combining traditional credit scores with psychometric tests led to more effective screening outcomes. For unbanked entrepreneurs, the psychometric tool facilitated increased access to credit without elevating risk, thereby promoting financial inclusion. The study also demonstrated that the tool complemented rather than replaced traditional credit bureau information, offering a more comprehensive assessment of creditworthiness. Given the success observed in Peru, the study suggests that psychometric assessments could be beneficial in other regions facing similar challenges in credit access.

Globally, companies like ZestFinance are leading the way in alternative credit scoring by using a mix of traditional and non-traditional data. ZestFinance operates under the belief that "all data is credit data." They utilize an extensive range of data points from both online and offline activities to determine creditworthiness. Their proprietary algorithm, which is kept confidential, examines factors such as how an applicant types their name, whether they read information on the company's website, their type of phone connection, and their spending habits relative to their location. For example, if an application is submitted online, the algorithm might consider browser behaviour, such as the number of pages viewed and time spent on the application page. These behaviours are transformed into scores that reflect the applicant's attention to detail.

Similarly, Lenddo, based in Singapore, offers a patented scoring system known as LenddoScore, which predicts an individual's willingness to repay loans. This score complements traditional credit scores by exclusively using non-traditional data derived from a customer's social and online behaviour. The LenddoScore considers data points from credit bureaus, telecom companies, browsers, mobile activity, social networks, e-commerce transactions, financial records, form-filling patterns, and psychometric data. This approach allows lenders to assess creditworthiness even in the absence of conventional credit history, thus enhancing financial inclusion.

In India, several companies are leveraging alternative credit score models to enhance financial inclusion. CreditVidya, based in Hyderabad, combines alternative data with traditional credit reports using AI-based algorithms to generate credit scores. Their 'CV Score' considers 10,000 data points from applicants' commercial SMSes, such as utility bill payments,

e-commerce transactions, and phone location data. Lender partners, including banks and NBFCs, use this score to approve or reject loan applications based on the company's proprietary algorithm that analyzes unstructured data according to the lender's risk appetite.

Similarly, Early Salary is an online lending platform providing short-term financing solutions by blending traditional credit scoring with new social and online scoring technologies. The platform collects data from SMS, browsing history, and social networking sites like Facebook and LinkedIn. Customers must log in via social media, allowing Early Salary to use their internet presence as a benchmark for assessing creditworthiness.

CASHe, another online lending platform, targets young salaried professionals with short-term personal loans. It employs a proprietary predictive algorithm called the 'Social Loan Quotient' to create credit profiles using alternative data, such as mobile and social media footprints, education, monthly salary, and career experience. This dynamic score evolves with more user interactions. While financial institutions provide the loans, these technology companies support partner lending institutions by digitizing the loan underwriting process.

Challenges and Opportunities in Developing These Models

Alternative credit scoring systems face several challenges, primarily centered around data quality and the methodologies used. The vast amount of data these systems rely on can be inconsistent and unreliable, raising concerns about the accuracy and fairness of the credit scores produced. The methods used to analyze this data are often opaque, making it difficult to understand how scores are calculated or to verify their validity. Additionally, there's skepticism about whether these alternative data points can accurately predict an individual's ability to repay loans. This lack of transparency and potential for bias can lead to unintended discrimination, disadvantaging certain groups, such as those with less social media presence or from marginalized backgrounds.

Moreover, the reliance on big data and machine learning algorithms in these systems introduces further complications. These algorithms can inadvertently encode existing biases present in the training data, leading to discriminatory lending practices. For example, an algorithm trained on data from a predominantly white population might unfairly disadvantage non-white borrowers. Also, the complexity of these algorithms often makes it difficult to pinpoint how decisions are made, reducing accountability. If the data used for credit scoring includes proxies for sensitive characteristics like race or gender, it can lead to systemic discrimination. Despite the potential for reducing subjectivity in loan approvals, these challenges highlight the need for careful regulation and transparency to ensure fair access to credit.

Psychometric tests can have inherent biases. They often assess individuals based on their verbal and mathematical abilities, which assumes that respondents have a certain level of education. This can unfairly favor those who are better educated. Additionally, these tests can be manipulated because some answers—such as showing proficiency with technology or a tendency to save money—are obviously preferred by lenders. This means that individuals can tailor their responses to meet the lender's expectations, which may result in lenders taking on clients who

may not be as reliable as their test results suggest. However, EFL (Entrepreneurial Finance Lab) claims to address these issues by allowing users to select an "I don't understand the question" option and by simplifying assessments through statements rated on a sliding scale.

For alternative credit scoring methods to be effective, they need to be customized for specific demographics. For instance, psychometric testing may be valuable when applied to well-educated teenagers and young professionals. On the other hand, alternative scoring methods that use social media data to create behavioural profiles might be more suitable for individuals from less privileged backgrounds. To ensure that these alternative systems are inclusive and do not replicate the biases of traditional credit scoring methods, it is important not to apply a one-size-fits-all standard across diverse groups.

Future

Financial inclusion is a critical benefit of alternative credit scoring, enabling access to credit for underserved populations. This access is essential for fostering economic growth and reducing poverty, as it allows individuals and small businesses to invest in opportunities that drive development. For instance, individuals who previously could not obtain loans due to a lack of credit history can now access financial services thanks to alternative data points like utility bill payments and social media activity. This inclusive approach helps bridge the gap between traditional financial systems and marginalized communities, ultimately contributing to a more equitable economic landscape.

Enhanced risk management is another significant advantage offered by alternative credit scoring. By incorporating a wider range of data points, lenders can improve the accuracy of their risk assessments, thereby reducing default rates and increasing profitability. Traditional credit scores often fail to capture the complete financial behaviour of an individual, especially for those without extensive credit histories. However, alternative credit scoring models analyze diverse data sources such as payment histories and online behaviours, providing a more holistic view of a borrower's creditworthiness. This comprehensive analysis enables lenders to make better-informed decisions, leading to more stable and profitable loan portfolios.

The drive for innovation in financial services is also fuelled by alternative credit scoring models. These models pave the way for the creation of financial products and services specifically tailored to the needs of the unbankable population. For example, fintech companies develop unique loan products that consider non-traditional data, such as mobile phone usage patterns and e-commerce activity, to assess creditworthiness. This innovation not only caters to the financial needs of underserved communities but also enhances the overall financial ecosystem by introducing diverse and adaptive financial solutions.[83]

Lastly, data-driven decision-making is a cornerstone of alternative credit scoring. By leveraging advanced data analytics, lenders can make more informed lending decisions and optimize their credit portfolios. The use of big data and machine learning algorithms allows for real-time analysis of vast amounts of information, identifying trends and patterns that traditional methods might miss. This approach not only enhances the precision of credit assessments but

also enables continuous improvement in lending strategies. As a result, financial institutions can better manage risks, allocate resources more efficiently, and ultimately serve a broader range of customers with varying financial backgrounds.

Conclusion

The evolution of microfinance in India has significantly impacted financial inclusion, particularly for the underbanked and unbanked populations. This paper has explored the historical development of microfinance, highlighting its role in empowering economically vulnerable groups through innovative credit mechanisms. Key models, such as the Self-Help Group (SHG)-Bank Linkage Programme and Joint Liability Group (JLG) models, have been instrumental in reaching the marginalized sectors, showcasing the dynamic adaptability of microfinance institutions (MFIs) in diverse socio-economic contexts.

The study underscores the critical need for developing robust credit scoring models tailored to the unique needs of the underbanked and unbanked. Such models are essential for accurately assessing creditworthiness and managing risks, thereby ensuring sustainable growth for MFIs. By integrating financial literacy programs and leveraging technology, MFIs can enhance their service delivery, improve client outcomes, and foster greater financial stability among their clientele.

Despite the progress made, challenges persist, including limited access to capital, regulatory constraints, and the need for consistent and reliable investment validation methods. Addressing these issues requires a concerted effort from policymakers, financial institutions, and MFIs to create an enabling environment that supports the sector's growth and sustainability.

In conclusion, microfinance in India has made remarkable strides in promoting financial inclusion. However, continuous innovation and collaboration are necessary to overcome existing challenges and further enhance the sector's impact. By developing and implementing effective credit scoring models and fostering an inclusive financial ecosystem, MFIs can play a pivotal role in transforming the economic landscape for India's underbanked and unbanked populations.

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Phage Therapy Enhanced by CRISPR: A New Frontier in Combating Antibiotic-Resistant Bacterial Infection By Peter Kriger

Abstract

This research project explores how genetic engineering of phages can be used to manipulate the coevolutionary arms race between bacteriophages and bacteria to effectively combat highly adaptive infectious diseases. In 2023, the World Health Organization stated that antimicrobial resistance caused 4.95 million deaths annually worldwide, and it is projected that the mortality rate may rise to 10 million deaths per year by 2050; it is imperative that alternate treatments for antibiotic resistant infections are urgently developed and implemented. CRISPR can be used as a cheaper, faster, and more precise method to engineer phages to fight antibiotic resistant infections and save lives. Throughout this paper, various studies and data will be consulted to draw logical conclusions about the future of phage therapy, antibiotic resistance, and the effects of utilizing genetic engineering on these topics. Phage therapy, especially when combined with antibiotics, effectively treats multidrug-resistant infections, and CRISPR can enhance phage therapy by addressing its limitations. Overall, combining phage therapy, enhanced by CRISPR, with antibiotics presents a promising, adaptable, and targeted approach to combating multidrug-resistant infections, despite some remaining challenges and costs.

Introduction

Antibiotics are a key medical tool in slowing the spread of and curing bacterial infections in people and animals. Bacteria are able to evolve resistance to antibiotics and transfer this resistance between individual bacterial cells, which are not necessarily of the same strain or genus, because their massive population and short life cycle sizes allow for extremely fast evolution (Pepper). This works through a process known as adaptive evolution, which is similar to Darwinian evolution, but works on a shorter timescale. Antibiotics are never one hundred percent effective, and usually leave bacteria with the most drug resistance alive to reproduce and increase resistance across the entire population, much like the "survival of the fittest" proposed by Charles Darwin. This is a growing issue in the global medical scene, where bacterial gene pools are changing to survive antibiotics through the development or modification of membrane proteins that pump out antimicrobials from the cell, neutralize the chemical components of the antibiotic, or never allow the drug to bind to the cell wall at all (Habboush and Guzman). Studies done in hospitals in India showed that, between 1990-1995, the highest percentage of bacteria that showed Methicillin-resistance in *Staphylococcus aureus* was 30-40%, but between 2005-2010, that number increased to 80-90% (Ganguly et al.). Between the years 2000 and 2021, the prevalence of antibiotic resistant bacteria across 18 studies in Africa was about 87%. Around 37% of the bacteria exhibited the ability to resist multiple antibiotics within the cephalosporin spectrum, most of which were salmonella (Walusansa et al.; Ghafourian et al.; *MRSA | CDC*). This evidence suggests that bacteria are growing increasingly resistant to existing broad spectrum chemical antibiotics; however, the creation of new antibiotic drugs is becoming a less viable option to combat these new superbugs. Development of new antibiotics will eventually

lead to a resistance to these antibiotics, leaving humans with fewer options for treating these superbug infections.

However, the solution may be all around us, in the form of the most abundant organisms on the planet, bacteriophages. These are viruses that infect a narrow spectrum of bacteria, usually those of the same genus, instead of being a broad-spectrum treatment for infections. Their existence was first theorized by Fredrick Twort in 1915, when he noticed spots of dead bacteria in his cultures (Kakasis and Panitsa). They were discovered by Felix D'Herelle when he noticed dead bacteria in the fecal waste of dysentery patients. The study of these viruses gained traction until World War 2, when it was largely overshadowed by Alexander Fleming's discovery of the first broad spectrum antibiotic, penicillin.

Bacteriophages can exist anywhere, and finding a specific variant is as simple as finding its host strain of bacteria. As stated previously, bacteriophages target only a specific set of bacterial host strains. According to a 28-day study by Hallie P Febvre *et al.*, 2019, when phages selected to directly target *Escherichia coli* were administered to patients, fecal and blood samples concluded that the amounts of these *E. coli* strains were lowered, while the rest of the gut microbiome remained unchanged. A study done by Cepko *et al.*, 2020 also concluded that when a phage that was determined to kill enteroaggregative *E. coli* was isolated from wastewater and added to an anaerobic bacterial culture, which resembled the typical human gut microbiome, the phage solely targeted this specific *E. coli* strain without harming other bacterial species. This research indicates phage specificity, where phages can be utilized to target only a limited set of bacterial strains, leaving the rest of the human microbiome intact.

One of the main differences between chemical antibiotic treatment and phage therapy, is that antibiotics generally eliminate as many bacteria as possible within the human microbiome, with no distinction between beneficial and malignant bacterial strains. Chemical antibiotics have many mechanisms for killing bacteria: disrupting protein synthesis, bonding to the bacterial cell wall to destroy it, messing with mechanisms of DNA replication, etc.(Kapoor et al.). However, these antimicrobial agents are not specific, usually eliminating many large populations of many bacterial species in the human microbiome. They do this because chemical antibiotics have no method of distinguishing beneficial or benign strains from harmful ones. These antimicrobial agents are designed to differentiate between bacterial cells and human cells, targeting features only present in bacterial anatomy, such as peptidoglycan cell walls (Kapoor et al.). As stated above, more bacteria are showing multiple antibacterial drug resistance, which is another advantage of phage therapy in comparison to chemical antibiotics.

Phage therapy is the use of bacteriophages or phage cocktails (mixtures of selected phages) to treat bacterial infections (Loc-Carrillo and Abedon). Generally, whether a bacterium has resistance to antibiotics or not, phage therapy tends to be equally viable with only a minor impact on the human microbiome. Since phages tend to focus their target bacteria to a narrow range of hosts, most bacterial populations within a microbiome remain unaffected. While the host specificity of phages is one of the main benefits phage therapy has over antibiotics, it is also one of its major downfalls (Chan et al.). It is difficult to determine which phage will target the

specific infecting bacterial strain and destroy its cells, but the use of phage cocktails or phages with wide host ranges can be utilized to ensure treatment is successful. Also, because phages eliminate bacterial cells by forcing them to produce massive amounts of phage progeny until the cell membrane and/or cell wall ruptures, the amount of phages within a subject continues to increase the longer therapy continues (Loc-Carrillo and Abedon). There are theories that suggest that this increase in phage population could result in a potential autoimmune response, but there is no documented evidence of this actually occurring.

Another distinction between chemical antibiotics and phage therapy is the fact that bacteria and phages coevolve, meaning that if bacteria develop a resistance to phages, phages can also adapt to infect the bacteria again (Magill et al.). This phenomenon is known as the Red Queen Hypothesis, and it exists in many forms across the biosphere. The observation of phage-bacteria relationships is a method of studying this coevolutionary arms race. Additionally, phages can mutate faster than their host strain on average (Kashiwagi and Yomo). According to a 2011 study done by Akiko Kashiwagi and Tetsuya Yomo with *E. coli* and its coinciding bacteriophage, the bacteria were observed to have mutated a resistance to the phage first. The phage then responded by evolving an increased rate of release and a decrease in severity about three and a half times faster than the bacterial strain could initially gain resistance. This means that, if a highly adaptive strain that is being treated through phage therapy begins to develop an immunity to the selected phage, the administered phages can quickly respond with their own mutation without researchers having to manufacture a new phage. If needed, these mutated phages could be isolated and be used for further treatments. Every documented instance of the Red Queen Hypothesis in action could help researchers learn to predict the genomic behavior of bacteria and its pathogen under the conditions of phage therapy.

Bacteriophage genetic engineering centralizes around the artificial modification of phage genomes to accomplish a specific purpose. This can be done through homologous recombination of the phage genome, but this is an inefficient strategy, as the chances of finding the desired mutation of phage are low (Kurzepa et al.). CRISPR is a more modern genetic engineering technique, and it is much more effective. CRISPR works by attaching a segment of RNA to a protein called Cas, which uses this nucleotide sequence to target a specific section of a genome to cut out. This segment can be left cut or be replaced by a different sequence of nucleotides (Su et al.; Chu et al.). There have been many studies done on the T4 bacteriophage and on how it is affected by these genetic engineering methods. This research has shown that minor alterations in this phage's genome result in extreme differences in its behavior. With genetic engineering, phage therapy may be a possible replacement for antibiotics when dealing with highly adaptive bacterial strains and/or strains that have evolved an immunity to chemical antibiotics (Gorski; Häusler; Lorch and Sobrin; Merril et al.; Pirisi; Stone).

In this review, we will cover the application of genomic engineering in phage therapy, the solutions this combination technique can provide, its limitations/ethical concerns, and its possible effect on multiple antibiotic drug resistant superbugs. This research is important because of the increasing instances of these superbugs and their growing populations globally. According

to the Antimicrobial Resistance Collaborators, multiple drug resistant bacteria were estimated to be directly responsible for around 1.3 million deaths around the world, with about 73% attributed to *E. coli*, *staphylococcus aureus*, *Klebsiella pneumoniae*, *Streptococcus pneumoniae*, *Acinetobacter baumannii*, and *Pseudomonas aeruginosa* (Antimicrobial Resistance Collaborators). This is a serious global medical issue, and phage therapy may provide a valid solution. The purpose of this review is to outline the possible connections between genetic engineering techniques, mainly CRISPR, and the benefits these links could provide in direct regards to superbug outbreaks and as opposed to the separate usage of the two treatment methods.

Multiple Drug Resistant (MDR) bacterial infection treatment using bacteriophage and antibiotics, limitations and future directions

Before CRISPR was used for genetic engineering, homologous recombination was the main method in which researchers modified the genomes of organisms such as bacteria and phages. Homologous recombination is a genetic engineering technique involving the exchange of genetic material between two nucleic acid sequences that share similar structures (Chen et al.). When regarding phages, it is achieved by having two phages with the desired genomes infect a single bacterial cell, and, in a process called "phage crosses," the genotypes swap and recombine corresponding parts. The desired phenotype is then be isolated from the progeny; though, the rates in which the desired phenotype is created and found are extremely low, especially in Gram-positive bacterial genera, such as *streptococcus* and *staphylococcus*, making homologous reconstruction a time-consuming yet inefficient genome modification method.

In comparison, when CRISPR was used in conjunction with homologous recombination to genetically engineer *Vibrio cholerae* bacteriophages, the result bore phages with specifically replaced gene sequences. Also, when used to engineer *staphylococcal* phages, one hundred percent of the resulting phage progeny that had been tested were found to have the desired genetic modification (Bari et al.). CRISPR is a useful gene engineering method because it allows a researcher or potential phage therapist to encode a number of specific traits into a desired phage. These same aspects are seen in high rates in the modified phage progeny with the genome engineering and screening being both inexpensive and time efficient. In these cases, the superiority of CRISPR engineering over homologous recombination is exemplified in the higher rates in which desired mutations occur in the phage progeny.

As stated previously, phage therapy involves using bacteriophages to eliminate bacterial infection, particularly with focus on antimicrobial resistant strains. In a university clinical study, 24 patients with a chronic ear infection caused by an antibiotic resistant bacterial strain, *Pseudomonas aeruginosa*, were treated with a selected bacteriophage designed to kill this bacteria, which resulted in a far lower count of *P. aeruginosa* after 42 days (Wright et al.). According to these trials, phage therapy showed promise when dealing with this ear infection, while antibiotics were ineffective. A Georgia clinical study concluded that, when used to treat various conditions caused by *staphylococcus aureus*, such as peritonitis, osteomyelitis, mastitis,

etc. phage therapy by itself proved to cure 44% of people with a local infection and 41% of people with a chronic infection (Kutateladze and Adamia). Alternatively, independently used antibiotics were 32% and 11% effective. However, when using antibiotics and phage therapy in conjunction, the treatment was successful with 78% of patients with chronic infections and 71% of those with local infections. Though phage therapy was marginally more successful than antibiotics in treating these *S. aureus* infections, the combined use of these two treatments was by far the most fruitful strategy observed in these clinical trials. These success rates can be further heightened through genetic engineering. CRISPR is an accurate, effective, quick, and cheap form of genome editing, meaning that, during therapy, a phage does not need to be found in the environment. It can instead be designed to have any traits deemed necessary in a specific instance of bacterial infection without the intensive and time-consuming screening efforts of homologous recombination.

CRISPR to improve bacteriophage treatment

CRISPR can be used to modify phages for therapy, giving them specific traits that a naturally occurring phage may not have, with precision and efficiency. In a study that utilizes CRISPR gene engineering to improve phage therapy, the researchers found that CRISPR allowed them to achieve a 28% recombination rate of the desired phage when it was used to induce homologous recombination in a lysogenic phage (Khambhati et al.). A lysogenic phage is simply a phage that injects its DNA into a bacterial cell, and this DNA will then lie dormant within the cell until triggered by something or until ideal environmental conditions are met (Howard-Varona et al.). This contrasts with a lytic phage, whose DNA and enzymes begin rapid phage replication and cell wall lysis (rupture/destruction) immediately upon injection. This high recombination rate is the result of a negative screening strategy, which allowed for a one-step recombination of the phage genome without any signs of resistance (Khambhati et al.). The screening method utilized here essentially forced the bacterial cell to destroy itself if the CRISPR sequence segment was not integrated into the bacterial genome, thus transforming the cell and replicating the desired phage. In a different case, yeast was used to swap the tail fibers of phages, which edits the phage's specificity. In general, being able to alter host range is useful in phage therapy. To elaborate, not all members of a bacterial genus are harmful during an infection. Usually, phages will attack and kill all or most members of a bacterial genus. Doing this during phage therapy, however, would eliminate one of the main advantages bacteriophage therapy has over antibiotic treatment: specificity in targeting a bacterial species. On the contrary, as a precaution, broader host ranges can also be utilized to ensure that an administered phage population is suitable to kill the targeted bacterial population (Hyman). The researchers mentioned above found that when these engineered genomes were transformed into *E. coli* cells, the T7 phages produced had a broader host range (Khambhati et al.). It is important to note that phages with broad bacterial host ranges are preferred to those with narrower ones for phage therapy because multiple phages do not have to be isolated, engineered, and/or administered to eliminate a bacterial genus.

CRISPR relies heavily on the correct selection of nucleotide sequence to achieve desired phenotypes, but screening can be used to increase the recombination rates. In simpler terms, when using CRISPR, researchers and phage developers would need to know exactly which genes to edit to achieve success in any particular instance of phage therapy; while difficult, there are "screening" methods that are used to isolate desired phages and speed up the process. This technique is also relatively ineffective against phages with a resistance to CRISPR proteins. When using CRISPR to edit the genome of a *Klebsiella sp* phage, a bacteriophage corresponding to a very common bacteria that is likely multiple drug resistant, it significantly improved the newly developed phage's performance when used in phage therapy (Shen et al.). In this way, CRISPR has been used in conjunction with screening efforts to enhance the effectiveness of phage therapy.

To edit host specificity, it is useful to modify a phage's tail fibers and/or absorption structures (Hassan et al.). Being able to edit host range allows phage therapy to have likely effectiveness against the targeted infection without causing the same damage to the microbiome as general chemical antibiotics. This has been done through the editing of receptor proteins on the tail fibers to expand host range. Absorption relates to the attachment of the bacteriophage to the surface of the bacterial cell, which begins the process of viral DNA injection (Shao and Wang). Other traits that are especially significant to phage therapy include lytic activity (the lysing or destruction of the bacterial cell) and biofilm degradation (Chan et al.; Usman et al.). Bacterial biofilms are groups of bacteria attached/embedded in a protein and nucleotide matrix that can inactivate antimicrobial agents or change environmental conditions required for these agents to function properly; therefore, biofilms have higher resistance to antibacterial substances than each individual bacteria that composes them (Vestby et al.). Additionally, these biofilms can hide from the immune system and harm surrounding tissue. Phages and their enzymes are effective against these bacterial clusters, and K29, *Listeria sp*, and coliphage T4 are capable of completely destroying them, making the bacteria vulnerable to phage infection (Usman et al.). By exchanging tail fibers of related/similar phages or constructing a new structure similar to the tail fiber of the phage with desired properties, host specificity can be adjusted (Dams et al.). Hence, Phage therapy is effective against antibiotic resistant bacterial strains and structures, and the manipulation of bacteriophage host range will be essential in maintaining control over only the intended infection while leaving the rest of the microbiome unharmed.

Conclusion

The research on phage therapy, as well as the use of CRISPR to enhance and modify phage properties, is important because it outlines a method that has been proven to be effective in combating multidrug resistant bacterial strains and discusses ways to improve this method and minimize its drawbacks. As stated previously, multidrug resistant bacteria are bacterial strains with increased resistance to multiple forms of antibiotics that may have higher adaptivity in response to chemical antibiotics compared to other bacterial strains. Around the world, MDR

bacterial strains are increasing in both prevalence and number, posing a global medical threat that the development and implementation of new antibiotics only worsens.

In this paper, phage therapy has been supported as the key to vanquishing these newfound microbial adversaries. Phage therapy does not involve a chemical antibiotic, so multidrug resistant bacterial strains do not have an adaptive edge. On that note, if the bacterial strain does evolve resistance to phage therapy, not only could the phages respond with adaptations of their own, the bacterial strain may be forced to lose immunity to chemical antibiotics to evolve this phage resistance in the first place. On top of that, phages, as viruses, can evolve alongside their bacterial host strain. This is known as the Red Queen Hypothesis and could perhaps negate the need for repeated administration of phages or phage cocktails. Phage therapy is also highly specific, targeting only a narrow set of bacterial strains, while chemical antibiotics are broad spectrum, eliminating all bacteria regardless of whether it was a malignant, benign, or beneficial member of the microbiome. To sum this up, phage therapy can actively adapt to bacterial evolution during treatment, contribute to the lessening of the severity of widespread multidrug resistance, and efficiently target a specified bacterial range without damaging the rest of the microbiome.

To minimize the potential drawbacks of phage therapy, this paper proposes CRISPR genetic engineering as a solution. CRISPR would allow researchers and phage therapists to edit a previously isolated phage or design a new one to perform a desired task. Historically, genetic engineering was time intensive and required high screening efforts because of its low recombination rates. On top of this, there was no guarantee that the desired trait would even be created due to a lack of specificity during modification. CRISPR is better because it targets specific regions of the genome (high specificity) and has high recombination rates with fewer time intensive screening expenditures.

In some cases, phage therapy by itself is not the most effective treatment for an antibiotic resistant infection. Though antibiotics would clearly bear little to no desired results, phage therapy has been shown to be far more successful. On the contrary, the combined use of both antibiotics and phage therapy has, in some instances, proven more fruitful than either treatment individually. This may be because, as phages attack and lyze bacterial cells, they force the bacterial strain to adapt. In the process, the bacteria can often lose its antibiotic resistance, meaning that the antibiotic treatment would then become effective. It essentially pins the infecting bacteria between a rock and a hard place, so there are fewer evolutionary pathways that a bacterial strain can go down to survive.

In particular, CRISPR has useful applications in phage therapy because of the highly specific nature that a desired phage must have in order to be utilized in phage therapy. The targeting of only a couple bacterial strains is a valid advantage that phage therapy has over antibiotics, but a host-range that is too narrow can cause the treatment to simply "miss" the infecting strain. CRISPR can broaden host range just enough to ensure that the correct strain is eliminated without disrupting too much of the rest of the microbiome. Simply put, researchers have terrible aim, but they are more likely to hit the bullseye with a wide-spraying shotgun than

with a rifle. This can be done by editing or swapping the tail fibers of a phage, the part that the phage uses to infect and lyse (destroy) a bacterial cell, which CRISPR can accomplish.

Even though there has been a significant amount of research into bacteriophage therapy both on its own and in conjunction with CRISPR, there are still open questions in the field. In general, additional study of both phage-host interactions and the mechanisms of phage therapy are necessary to continue expanding the potential applications of phage therapy as an alternative or adjunct for antibiotics (Hassan et al.). Additionally, doubts remain regarding the safety of phage therapy and whether it can cause an immune response (Loc-Carrillo and Abedon). An immune response may be caused by mass bacterial death due to increased presence of phages during an infection, considering the phage is correctly selected or designed to kill the infecting bacterial strain, releasing too much toxin into a patient's system at once. Though, because phages are extraordinarily common, they are generally considered safe, and there are no documented instances of this potential side effect; also, many broad spectrum chemical antibiotics can cause this already, but they are still utilized (Kakasis and Panitsa; Loc-Carrillo and Abedon).

The costs of phage therapy depend on many factors (Loc-Carrillo and Abedon). Generally, they do not stand out amongst those of other treatment options, but they can vary with regard to the bacterial strain; additionally, screening (finding and isolating a desired phage) is not costly. The Yale Genome Engineering Center charges anywhere from $11,000 to about $20,000 to use its CRISPR related research services and technologies. To conclude, though phage therapy is generally inexpensive, the added conveniences and benefits of CRISPR may be overshadowed by its costs.

Phages are also difficult to store and keep stable for longer periods of time (Principi et al.). Bacteriophage researchers and therapists would typically have to select a phage that could remain stable in standard storage while also having other attributes necessary for therapy, such as bacterial lysis (cell destruction) (Loc-Carrillo and Abedon). Through CRISPR, however, these researchers might be able to design or modify a phage to have these abilities. Finally, since phages generally tend toward narrow host ranges, phage cocktails or genome engineering may be required to expand host range enough to where treatment is most likely to be successful without devastating the rest of the microbiome. Because CRISPR is a highly accurate, relatively inexpensive, and time efficient method of genetic engineering, it would likely be the best way to modify phages and give them specific traits needed for treatment. In conclusion, phage therapy is not a perfect treatment method, and it does have its limitations, but with the development of new genetic engineering technologies and strategies, like CRISPR, along with the implementation of these tools in phage therapy, these drawbacks can potentially be largely minimized or eliminated entirely.

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<div align="center">

Literature Review
Title: "Vitamin D and Its Impact on Disease Prevention and Management"
Question: How can Vitamin D be used to prevent disease and manage symptoms in common illnesses? By Nishika Mada

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Abstract:

In this paper, vitamin D's role in the immune system is discussed specifically regarding preventing disease and managing symptoms of common viral and chronic illnesses. Vitamin D is a fat-soluble vitamin essential to immune function, nerve conduction, and musculoskeletal stability (Bhatt et al., 2019). Deficiencies of Vitamin D have also been shown to be detrimental in populations of all ages, especially in the pediatric and geriatric populations (Rusińska et al., 2018). This paper provides insight regarding Vitamin D's role in diseases such as COVID-19, rhinovirus, and diabetes mellitus through a literature review. Vitamin D can help amplify the impact of both the innate and adaptive immune symptoms to optimize the body's response to infection and improve symptom management (Wimalawansa,2023). Although Vitamin D is classified as an unapproved singular form of relief for the common cold and other respiratory tract infections, it is fundamental for proper functioning in the healthy and chronically ill. The purpose of this literature review demonstrates that there is still more research needed to elucidate if Vitamin D can be an adequate source of symptomatic relief for these various illnesses.

Vitamin D's Significance:

Vitamin D plays an important role in the well-being of the human body. It is brought to the body by exposure to sunlight and consumption of foods like, fatty fish, fish liver oils, egg yolks, and cheese. Usually, 50 to 90% of Vitamin D is produced by sunshine exposure to the skin and the remainder comes from the diet (Whiting and Calvo, 2011). There are two types of Vitamin D; D2 and D3. Vitamin D2 can be acquired from plants; however, Vitamin D3 can be acquired from proteins that have to be consumed. Vitamin D helps absorb calcium and phosphorus from foods that are consumed. However, it must be activated first, which occurswhen it is converted to calcidiol in the liver and then calcitriol in the kidneys. Calcium and phosphorus assist in bone development, healthy psychiatric behavior, immune system function, and vibrant skin health (Marizzetti et al., 2021). Fluctuations in the body's Vitamin D levels dramatically impact the function of several body systems. For instance, in patients with chronic kidney disease, where they are unable to effectively activate Vitamin D, this causes a decrease in body calcium, which can cause symptoms such as neuropathy, muscle aches, tetany, laryngospasms, arrhythmia or congestive heart failure (Juan,1979). In addition, patients with malabsorptive diseases, such as Celiac disease, since Vitamin D is fat-soluble, these patients may have difficulties absorbing appropriate amounts of Vitamin D, causing similar symptoms (Bikle,

2004).
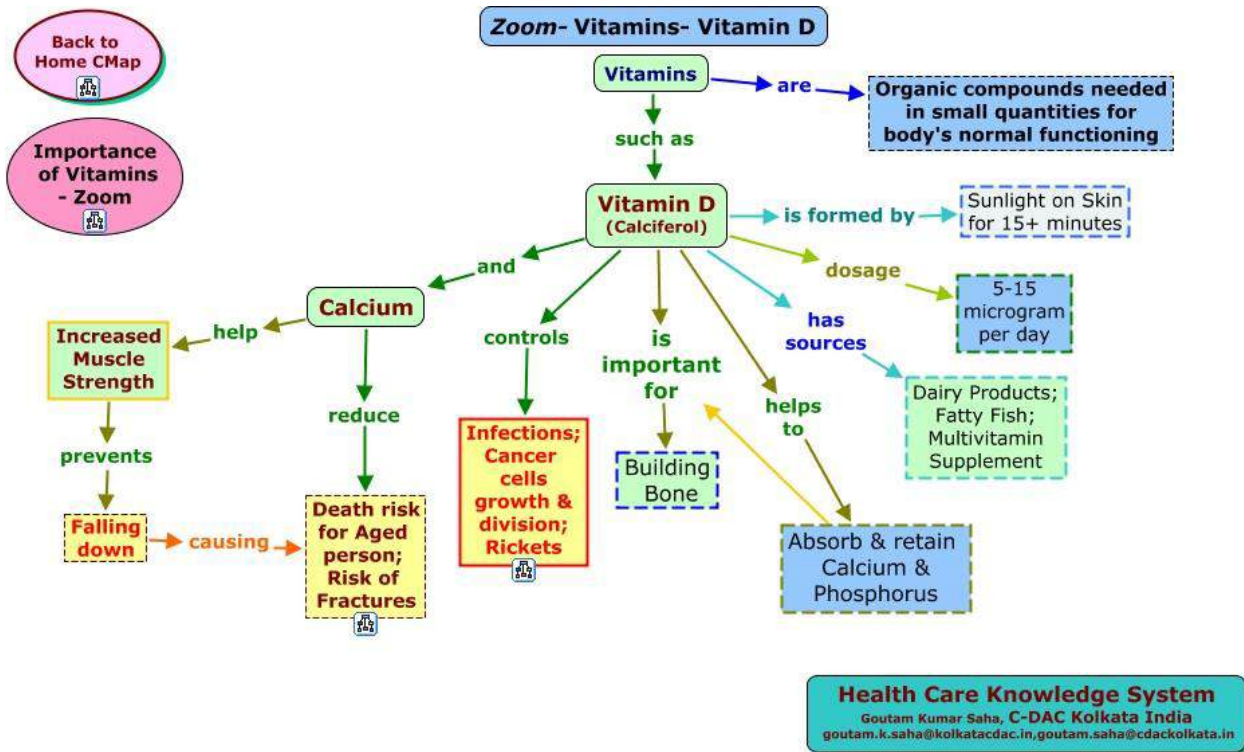
Immune System:

Recent studies have investigated the impact of Vitamin D on the immune system. It has been reported that Vitamin D plays a role in immune responses when the body is being attacked by pathogens (Lang, 2012). The immune system plays a large role in protecting the body from foreign illnesses, unknown organisms, and itself. Without Vitamin D, the body would be more at risk of illnesses and infection due to a less active immune system. Vitamin D is a great help to this part of the body, and it can be used as a treatment for the common cold and other upper respiratory illnesses.

Vitamin D Deficiency:

Vitamin D deficiency impacts individuals of all ages and can cause several illnesses, depending on the age and chronic health conditions of the patient.When the body does not receive enough Vitamin D, it leads to a loss of bone density because it is unable to absorb enough calcium and has to take calcium from the body's current supply which is deposited in the bones (Gallo,1996). This deficiency can cause bone-related diseases such as rickets and osteomalacia, based on the person's age. During pre-adolescence, children's bones are still growing and developing, they might contract rickets. Whereas, when adults develop chronic Vitamin D deficiency and are no longer growing, they are developing osteomalacia. Both these diseases affect bone density, making the bones softer and possibly deformed because of the lack of calcium absorption in the body (Gennari, 2001).

Rickets can be caused in two different ways but revolve around the deficiency of active Vitamin D, causing deficient calcium and phosphate levels in a child. Rickets can occur if a baby is born to a woman with severely deficient Vitamin D levels or if in the first months to years of life, they have a lack of proper nutrients, containing Vitamin D. This result tends to be more prevalent in children who do not have routine healthcare services available.. Most milk in the United States is fortified with Vitamin D, and pediatricians often recommend mothers who are breastfeeding to give their children Vitamin D supplements (Perrine et al., 2010). Vitamin D regulates bone growth depending on the supply of calcium and phosphate the body has available which aids in the mineralization process of the bones (Laird et al., 2010). When the body persistently has an insufficient supply of calcium and phosphorus, the clinical symptoms of rickets arise. These symptoms are swelling of the elbows, wrists, knees, and ankles and in severe cases the bowing of the legs due to poor bone and cartilage development (Adams, 2018). This deficiency increases the risk for these children to have growth restriction and fractures due to minor traumas (Sierra & Christian, 2021).

Anti- Inflammatory Disease:

Vitamin D is also known for its anti-inflammatory properties. According to a case study, Vitamin D supplementation aids in decreasing the risk of inflammatory diseases ((Taylor & Francis, n.d.). This article also mentions the two major forms of Vitamin D that promote the production of IL-10, an anti-inflammatory cytokine that also reduces pro-anti-inflammatory mediators in the body (Colotta et al., 2017).

COVID-19:

Vitamin D has also been considered a treatment for COVID-19, but due to the limitations in the studies, researchers are still unsure if it is a viable source of symptom management (Stroehlein et. al, 2021) These limitations include sample size and lack of randomization within the sample. Multiple observations have brought up the hypothesis that people with low Vitamin D are at more risk than others of contracting such diseases. Vitamin D deficiency is common among the Black and Hispanic populations in the United States, which makes these groups overrepresented in COVID-19 cases that could be correlated with decreased access to healthcare (Benskin, 2020). Social disparities, like race, gender, and socioeconomic status could also cause more limited access to patient treatment.

Common Cold

Vitamin D has proven to assist patients with upper respiratory illnesses and has shown a 70% reduction in illnesses (Vitamin D and COVID-19 Research | Center for Health and the Social Sciences, n.d.). Vitamin D has been noted as a viable source of relief for certain respiratory illnesses. The mechanisms in this vitamin contain cathelicidins, which kill microorganisms by membrane disruption . Vitamin D also contains defenses that lower viral replication rates and reduce the amount of proinflammatory cytokines which leads to pneumonia

expansion and contributes to acute-stress syndrome which worsens COVID (Grant et al., 2020). Social disparities in health can cause these conditions to occur; this is noted when studying predominantly Black and Hispanic populations, as they have more limited access. Some studies revealed a correlation between Vitamin D status and COVID mortality rates, but this association was not significant enough to be proven. On the other hand, Vitamin D was shown to reduce the risk of viral respiratory tract infections. Taking Vitamin D is not a guaranteed guard against the cold or flu. However, Vitamin D supplementation can help protect against acute respiratory infections and manage symptom severity (Jolliffe et al., 2020).

Diabetes:

While looking at Vitamin D in diabetes, it has been shown that in a population of _____ patients low levels of Vitamin D and increased risk for type 2 diabetes have an association (Dickens, 2021). Low Vitamin D levels have also been proven to increase insulin resistance (source?). Vitamin D deficiency is associated with decreased insulin release and an increase in the risk and fatality of Type 2 Diabetes patients. I (Adler) The addition of Vitamin D into the treatment plan of Diabetes Mellitus improves (hypo/hyper)glycemia and insulin secretion in patients with Type 2 Diabetes with established low levels of Vitamin D (Haroon et al., 2015).

Discussion

Vitamin D can assist patients in the prevention of specific diseases, including diabetes and upper respiratory infections. Research data could be utilized to advocate for Vitamin D as a treatment for inflammatory diseases. A strength of the study was the sources that began the discussion on the impact of Vitamin D on chronic illnesses. After compiling this information, Vitamin D can serve as an option for symptom management for specific illnesses, especially respiratory infections. Previous studies demonstrated Vitamin D's impacts on inflammation in the body, which suggests that it may be useful as a treatment for common illnesses that cause inflammation, like upper respiratory infections (URIs) (Yin & Agrawal, 2014). However, a recent systemic analysis revealed that while Vitamin D did not cure or reduce the effects of these URIs, there was a benefit of Vitamin D in the prevention of URIs. The increased effect of prevention was especially seen in patients who were previously Vitamin D deficient (Martineau et al., 2017). Despite not being approved by the FDA, Vitamin D happens to be a crucial

Conclusion

Vitamin D has been shown to have anti-inflammatory properties that could be potentially useful to patients with respiratory infections and diabetes. However, it is still unclear if supplementing the diet with Vitamin D is effective for decreasing the symptoms and effects of the diseases"

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The Use of AI in Supply Chain Management - An Amazon Case Study By Lalitaditya Akkaraju

Abstract

AI has proliferated in supply chain management over the past decade. This paper seeks to review the use of artificial intelligence(AI) in the major aspects of supply chain management(SCM) through a review of existing literature and a specific case study into Amazon's use of AI in its supply chain. This paper touches on 5 major parts of the supply chain: Sourcing, Inventory management, Last-mile delivery, Returns, and Demand forecasting. Within each of these parts of the supply chain, this paper gives an overview of that aspect of the supply chain, how AI is already being used in that element of the supply chain, Amazon's utilization of AI in that component of the supply chain, and finally address the future of AI's application in that branch of the supply chain.

Introduction

Artificial Intelligence (AI) is everywhere in the world today. It is in every sector of the economy, every household, and with every person. The supply chain, an integral part of any business, is a sector in which AI has had the opportunity to prove its use. You need not look further than Amazon to see this. Amazon's strategy, regarding its supply chain, has AI integrated everywhere within it. Not all AI is created the same, however. There is a classification system of AI within the sector of the supply chain. It consists of 3 branches: sensing and interacting, learning from data, and decision-making. The first branch, sensing and interacting, deals with models that are "associated with" text, audio, and video, such as "speech, vision, and NLP"(Pournader et al.). The second branch consists of models that are intended to "learn from data", or in other words take data as input and give some insight as output. The last Branch of decision-making uses insights and other information to make decisions in supply chain management(SCM)(Pournader et al.). AI's growth in this field has also been fueled by the COVID-19 pandemic 3 years ago. This pandemic has caused a "boom" in the use of AI in supply chain management – especially in last-mile logistics(Oviedo and Hincapié). Again, Amazon is a perfect example of this, launching its Prime Air(a drone delivery service) in late 2022 and hoping to expand by the end of 2024. This paper will use Amazon as a case study to explore the impact of AI on the supply chain. It will examine the impact of AI on each aspect of supply chain management, list Amazon's way strategy for incorporating AI into that specific aspect of the supply chain, and then address the future of that aspect and room for future innovation.

Sourcing

One of the many ways that AI is used in SCM is in sourcing. Sourcing is "the obtaining of goods and components from a specified or understood source"(sourcing - Quick search results | Oxford English Dictionary). Sourcing, especially in this context, can also refer to "the decision" that is "aimed at minimizing transportation costs associated with that order " for a

business(Bharadwaj). Sourcing is, in essence, anything to do with finding the right suppliers for your products and ensuring that your products are steadily coming in. As one can already see AI can have a massive impact on this aspect of SCM due to it being "rich with data" and the implementation of AI into this aspect of business can help "businesses save money, manage supplier risk, and meet customer demand with speed and agility"(How AI and Analytics Are Transforming Procurement).
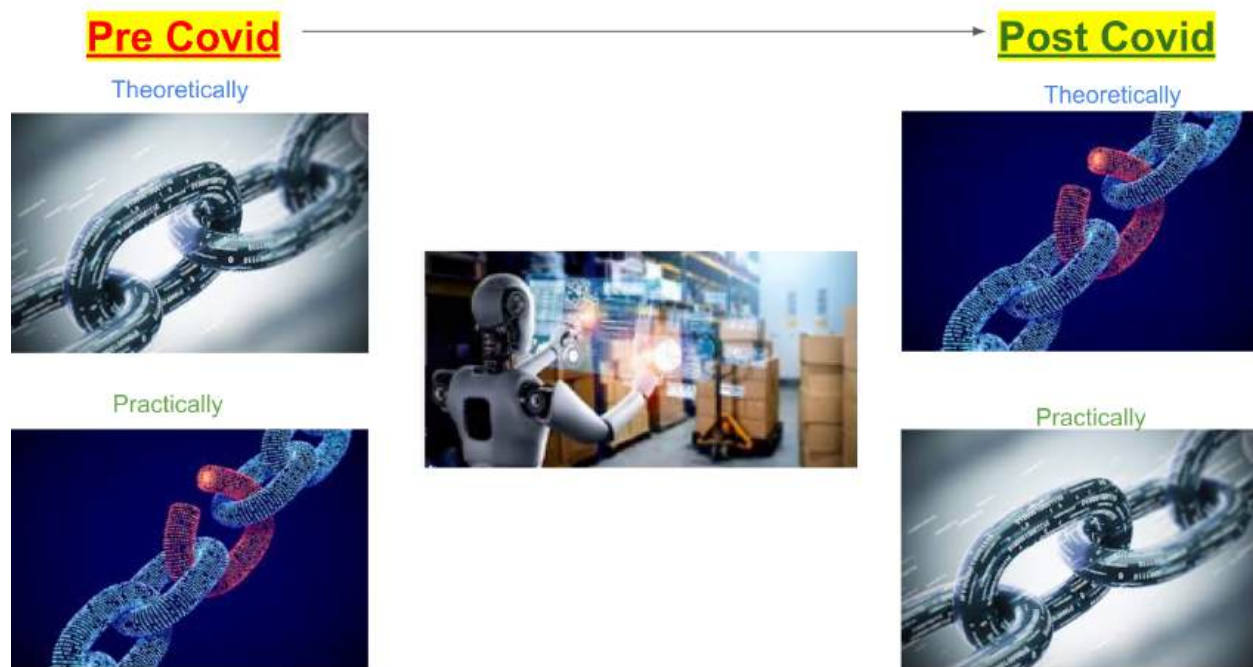
Figure 1: **A)** Supply Chain Pre-COVID-19. **B)** Supply Chain Post-COVID-19

In fact, we saw this use of AI transform the supply chain recently during Covid-19. Before Covid-19 the supply chain was theoretically intact as we didn't see any faults due to the fact that everything was very interconnected and the flow of goods was going smoothly. However, practically there were a number of issues and faults with the supply chain that were waiting to be exposed. This is exactly what Covid-19 did. It exposed these faults in the supply chain mainly the lack of resilience, our overreliance on our interconnectedness and our lack of a plan to turn to should this interconnectedness and reliability on interconnectedness become infeasible one day. Post-COVID, however, we realized these hidden faults in our supply chain and used AI to help address them. For example, AI can help mitigate disruption impact. AI can "offer a higher degree of flexibility and automation" which "allows firms to quickly adjust to the changing environment and enables supply chains to improve performance by mitigating the risk of disruption"(Modgil et al.). Because of this realization about our supply chain, we thought that it was broken as we were working to address these issues(the Evergreen ship was also an event that revealed the flaws in our supply chain and aided in the connotation of our supply chain at the time as we were beginning to address these issue.). However, within a couple of years of time,

we became practically where we were theoretically pre-COVID-19: A supply chain that is capable, resilient, advanced, and adaptable.

AI's role in this sector of business is very pronounced. One paper states that AI "can help with supplier evaluation, performance monitoring, and selection". It also can "spot possible supplier problems, and enhance supplier relationship management by examining supplier data, performance indicators, and risk factors"(Ahmed et al.). Amazon for one knows this as they have implemented both AI and ML into their sourcing procedure. Specifically, they use AI and ML to "assist with supplier evaluation and selection", doing this by "flagging potential disruptions" and "automatically recognizing issues among potential suppliers", which, according to them, "minimizes disruptions to operations and saves time" (How AI and Analytics Are Transforming Procurement). This type of AI is categorized in the second branch of the AI taxonomy because it uses data about different suppliers to drive insights about those suppliers.

Seeing as these models are so valuable and integrated into our current sourcing systems, we should continue to improve them and ensure that they result in the best and most accurate insights. We should constantly update the models to deal with data that may not be as good but still ensure that the insights are reliable. This is the problem that is cited by Dr Samrat Bharadwaj, saying "Sophisticated operations research models and IT capabilities need to be developed to implement" them to, in essence, reduce costs for the business(Bharadwaj). Today models are being developed for this task which helps with not having as good of data as well as other problems that this sector faces such as sustainability.

One paper proposes a model, which through the use of a fuzzy set theory built into the model, mitigates the imperfect data problem. The "basic idea" is that the model generates "a probabilistic programming problem that is converted into an intervalistic programming problem" by the x-level(Hatami-Marbini et al.). Along with this, a number of other smaller computations are performed for other minor problems such as computational efficiency.

Through the use of the paper's 4-step system to evaluate suppliers, the problem of sustainability is diminished. The first step, using the Kraljic model, classifies suppliers into 4 categories based on two criteria: profit impact and degree of supply risk(Hatami-Marbini et al.). This helps identify 4 types of suppliers: strategic, bottleneck, leverage, and routine(Hatami-Marbini et al.). Strategic suppliers are high value as they provide high-profit potential but also high risk(Hatami-Marbini et al.). Bottleneck suppliers "(low profit and high risk)hold a present influence position"(Hatami-Marbini et al.). Leverage suppliers(high-profit impact and low supply risk) "consider a relatively large share of the end products cost price"(Hatami-Marbini et al.). Routine suppliers(low-profit low risk) have a "small value per unit"(Hatami-Marbini et al.). The next step "defines qualitative and quantitative data for each group of suppliers for operational, organizational, and sustainable aspects"(Hatami-Marbini et al.). It sets out numerous factors that are categorized within broader terms and defines what is being looked for. This is where many operational and sustainable criteria are quantitatively looked at. This step is focused on SCM modeling with the global reporting initiative data to help build proper criteria(Hatami-Marbini et al.). The third step evaluates the performance efficiency

of the model using a DEA-based model. In this model, which is "based on the profit-cost ratio for measuring the relative efficiency of suppliers with multi-inputs and multi-outputs", each supplier "is defined as a quotient of the weighted inputs against weighted outputs" which will cause the "maximization of outputs" to increase efficiency(Hatami-Marbini et al.). Finally, in step 4, the suppliers are put into 1 of 3 groups: "preferred, approved, and phase-out suppliers"(Hatami-Marbini et al.). The preferred suppliers are suppliers which the model has deemed to be suitable for the long run. The approved suppliers are ones that the model has deemed to be "potential candidates" for the medium term but should be replaced in the long term, and the phase-out suppliers are ones that the model has deemed should be replaced immediately if possible. In the future, we need to keep refining these things and implementing them to help further the good impact that this technology has.

Inventory Management

Inventory management is one of the aspects of the upstream supply chain. The upstream aspect of the supply chain "includes the activities of organizations or business institutions with supplier partners"(Sofiah and Aisyah). These could include activities such as the "planning process, searching for suppliers, and procuring products/services"(Sofiah and Aisyah). Inventory management, specifically, "is the process of monitoring and controlling inventory level and ensuring adequate replenishment to meet customer demand"(Priniotakis and Argyropoulos).
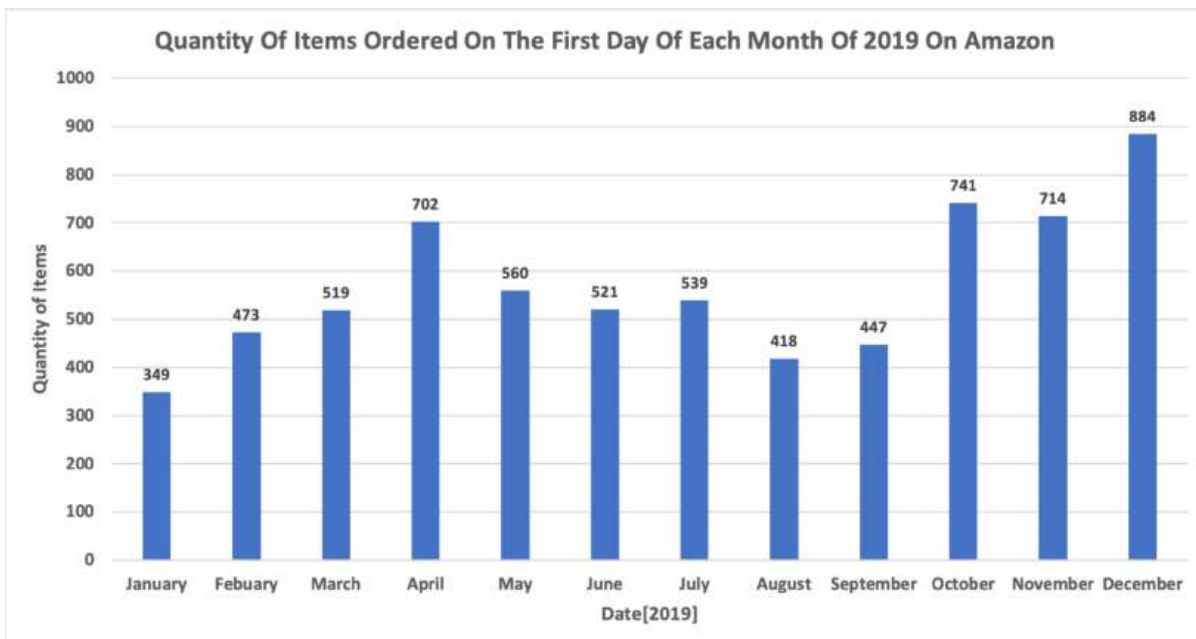

Figure 2: Sample of the number of items ordered on the first day of each month in 2019 on Amazon

This figure depicts a sample of the number of products bought on Amazon on the first day of each month in 2019. At the beginning of the year, the quantity of products ordered on Amazon starts out relatively low(just under 350 products). Then as the year progresses this

quantity hits a relatively maximum around mid-April. The amount of products ordered then starts to decline, and it hits its relative minimum around the August-September time. It then takes a turn, quite dramatically, and shoots up in the months leading up to mid-December. This trend tracks the holiday season relatively well. At the beginning of the year, there are no major holidays/events coming up so people are just buying the basic things. Then as we get closer to the middle of the year there are more holidays(Easter and St. Patrick's Day to name a few), after coming into the third quarter there are again fewer holidays so the number of things that people buy goes down. Finally, in the fourth quarter, the holiday season is in full swing and people are getting into the holiday spirit so they are also buying more products on Amazon.

The use of AI in inventory management can help a company meet this changing demand for products during the year. AI enables a company's inventory management to increase its productivity and be more efficient. AI does this by increasing accuracy, improving sales, and reducing costs. For example, "according to a study, forecasting powered by AI reduces errors by 30-50% in supply chain networks. This leads to the increased accuracy, and 65% of lost sales reduction, which was mainly due to inventory being out-of-stock, and, also, warehousing costs decrease by 10-40%" (Foya). Some of AI's use cases in inventory management are AI-driven robots, planning and predictions, stocking management and fulfillment, and demand forecasting(Osman et al.). These use cases involve both data analysis to drive insights and the use of past data to forecast the future. Both of these types of use cases drive efficiency and productivity which in turn drives the goals of inventory management which will boost the business. The use of AI in inventory management also falls under the second branch because it is driving insights with clean data and hasn't gone as far as to make decisions yet.

Today a plethora of robots and other technology is being used in warehouses to aid with inventory management. For example, warehouses use Radio Frequency Identification (RFID) technology to aid with inventory management, which increases efficiency and provides a stepping stone for AI to be used which is already being implemented today(Korićanac). RFIDs allow businesses to track products throughout the supply chain as well as the ability to "scan the whole warehouse in search for a particular item"(Korićanac). Robots then use these RFIDs to place products in the appropriate spot and pick from their spot when they are ready to be shipped. AI-powered systems are using these RFIDs to gather data massive amounts of data and use that data to provide valuable insights to warehouse management. Today, for example, AI is being used to "identify slow-moving items" via these RFIDs. Also, AI is used to "optimize inventory levels by predicting demand and prioritizing high-demand products"(Dhanasekar and Rajakrishnan). This has the benefit of "reducing waste, minimizing stockouts, and improving order fulfillment"(Dhanasekar and Rajakrishnan).

The advanced use of inventory management is paramount to a business's success – especially in e-commerce. Amazon is no exception and their supply chain, according to some, "is the world's most efficient [and is] leading in the world"(Sofiah and Aisyah). One aspect of their supply chain that causes all of this fanfare from people is their inventory management strategy.

Their strategy is to outsource most of their inventory management – 82% in 2016 – to third-party warehouses (Sofiah and Aisyah).

However, the other 18% of the product comes from Amazon's warehouses. These warehouses employ massive amounts of AI to increase efficiency. For example, Amazon acquired Kiva Systems, which manufactures "Internet of Things-based robots"(Sofiah and Aisyah). These robots automate a lot of processes that were previously performed by humans such as selecting, scanning, picking, and packing products without human assistance(Sofiah and Aisyah). It has been shown that with the implementation of these robots coupled with the elimination of inexperienced worker inefficiency that comes with this implementation, the increased expected throughput for Amazon is around 10%(Stowe). AI, specifically, within Amazon has been used heavily in inventory management(Kumar). For example, Amazon uses reinforcement learning systems to analyze time series data to help predict inventory levels, among other things(Osman et al.). This use of AI helps Amazon become more efficient and drives useful insights for the brand. However, the advancement of these models, as well as coupling with other models could be advantageous to the firm to help them become even more efficient and sustainable.

The future of inventory management will be centered around technologies that can increase "sustainability and efficiency"(Dhanasekar and Rajakrishnan). As the use of advanced technologies allows businesses to improve efficiency, the more advanced the technology being used in the warehouses is, the greater the efficiency will be(Dhanasekar and Rajakrishnan). Therefore in the future, Amazon should consider investing heavily into their AI models and developing extremely advanced models to increase their efficiency and accuracy.

One of these such models, developed by Umamaheswaran Praveen and colleagues, uses deep learning to realize both efficiency and accuracy benefits. The specific model is an Artificial Neural Network(ANN). The model uses a multilayer feed-forward neural network[3] and backpropagation[4] for training. This specific model is displayed to have a great benefit in inventory management as this model reduces both transportation costs and storage costs, which in turn reduces overall operational costs in inventory management. All of these benefits will eventually improve the supply chain surplus. This model is also effective for analyzing "data with non-constant variance and high volatility in a better way "(mention what those terms mean)(Praveen et al.). This is very useful when it comes to inventory management because, as we saw in Figure 2, the e-commerce data for Amazon was very volatile and didn't display constant variance. This benefit of the model, therefore, will be extremely useful to Amazon because their data fits the benefits of this model.

The second major trend in inventory management going forward is the sustainability of inventory. Sustainability inventory, as defined by one article, "seeks to reduce the environmental and social impacts of an industry without affecting its profitability"(Tiwari et al.). This model

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[3] A type of neural network in which the data flows only one way from the input to the output through multiplier layers of nodes

[4] The process in which during training of a neural network the weights between nodes are tweaked based on how the previous iteration(epoch) preformed and its error value

also aids with the sustainability aspect of inventory management because it helps with using a Just In Time(JIT) supply chain management strategy that aims to "precisely match the demand for care with supply"(Balkhi). This model aids in sustainability as it helps "eliminate waste" and "reduce the environmental and social impacts" of inventory management(Malik; Tiwari et al.). The model discussed previously, helps to forecast demand at much better levels than previous models. The older models can only forecast demand at 72% of the accuracy that this new ANN model can (ANN model article). This allows the model to help drive JIT inventory management because JIT inventory management relies on accurate demand forecasting, and seeing that this model is much better at that than previous models, this model will help drive JIT inventory management, which will intern help drive sustainable inventory management.

Last Mile Delivery

Last Mile Delivery is "the most complex part of the whole delivery process"(Sharma). Its importance, however, cannot be overstated as it can "make or break the relationship between a customer and supplier"(Oviedo and Hincapié). Last-mile delivery refers to the last step of the delivery process where the package goes from transportation to its final destination.

Since this step of the supply chain is so important because it is the last touchpoint the company has with the customer in the supply chain, companies try to innovate as much as possible in this field to put their best foot forward to their customers. Some of these innovations include the use of AI to streamline the process of last-mile delivery both for the company and the customer. For example, AI is already being used in last-mile delivery for route optimization and planning. For example "Delivery options could be combined with AI-performed analysis of the situation to determine, which specific order should be processed and delivered as efficiently as possible"(Jucha). Not only can AI plan the routes that drivers should take but it can also do this well in advance. For instance, AI can be used in this domain to analyze historical data and "better predict shipments", allowing delivery companies to plan routes and deliveries(Jucha). Another use of AI in last-mile delivery is the outright takeover of it by AI. The use of autonomous cars in last-mile delivery as is starting to happen will no doubt be helpful to businesses and help increase efficiency (these savings are at apparently $2,000 per Autonomous vehicle per year when accounting for "crash savings, travel time reduction, fuel effiency[,] and parking benefits" and can go up as high as $4,000)(Jucha; Malik). This type of AI is classified as the third branch of AI in the taxonomy because it uses data to drive insights(which way is fastest) and then couples that with rules to finally output the best route the driver should take. This increased efficiency, however, doesn't come without its drawbacks, one being the loss of jobs. If AI takes over all of delivery jobs then what will happen to the nearly 2 million jobs that are delivery drivers in the US(Delivery Truck Drivers and Driver/Sales Workers : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics)? One last way that AI is being used in last-mile logistics is through the use of tracking. For example, AI can be used to track and "provide real-time information on the location and status of packages, allowing customers to track their deliveries and receive updates on their expected delivery times"(Jucha). This will

help boost customer satisfaction, and as was aforementioned, this is what companies are trying to do, especially in this sector. Not only can AI track packages for customers but it can also track trucks in real-time and "detect issues" with them, and then provide "alternative routes or solutions"(Jucha).

Amazon not only sells products but also delivery services. To do this their service of last-mile delivery must be impeccable, to not only accommodate both their in-house deliveries but also third-party deliveries. Their last-mile delivery network is split up into three major components, each one a different way to get the package to your house. The first one is "us[ing] its[Amazon's] own network of couriers" to fulfill the delivery(Aćimović et al.). The second component of Amazon's delivery work is the use of Amazon Flex. This is kind of a "crowdsourcing platform" in which people from the general public sign up to deliver for Amazon with their car and get paid for it. Amazon Flex is so big it covers some of Amazon.com's orders as well as orders from Amazon Prime Now and Amazon Fresh(Aćimović et al.). These operations are covered through an app that "enables all, from scanning the packages in the package collection center, determining the routes to follow, right up to the final confirmation that the package has been received"(Aćimović et al.).In this system "fuel and all other costs" to be able to drive for Amazon Flex are for the owner of the vehicle to pay for(Aćimović et al.). The last component of Amazon's last-mile delivery system is the supplier program. This is a program in which "partners"(entrepreneurs who "start and lead smaller courier campaigns which deliver Amazon orders") perform deliveries in branded Mercedes Benz vans(Aćimović et al.). Amazon will help these entrepreneurs get started by "simultaneously offering discounts for vehicles, uniforms, fuel, insurance, etc"(Aćimović et al.). The primary difference between the supplier program and the Amazon Flex program is that the supplier program participants start their own business of couriers who employ drivers in the vans which Amazon helps to fund, while Amazon Flex is people who drive their cars to deliver Amazon packages in which Amazon will not help them to do so. When delivering these drives can either go to the customer's home(most common) or Amazon Locker(A locker in a center of commerce usually near the customer's home in which the package can be delivered and wait there for a maximum of 3 days for the customer to pick it up) or The Hub(much like Amazon Locker except the places of pickup are in residential buildings)(Aćimović et al.).

Amazon is also experimenting with other forms of LMD that can also help increase efficiency. For example, Amazon is "embracing" AI technologies such as "autonomous vehicles, robots, and route planning systems" as well as "driving development" of these systems and more AI systems in last-mile logistics(Sorooshian et al.). One of the ways that Amazon is driving innovation in AI in the last-mile delivery sector is through the use of drones due to their increase in efficiency((increasing time-saving by as much as 24%, improving on-time service level by as much as about 20%, and increases the number of customers reached by as much as over 50%.[5]))(Lu et al.). As was previously discussed Amazon, through the launch of Prime Air(a

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[5] Note: All figures are compared to "truck-only mode" and are about drones in general not specifically in relation to Amazon's usecase

drone delivery service), has been using drones to do last-mile delivery and hopes to expand by the end of 2024. As of the time of writing(November 2023) they have started deliveries in some US and European cities. They plan to use this technology for "30-minute deliveries" which are "directly to [a customer's] home"(Aurambout et al.)This is driving innovation for the company and the industry because, through the use of AI, they are eliminating the need for humans to do this task, which allows them to save on costs of this massively. This is extremely helpful to the company because last-mile delivery accounts for up to 50% of all of their delivery costs, so allowing them to cut these costs will net them a lot of money(Sorooshian et al.). The use of these AI tools in last-mile delivery allows Amazon to realize many of the benefits discussed above of decreasing delivery times, being more efficient, earning more profit, and, arguably most importantly, increasing customer satisfaction.

There are a plethora of ways that AI will impact last-mile delivery in the future. The first such way is that AI will be used to help drive sustainability (Peppel et al.). This ties back into the use of sustainability for inventory management. Just like AI will be used there to help eliminate waste, here it will be used to help ensure the most sustainable method of last-mile delivery. Another such way is through the use of instant delivery(Peppel et al.). The use of AI can "optimize location-based routing including the changing locations of recipients" to help make instantaneous delivery a reality(Peppel et al.). This, the article specifies is just one use case and the increased use of AI and other software technologies in last-mile delivery in the future is certain so IT/Software providers "need to build use cases" to help use this to their advantage(Peppel et al.). Not only is the integration of AI going to be very prevalent in the future in this industry, but implementing and integrating AI, in that process, will become easier. This is because, as their study showed, "recipients of parcels will become more willing to share personal data" therefore contributing to "an increased amount and variety of recipient data at higher speed" (Peppel et al.). However, the use of recipient data isn't the only type of data that can be used to help optimize last-mile delivery. There are several other types of data out there that also play a factor in delivery times which can be implemented into models such as weather data(Peppel et al.). The "combin[ation]" of outside data as well as recipient data will help better "efficiency and customer experience" in last-mile delivery(Peppel et al.).

The second trend in last-mile delivery is the use of objects/robots to deliver goods rather than humans. The more favorable opinion is the use of drones to fill this role – however, even this is contested. The article does touch on droids("small autonomous robots that can ship one parcel at a time"), and an expert panel had "a slight tendency" that droids "will not achieve a significant share of last-mile delivery". If this does happen, it will happen in very urban areas such as university campuses or hospitals as the expert panel said "droids will be applied only in certain environments". Another study found that robots like droids can reduce "costs by 40%"(Schnieder 2022). Drones, on the other hand, are more contested. While some articles think that drones in the future aren't as likely(giving them a score of only 4.58)(Peppel et al.) others think that they are likely, saying "it[the use of drones in last-mile delivery] is likely to become a reality in the near future"(Aurambout et al.). Regardless of whether they will come about,

articles agree on where they will be used most – rural areas(Peppel et al. and Aurambout et al.). Regardless of whether they will come about this is an area of last-mile delivery that will see a lot of AI in the future, as it is necessary to operate these drones. For example, AI is necessary to not only guide these drones but also to "calculate the costs and returns associated with delivering a parcel to each individual."(Aurambout et al.).

Returns

Returns in the e-commerce sector is the process of giving back purchased merchandise to the seller. This is costly to the seller so companies are looking to minimize this cost in a variety of ways. This is primarily done by increasing product-consumer fit which AI has a massive role to play in.

The use of AI for returns is two-fold. AI is being used to try to decrease returns as they are costly for businesses and AI is being used to help make the returns process more seamless for the consumer. The first part of AI in returns is to reduce them and to help make the product "fit" the consumer on the first order(Yang et al.). AI helps accomplish this in several ways but they all boil down to one thing – providing more information(Yang et al.). The increased information provided to the consumer not only has the benefit of reducing returns but also helps the business increase sales(Yang et al.). For example in an industry such as apparel, the natural product fit uncertainty is high(due to sizing, feel, etc.) which lends itself to a high return rate compared to other industries. However, with the implementation of AI technologies such as virtual fitting-room technologies, chatbots, and intelligent recommending agents, this proportion goes down which reduces the return rate – in some cases by as much as 30%. The virtual-fitting room technologies, for example, just give more information to the consumer about how the piece of apparel will fit that specific consumer and therefore personalize the buying experience for every specific consumer(Yang et al.). The same is true about chatbots and intelligent recommending systems. This personalization in the buying process, increases consumers' attachment to the product, therefore "induc[ing]" higher sales(Yang et al.). These methods are so effective that in some cases AI technology with virtual showrooms is better than the offline option of just a regular in-person showroom(Yang et al.). This type of AI is classified in the first branch of the AI taxonomy of the supply chain because these models deal with unstructured data like videos and text.

The second way that AI is being used with respect to returns is to help the returns be more seamless for the consumer. For example, Artificial intelligence helps "recommend better-matching exchanges" in the return process(Yang et al.). There are two types of matching exchanges that AI can recommend. There is a horizontally differentiated exchange(one in which the product that is recommended "has similar characteristics but with better-matching information") and a vertically differentiated exchange(one in which the recommended item has higher quality and better matching information)(Yang et al.). This allows the customer to be happier, as they now have the product that they originally wanted and it allows the AI to gather more data on the consumer allowing them to get the recommendation right the first time, which

will in turn, affect returns in a positive manner for the business allowing businesses to be even more successful. This type of AI in the supply chain is classified as the third branch in the AI taxonomy because it uses the customers' past data to drive insights on what types of things they like or might need and then uses those insights to recommend products that are a better fit to them.

Amazon's use of AI in returns is heavily based on the first way - to try to stop them. However, Amazon takes this to a whole new level. They employ machine learning to power their "Customers who bought this also bought" and "Customers who viewed this also viewed" widgets(Rastogi). These widgets take a look at the viewing and purchase history respectively of that product and see any other products they either viewed or purchased after they viewed that item or purchased that item(Rastogi). Specifically in apparel, Amazon identified the ambiguity between sizes in different companies(i.e. A size 6 for a Reebok shoe is 15cm whereas a size 6 for a Nike shoe is 16cm) and saw how that was leading to a lot of returns from the user(Rastogi). To combat this, Amazon developed machine learning algorithms "that leverage past customer purchase and returns data … to infer the best product size for the customer"(Rastogi).

The future of returns will be focused on decreasing them and making the customer experience better. This is because, as we already discussed, product returns are very bad for a business, they are costly and accrue inventory. The way that people are planning to try to reduce returns as much as possible in the future is through the use of artificial intelligence and augmented reality. As was aforementioned, companies are already starting to do it. As one article put it, "most innovative companies" are already trying out "artificial intelligence and augmented reality" to make up for "the lack of interaction, improving customer experience, and reducing returns"(Castelblanco). The goals of today are the same as the goals of tomorrow, the difference is just how much we have completed them. The future trend, therefore, is just to keep building out and improving these models for online showrooms, chatbots, recommending agents, and more. Chatbots, right now, are growing at an unprecedented rate. Take, for example, Chat GPT, in a year it improved by almost 5 times what it was before(Popli). As for other methods such as online showrooms, improvements are being made in that realm as well such as online try-on models.

For example, a model was proposed by Duong Van Ngoc and colleague Cao Xuan Canh to reconstruct a human's body in 3D for the virtual try-on. The model in and of itself is comprised of 4 elements: the web server, the queue, the database, and worker modules(Van Ngoc and Canh). The web server is the primary front end of the model, receiving requests from the client, assigning unique request IDs, and sending the requests to the queue for processing(Van Ngoc and Canh). The queue is a buffer between the web server(which takes in the information) and the worker modules(the component that performs the task) and assigns jobs to the worker modules(Van Ngoc and Canh). The database is responsible for storing and retrieving the necessary data related to the reconstruction process of the 3D human body(Van Ngoc and Canh). The worker modules are the components that construct the 3D reconstruction of the body(Van Ngoc and Canh). They receive tasks from the queue and store their output in the database. The

model, through the use of its centralized processing system, realizes these benefits through the use of its centralized processing systems such as managing a large amount of 3D data, scalability, significant capital allocation to specialized hardware requirements, and scalability(Van Ngoc and Canh). Also through the use of the cloud as the medium of deployment, the model realizes other benefits such as increased data security, as the cloud is known to be very secure. All of this improvement to these models, now and in the future, is to get closer to the major goals in returns – to decrease them and to improve the customer experience while doing so.

Demand forecasting

Demand forecasting is the process of predicting the demand for goods in the future to help drive decisions in the present. There is a lot of data involved in this so AI will help forecast this demand, both internally(demand that the company needs to keep up and running – i.e. predictive maintenance) and externally(demand that is not required to keep the company up and running, but rather to make it money and to carry out its supply chain). However, these relationships can be very complex as the data they deal with(company maintenance data or consumers buying behavior) has multiple variables influencing it therefore making the relationship between input and output very complex. This is where AI, especially some models that are discussed later, excels and helps companies drive these insights to improve the company.
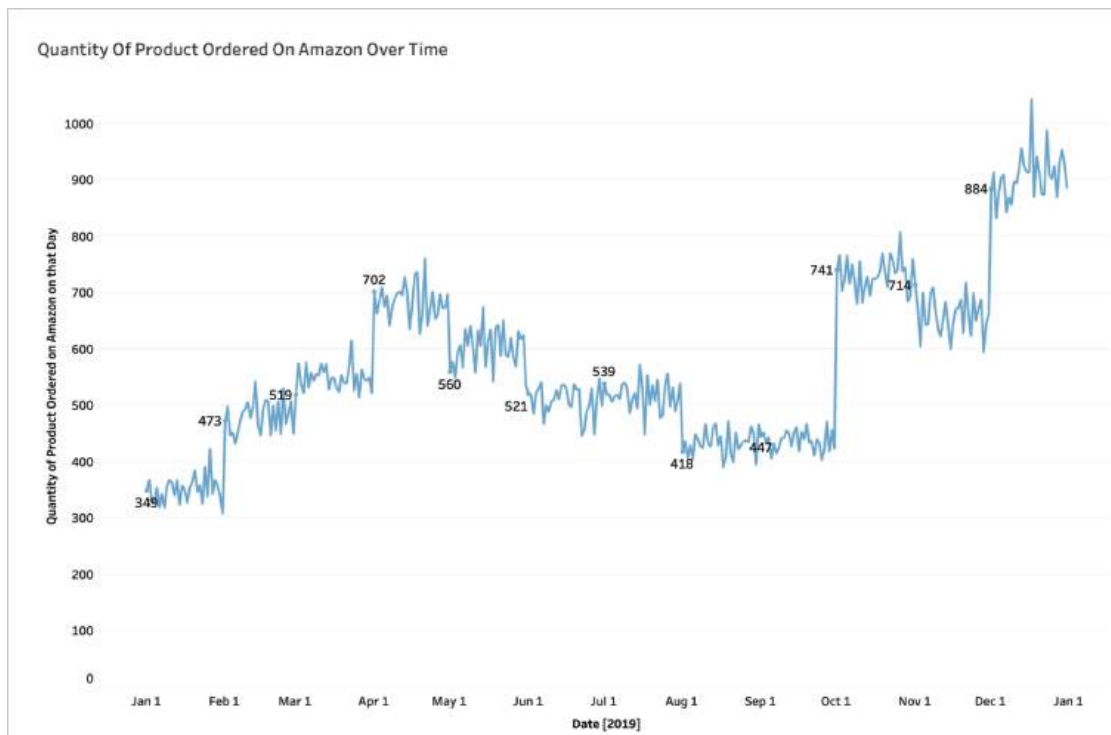

Figure 3: Sample of the quantity of products ordered each day on Amazon in 2019

This figure depicts the number of product orders on Amazon in the year 2019. With this depiction, you can really see how the volatility in the months varies between months. For

example, in September there is a relatively low volatility(difference between the amount of products bought each day) whereas in April it is much higher. The trend appears to be that the higher the average number of products is that month the higher the volatility will be that month as well(a direct relationship between average number of products and volatility). This could be because of consumer behavior such as increased reviews with higher average product sales which could be swaying potential consumers to either purchase or not purchase the item and this cycle constantly loops day to day in that month.

These small changes are very hard to predict, especially accurately because they are so prone to small changes. The use of AI in demand forecasting in supply chain management enables it and improves this accuracy. One paper did a study on the methods of artificial intelligence that are used in supply chain management concerning demand forecasting and found that the "most widely used methods in this field are Multi-Layer Perceptron MLP, Long Short-Term Memory LSTM, and Artificial Neural Network ANN" models (Mediavilla et al.). MLPs are a type of neural network in which each node is connected to every single node in the subsequent layer. These models are commonly used for supervised learning like classification and regression. The LSTM, a type of recurrent neural network, deals with the limitation of learning long-term dependencies. They excel in capturing and remembering information over longer sequences. ANN models are a type of neural network that is good for pattern recognition(especially complicated patterns between the input and output variables). Another thing that the article found is that some publications used dimension reduction and clustering in their data (Mediavilla et al.). This is applied to the data to aid with demand forecasting and is not a model that is used(Mediavilla et al.). The main purpose of this is to aid the model in analyzing the data and making the data easier to make sense of and easier to draw insights from by removing unnecessary things such as noisy data and helping to protect against things such as overfitting. The data overall showed a clear trend of "applying AI methods with multivariate datasets to improve forecasting accuracy"(Mediavilla et al.). Also, this aligns with the most common types of models that are being used in supply chain management for demand forecasting, as those models are good at identifying complex trends in the data that multivariable data usually tends to have which makes sense because, as we saw in the figure, this type of data tends to be very volatile and shifts from day to day so the use of highly complex models that are designed for this type of data is required. Finally using hybrid methods "significantly increases the demand forecasting process"(Mediavilla et al.). Hybrid methods of demand forecasting are those in which multiple models or techniques are combined to forecast demand. This type of AI can be classified as the second branch of the AI taxonomy in the supply chain because this type of AI is driving insights from past data and using those insights to attempt to predict the future.

Amazon, as we already discussed uses AI in robots to automate their warehouses. This helps Amazon "adapt and handle the distribution of the warehouse products, and to keep the best condition for material processing with such procedure it is simple on capacity, rearrange the products and recover the information automatically"(Tran). This is one way that Amazon uses AI in their demand forecasting, to forecast their internal needs for their warehouse. This allows

Amazon to do things such as employ predictive maintenance, and ensure that their warehouse is in working order at all times to ensure that they are performing at the highest level possible – and making the most amount of money possible. Amazon, as we already discussed, uses AI to fuel recommendation engines for their customers which try to predict what the customer wants to buy next and recommend it to them. The technology for recommendation technologies coupled with the automation of their warehouses shows that Amazon has the technology to demand forecast in a second way – to use demand forecasting to predict what their customers will order next. We are therefore able to infer that Amazon also employs this type of technology in their demand forecasting arsenal as they already do it with the individual customers so it would make sense for them to put all of that data together and do it for the company as a whole. This would help the company massively as it would allow them to best stock their warehouses and ensure that they have the inventory on hand to meet all of the orders without overspending or overbuying leaving them with excess inventory. They wouldn't be the only company to do this as well other companies partake in this as well and now it is a relatively common practice.

The future of demand forecasting in e-commerce will extrapolate the problems that businesses are already facing if not addressed. These problems all have to do with the information and data. The main problem is that there is very limited information and the avenues to share information are also underdeveloped. In some cases, even within the same company, different departments have trouble sharing this type of information. The sharing of data is crucial to the development of these models, however, there are a suite of issues that arise when sharing data comes into play. Some of these are data privacy, regulations, and the protection of trade secrets as well as the "asymmetry" of this information(Li et al.). Therefore, the future of the use of AI in demand forecasting will be to help circumnavigate these issues to help improve these models.

One article proposed a new model to help combat these effects relying primarily on the process of federated learning which allows "enterprises to achieve the goal of demand information sharing modeling indirectly"(Li et al.). The difference between federated learning models and regular models is that in federated learning models, users train the model on their local machine and then upload the trained model to the cloud without any of the data used to train the model(Li et al.). Users of the model can keep updating their model via the latest trained one on the cloud(Li et al.) This helps to tackle the problem of data privacy. The process first sends a base model to all of the data providers(participants), then participants use their local datasets to train the model and then encrypt it, after the participants upload it to the server, finally, the server aggregates all the participant's models into one final model and that is the newest updated model for all the participants to use(Li et al.).

The actual model relies on ConvLSTM structure which lends itself useful to multiple things. A couple of these are handling multidimensional data and feature extraction(Li et al.). It works through the use of 4 gates: the forget gate, the input gate, the quasi-cell state, and the output gate(Li et al.). First, the forget gate decides which information from the previous step should the model forget and not pass on to the next step by returning a value from 0(none of the

information) to 1(all of the information)(Li et al.). Next, the input gate determines which new information should be added to the current step, again returning a value from 0(no new information) to 1(the new information is fully added)(Li et al.). After the quasi-cell state takes the previous hidden state as well as the current inputs and then puts a value from -1 to 1 for each element in the hidden state, representing how much of the information should be added to the cell state(Li et al.). This value is then scaled by the input gate to make the final decision on the amount of information added to the cell state(Li et al.). Finally, the output gate takes the previous hidden state and the current input as its inputs and then outputs a number 0 to 1 for each element in the hidden state which is then scaled by the cell state to determine the final output(Li et al.).

Conclusion

In conclusion, research has shown us how AI transformed many sectors of the supply chain, causing numerous benefits along the way. From its use in the evaluation and selection of suppliers, to, with the aid of RFIDs, to help identify slow-moving items and prioritize high-demand products, to help plan routes to help decrease returns and help make them more seamless for the consumer (Ahmed et al.; Dhanasekar and Rajakrishnan; Jucha; Yang et al.; Dhanasekar and Rajakrishnan; Mediavilla et al.). Amazon, in specific as we have seen, is using AI to innovate and use it as much as possible to help them. Amazon uses AI in the ways we discussed above but it also goes more in depth and tries to push the boundary of what can be done with this technology. For example, they also employ drones to deliver goods, robots in the facilities, and automatically recognize issues among potential suppliers (Aurambout et al. 2019; Sofiah and Aisyah; How AI and analytics are transforming procurement). The size of Amazon has caused them to realize major benefits with the use of these technologies – much more than some other businesses. Beyond just Amazon, however, AI in this sector can help analyze data, drive insights, improve efficiency, and help align both the businesses' and customers' goals. The impact of AI now and in the future on this industry cannot be overstated and is the cause for a lot of convenience that we know today and will come to expect in the future.

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When is Compliance Complicity? By Julia Cao

Introduction

Compliance is defined as individuals or organizations following laws or rules in terms of the social, political, or legal fields of practice. Complicity, on the other hand, is specified as being indirectly involved in criminal or unethical activity, in the sense of partnership, ignorance, encouragement, or assistance. The actions of complicity are unjust behaviors violating human rights and social fairness (PeopleFluent). The issue of complicity therefore sits at the heart of global fairness and development, particularly with regard to avoiding corruption, as evidenced by SDG 10 (reduce inequalities) and SDG 16 (peace, justice, and strong institutions) (United Nations). Even though compliance generally has a positive connotation and is understood as a social good, compliance can lead to complicity in two keyways. Firstly, Direct Complicity is when an individual or organization intentionally or knowingly supports the immoral or illegal actions of others (while complying with the rule themselves). Secondly, Indirect Complicity is when an individual ignores or participates in legal but immoral practices themselves. Even though the legality of the transgression and the identity of the transgressor varies in these two instances, insofar as either result in the harms of others, complicity should be strongly avoided, even if an individual is technically compliant.

Compliance

To investigate how compliance may lead to complicity, it is important to clarify the factors impacting compliance, which can be categorized into three points: intrinsic perceptions or motivations, extrinsic influence or support, and regulative conflicts (Tyran and Feld).

Firstly, individual morality, trust, awareness, and knowledge are significant factors of compliance. When the regulation is believed to be ill-founded, or deviating from moral consent, people disobey the rule due to their intrinsic moral obligation or moral norms. The Cognitive Theory of Psychology states that a key to compliance is personal morality and moral development (Sutinen and Kuperan). This indicates that people are more willing to comply with the regulation corresponding with their moral sense. Secondly, extrinsic factors such as social support, cultural norms, economic considerations, media, and expertise inform compliance. Concerns about one's reputation increase along with the increasing peer pressure and social influence to conform. In modern society, this phenomenon is furthered by media, public news, and public opinion which increase compliance through fears of ostracism, exclusion, and outvoting. The Socialization Theory of Psychology argues that another key consideration of compliance is social influence of the environment (Sutinen and Kuperan). For example, colleagues can socially pressure other colleagues into revealing their wrongdoings. They may also manipulate power and resources in ways that encourage compliance.

Lastly, people take the benefits gained into consideration of the institutional power of law and regulation being structured in such a way as to incentivize compliance. For example, although non-compliance may result in profiteering, sustainable profits require compliance.

There are four aspects taken into view. First, the effectiveness of outcome, which stands for the benefits of complying. Second, the distributive justice of outcome, which is the fairness of sharing the final benefits or sacrifices. Third, the efficiency of process, or the speed of the enforcement and process to bring products. Fourth, procedural fairness, indicating the fair treatment of individuals or organizations of the rule. Based on the four aspects, procedural fairness appears to be more emphasized compared to distributive justice; the efficiency of the process is greater than the favorable outcomes (Sutinen and Kuperan). It is inferred that when the legitimacy is inconsistent with the standards, non-compliance will increase.

Complicity through Compliance

For the most part, compliance is structured to realize public or collective goods. This is because compliance regimes are designed by states and regulators precisely to limit harms (KPMG); therefore, compliance generally has a positive political and social connotation. However, compliance can become a form of complicity when harms to others are generated. Two key instances are identified for this issue.

Firstly, compliance becomes complicity if the regulation itself is ill-founded in the sense of being morally unrightful or indirectly unlawful. For instance, during World War II, Nazi ideology prevailed in Germany and structured the regime of compliance. Some people, who strongly believed in Nazism, participated in the bankrupted movement under the command of Hitler. Additionally, even beyond those who intentionally sought to prosecute mass murder, millions of ordinary Germans were nonetheless complicit in the horrors of the war, meaning they ought to be held morally responsible. Hannah Arendt's concept of the Banality of Evil exemplifies this form of complicity. According to Arendt, the participation of most people in the Holocaust was not through the lens of intentional, individual evil, but also paying attention to the unthoughtful, shallow, and clueless consequences of individual actions (White). Since mass murder structured the legal and normative frameworks of the Third Reich, conditions under which this complicity is enabled. When the laws and orders are morally heinous, generating untold harm for others, compliance is not justified and is a form of complicity in which complying makes one responsible for the horrors that result.

The first form of complicity through compliance is direct complicity. In contemporary society, examples of this kind (whereby one follows unjust rules, even if they are legal) are common and produce many harms. For example, a business manager in a country with limited corruption regulations may command their employees to funnel bribery money to a powerful politician, to facilitate the business winning public contracts at inflated prices. The manager may threaten the employees with exclusion from the group and a wage cut or redundancy. However, if the employee acquiesces to these actions, even though they are not illegal, they are complicit, since harm is done to society, through the loss of public money. The employee consents to directly act legally, but immorally.

Nevertheless, it is important to note that one is not culpable for complicity when the harm to the community is not critical. For instance, one is required to pay 0.1% of annual income as a

tax to the local government for the development of the community, but wastage is rife in this particular local government. Even though we may conclude that one is complicit in this wastage by being compliant with this tax, the low cost on ordinary people means that the harm done is minimal. In brief, the weight of harm of the regulation plays an important role in examining the complicity of complying with immoral rules.

Secondly, one can be complicit through compliance when an individual purposely ignores the wrongdoing of others violating a regulation, but technically complies with the regulation himself. For instance, a mining company has been pouring toxic sediments into the rivers, where its manager has been earning a huge profit from it. There is a clear environmental regulation about the issue. The manager clearly knows about the actions and the subsequent harm done to the environment and people using the water of the river, but he refuses to stop the damaging actions to keep the salary brought, since he is not the one pouring in the contaminated water and is not personally responsible. In this case, there is measurable environmental and social damage as an indirect result of compliance. Thus, the manager has committed a form of complicity through compliance.

However, in this second instance of indirect complicity one is again not complicit when the damage is minor and inconsiderable, not surpassing the moral foundations. For example, dorm students are not allowed to bring an unreported second technology into their rooms and a penalty will be considered if it is found. Bob's roommate has brought a second piece of technology and has used it frequently after lights-out to complete homework. After contemplation, Bob refuses to report to the teacher, because he believes that it is unnecessary to ruin their friendship in this way. The damage of this instance is negligible even when the rule is ignored. Thus, Bob is not accused of indirect complicity. Overall, the ignorance of regulations does count as complicity when the damage of ignorance impacts the well-being of the majority.

Moreover, one is not accused of indirect complicity if one ignores a situation where there is no regulative responsibility or power to act, even if severe damage is done. Take the example of the mining company. Frank is a manager of a different mining company in a country with no environmental regulations. He clearly knows about the detrimental consequences of the toxic sediments, but he decides to ignore the problem. Frank is not complicit, because he is a member apart from the guilty company and has no power to bring about change in this country with limited environmental regulations. He has neither broken the rules nor violated moral obligations. This coincides with the "ought implies can " rule, which states that no one has moral obligations to something he or she is unable to do (Britannica). Therefore, it is deduced that one should not be charged with indirect complicity through compliance if he or she has no responsibility and ability to solve the problem.

Avoiding Complicity

Despite the difference in the two types of complicity, all complicity that produces harm should be avoided through a human rights framework that includes promoting due diligence, transparency, and practicality (Nestor). Due diligence is promoting regular and thorough

assessments of the rules and human rights violations in the community, which allows complicity through compliance to be defined publicly to the people. Due diligence, to some extent, informs the outsiders about the seriousness of the problem, avoiding indirect complicity obstructing the persecution of transgressors. Moreover, transparency stands for the allowance of public communication and conference about the issue, making the issue obvious to the community. The government can provide rewards for reporting wrongdoing and transparent penalties for the principal actors. Third party intervention and public courts also count as a part of transparency. Lastly, providing long-term solutions to conflicts ensures future community happiness (Nestor). Under the support of solid authorities of justice, ignorance can be dismissed as people tend to report problems more frequently. In the example of the mining company, states and businesses need to work to create a compliance regime whereby other employees who recognize the manager's bad actions have numerous opportunities to report and seek remedy.

Conclusion

In conclusion, compliance becomes complicity when one directly follows unjust rules, or indirectly ignores or supports an unrightful action against the regulations, creating a consequential harm to the community. The factors impacting compliance, including intrinsic motivations, extrinsic influence, and legislative conflicts. Complicity only counts when the harm outweighs moral foundations and is done knowingly by the subject. To avoid complicity, problems should be addressed firstly by factors of a human rights framework, balancing harm, and moral luck. In summary, while compliance is a fundamental element of fair and just global development, individuals and institutions must avoid creating scenarios and conditions whereby compliance leads to complicity. When major harms are generated for others, following the rules or ignoring the bad actions of others is illegitimate, irrespective of one's formal, legal obligations.
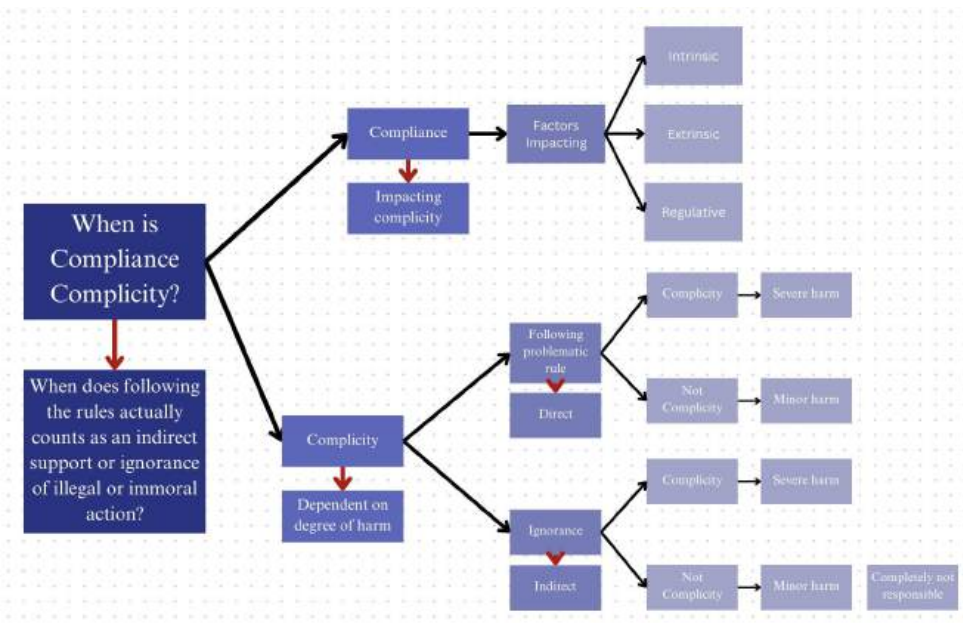
Fig 1: Compliance and Complicity

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To what extent did the institutions and policies created during the French Revolution represent Michel Foucault's theory about Europe's transition in their mode of punishment to target the soul rather than the body? By Ruchi Mangtani

From the medieval times of hanging those deemed criminals in front of a crowd of spectators to torturing people in as many creatively inhumane ways possible, many societies have now arrived at imprisonment as the commonplace form of punishment. In comparison to the past, it might seem reasonable, lenient even. French philosopher and historian Michel Foucault challenged this notion in his 1975 book Discipline and Punish, arguing that whereas in the past, social control was implemented through punishments targeting the body, it has transformed into psychological attacks against the soul. Foucault posits that in some ways, this psychological punishment is even worse. Through imprisonment, the state is able to better control people through surveilling, isolating, and "rehabilitating" them into docile subjects that labor can be extracted from. In particular, Focuault refers to the years 1760-1840 as a period of "great transformation" in Europe and the United States (Foucault 15). Thus, the question arises, how did this transformation take place?

While the French Revolution was not the focus of Discipline and Punish, it is a crucial event within the time period that depicts how some of these changes occurred and were reversed. This paper will attempt to prove that though the beginnings of the French Revolution portrayed Foucault's theory of the "new" form of punishment targeted at the soul, the brutality of the Reign of Terror marked a return to the older form of punishment targeted at the body. To do so, this paper will explore the mode of punishment used across Europe and the criticisms of this approach during the Enlightenment, and it will then trace the penological changes that occurred from the Ancien Régime to the Reign of Terror as France slowly moved into the new age of punishment.

Enlightened Criticisms of Punishment in Europe

In general, Foucault was accurate in his assessment of the proliferation of brutal, bodily focused punishments in Europe before the mid-eighteenth century. The early civilizations of Greeks and Romans used various forms of torture, including placing hot metals on the accused's skin and use the "rack" to distend their joints and muscles (Bessler 217). Medieval civilizations continued this legacy with leg-screws, thumb screws, water torture, and lighting flammable substances beneath their feet, among others. These forms of judicial torture were broadly accepted and established in all European systems, (Melville 225) often to gain confessions from defendants (Bessler 217).

Notably, these punishments had a necessary public aspect to them. In one example from Great Britain, the 1752 Act of King George II added to the death sentence of murderers the public display of their dead body afterward, denying them a proper burial (Tarlow et al. 32) This aligned with Foucault's theory of the criminalization of the crime rather than the person who committed it—it could have been any body that was on display; what was more significant in

this paradigm was the shame and humiliation it evoked as a consequence of going against the monarch's rules. As written by Foucault, the public execution "restores [the monarch's] sovereignty by manifesting it at its most spectacular (Foucault 48). There was no motivation for the redemption or rehabilitation of the accused person; instead, a theatrically gruesome display of the law in practice was used to reinforce the utmost power of the monarch.

Along with the common occurrence of torture and public executions in Europe was a biased and arbitrary legal system. Privilege was given to nobles and monarchs, and the same punishment would often be given for crimes of varying levels of severity (Hoggard 1). The irrational and cruel nature of the justice system led to many criticisms by Enlightenment thinkers in the 17th and 18th centuries. Their ideas for reform would resemble Foucault's theory of the modern form of punishment targeted at the soul.

Cesare Beccaria was one of the key Enlightenment figures who challenged the current criminal justice system. Hailing from Milan, Italy, Becarria published On Crime and Punishments in 1764. Beccaria advocated for a rational, fair, and transparent justice system. He opposed the death penalty, and a part of his argument was that the offender can still benefit society (Beccaria 28). In this sense, Beccaria reflected Foucault's view of the new form of punishment being developed during this era; Foucault similarly described in Discipline and Punish that the new disciplinary methods sought to generate "docile bodies" who could be used and controlled by the state (Foucault 137). Furthermore, Beccaria proposed that hard labor should replace the death penalty, writing that punishments should "make the strongest and most lasting impressions on the minds of others, with the least torment to the body of the criminal (Beccaria 27). This is textbook Foucault, as he wrote, "Discipline increases the forces of the body (in economic terms of utility) (Foucault 137). In Foucault's view, hard labor targets the soul rather than the body, where they turn into machines of the state rather than being killed. Hence, with Beccaria, an influential scholar of his time and onwards, support for a new form of punishment increased. In Beccaria's view, it was a more lenient and humane disciplinary technique; in Foucault's view, it was merely a smarter way for the state to exact the same obedience from the population.

The writings of Genevan Enlightenment thinker Jean-Jacques Rousseau also portrayed the ongoing transformation of the dominant perspective of punishment. In his book The Social Contract, he wrote, "There is not a single ill-doer who could not be turned to some good (Rousseau 11). This belief exemplifies another core component of Foucault's theory about punishment targeting the soul: correction. Foucault posited that the new criminal justice system had an emphasis on rehabilitation, writing, "[Judges] are intended to correct, reclaim, 'cure' [relieving] the magistrates of the demeaning task of punishing (Foucault 10). They can then perform this seemingly altruistic task of "correcting" in a controlled space like a prison cell or a mental hospital. Though this may have not been Rousseau's intention, his writings suggest the change in beliefs surrounding how states should respond to crime. To understand the perspective of the French Enlightenment thinkers, it is important to first study the general workings of the French justice system before the Revolution.

Punishment in the Ancien Régime

France during the Ancien Régime was governed by the Ordonnance Criminelle of 1670, a code of law which increased bodily punishments and generally toughened the judicial system. Previously, extremely violent punishments like the death penalty and mutilation were used only in certain severe cases. With the new code of law, however, these punishments became increasingly common (Kastenberg 58). Furthermore, the ordinance intended to let no crime go unpunished ("laisser aucun crime impuni"), and repressed lower classes (Roux 177). It should be noted, though, that the ordinance also established punishments proportional to the severity of the offense, which was an improvement from many other judicial systems that often did not make such distinctions. There were also slight improvements to the system before the Revolution, such as abolishing a form of torture called the preparatory question (Government of Canada 1). Overall, though, there was widespread dissatisfaction with the judicial system due to its draconian punishments, slow and expensive proceedings, the many courts and overlapping jurisdictions, and the privilege towards higher classes. It was essentially a continuum of the older form of punishment targeted at the body despite some minor developments.

Voltaire, a French Enlightenment thinker, heavily criticized this system and was an inspiration for the early insurgents of the French Revolution. He held that the Ordinance was oppressive, and he had similar beliefs to Beccaria about hard labor as a replacement for the death penalty. Voltaire wrote, "A hanged man is good for nothing, but a man condemned to public works still serves his country as a living lesson (Dictionnaire Philosophique 213). The same analysis of Beccaria's beliefs can be applied here: Voltaire's ideas encapsulate the new form of punishment targeted toward the soul. Indeed, Voltaire once referred to Beccaria as a "beneficent genius whose excellent book has educated Europe (Bessler 204). As such, Voltaire helped promote the newer form of punishment in France, which may have fueled some of the related changes to the judicial system that occurred during the beginning of the French Revolution.

Punishment during the Early French Revolution

At the first meetings of the National Assembly, the members planned for a new judicial organization based on the demands given in the records of the Estates General. Among these demands included the abolition of torture, presenting the desire for the punishments in France to become less physically tormenting (Whitcombe 36). Interestingly, the members of the Third Estate also demanded that "all state prisons shall be abolished," a more radical request that was a departure from Foucault's view of the new form of punishment. Though this demand was not fulfilled, it symbolized the initial revolutionary thrust that sought to completely transform France and not merely create another system of social control.

The new judicial system, however, was similar to the ideas expressed by Beccaria, Voltaire, and Foucault. Proposed by French lawyer Nicolas Bergasse, the system would require publication of proceedings, resembling the same desire for increased transparency the Enlightenment philisophes had (Government of Canada 1). Nicolas additionally demanded the abolition of tortures of the preparatory and preliminary questions and that the bodies of the

tortured could be given regular burial by their families. This marked a shift from the "spectacle" punishment used to create, with drawn-out executions and continued humiliation even after the person was killed. These changes were formalized in the French penal code of 1971.

What truly epitomized Foucault's theory of the new form of punishment was the change in the size of France's prison population during this period. The number of prisoners was three times higher than during the Ancien Régime (Prison life 1). The prison as described by Foucault is a key component of the modern disciplinary model of controlling people psychologically rather than merely through physical threats (Foucault 48). The increase in the prison population during the French Revolution thus portrays perhaps a new form of control emerging rather than purely causing physical harm to people.

In addition to prisons, surveillance was a central aspect of the revolutionary regime. The first Comite de Surveillance was established in 1792 to find suspicious individuals. The committees existed across France and consistently kept the prisons filled by issuing more arrests (The Very French History 1). Foucault identified observation as one of the three main mechanisms of control, specifically highlighting the Panopticon, theorized by English philosopher Jeremy Bentham, as the quintessential infrastructure of surveillance. Foucault wrote, "The major effect of the Panopticon [is] to induce in the inmate a state of conscious and permanent visibility that assures the automatic functioning of power (Foucault 200). In other words, this infrastructure is designed so that the inmate cannot see the guard, but the guard can see them, causing the inmate to act as if they are constantly being watched. Though this may not have been the exact case in France, the intention remains the same: to control the population, yet through the soul instead of the body this time.

The Reign of Terror

Though reforms made leading up to and at the beginning of the French Revolution embodied aspects of Foucault's theory about the shift in methods of punishment, the Reign of Terror marked a stark reversal of many of these developments. The Reign of Terror occurred between 1793 to 1794 and consisted of a massive assault by the Committee of Public Safety against anyone suspected to be counter-revolutionary. The National Convention decreed this order of "terror" on September 5, 1793, which French politician Pierre Gaspard Chaumette elaborated upon in a speech. He asserted, "We must either destroy its enemies, or they will destroy us. [...] We will finally exterminate the enemies of the revolution (Chaunette 416). This verbiage to "destroy" and "exterminate" counter-revolutionaries already depicts a step away from the newer psychological form of punishment where there is an intention to "correct" deviant behavior. Instead, the Jacobins sought to eradicate these individuals without the possibility of redemption.

As a result of this declaration of terror, public executions—a distinctly corporeal form of punishment—proliferated across France. Specifically, 16,594 death sentences were handed out during the Reign of Terror (Linton 4). Many of these executions were carried out by guillotine which Foucault himself described as a "theatrical ritual" that "provided a spectacle" during the

Revolution (Foucault 14). However, Foucault also noted the unique effect it had: "The guillotine takes life almost without touching the body, just as prison deprives of liberty or fine reduces wealth (Ibid 12). The guillotine takes life quickly and they thought painlessly as well, that this form of punishment could be seen as less focused on the body, and more focused on the psychological torment it invokes within the victim seconds beforehand. With this being said, it is still quite publicly humiliating. One example is the execution of Charlotte Corday, the woman who murdered the infamous Jacobin leader Jean-Paul Marat. Corday was guillotined in front of a crowd of spectators like many others, and observers were allowed to slap her face afterward, making the situation even more demeaning (Turner 4). Hence, overall, punishments were becoming more physical and public.

Many of these individuals did not have a trial or had a very hasty one. There are estimates that 10,000 to 12,000 people were executed without a trial (Greer 1), emphasizing the reckless violence that occurred during this time. Even for those in prison, an institution that is the basis for the newer discipline model Foucault theorized, four out of five were sent to their deaths (Parseval et al. 41). These purges were constant and catastrophic, with little intention of transforming these individuals into better, more loyal individuals of the state, as is the purpose of the newer model; instead, once the offenders were identified, they were sent to the guillotine.

One reason why there was such a strong intent to kill off the counter-revolutionaries rather than reform them may be unexpected: ghost stories. The sacred ghosts of the martyrs of the Revolution were known as "ombres" or "manes" and were considered to be in between life and death, "still bleeding." It was believed that these ghosts demanded vengeance in the form of sacrifices from the living, and that if their wishes were not granted, they would turn against the revolutionaries. Thus, for these martyrs to be avenged, more people deemed to be counterrevolutionary needed to be guillotined. This notion of the revolutionary martyrs haunting French society was particularly present during the Reign of Terror, where the term "manes" was used 15 times more frequently in records during the radical phase than during the liberal phase (Schechter 152). Thus, this superstition at least partly contributed to the physical forms of punishment used during the Reign of Terror that differed from the more psychologically manipulative punishments of the soul developed beforehand.

Conclusion

There appeared to be an almost cyclic pattern between the body and soul focused punishments, given that the Napoleonic era then saw the reinstatement of life imprisonment. Overall, though, these periods saw a slow shift to the new era of punishment. The use of prisons and surveillance intensified, and even the corporeal punishments that took place were swifter and less unnecessarily brutal. Almost two hundred years later, in 1981, the death penalty was finally abolished in France. Markedly, Foucault's work sends a reminder to not be complacent with this one success and to constantly be vigilant for what harms are still being committed.

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The Role of Artificial Intelligence (AI) and Machine Learning (ML) Models in the Prediction of Cancer Prognosis and Treatment Outcomes
By Jiehua Shi

Abstract

Improvements in diagnostic and therapeutic solutions are required due to the rising number of diseases like breast and lung cancer as well as the unpredictability of treatment outcomes as the treatment for one person may not work for the next. These issues are addressed by AI, which aims to enhance patient care by using precedences to anticipate treatment outcomes and tailor therapy plans. This research investigates the use of artificial intelligence (AI) in oncology, with a specific emphasis on how AI might improve the accuracy of cancer diagnoses and tailor treatment plans that have a high rate of success. The study's methodology is a mixed-approaches approach that makes use of meta-analyses and systematic reviews of data taken from IEEE Xplore, PubMed, and Scopus that span publications from January 2010 to December 2022. Studies pertaining to AI applications in oncological settings for therapy tailoring, diagnosis accuracy, and drug response prediction. These findings show that artificial intelligence (AI) is capable of achieving high diagnostic accuracy–it can surpass 90% in sensitivity and specificity in certain cases–and accurately predict each patient's reaction to therapy, thus making the process of creating individualized treatment programs more efficient. This study demonstrates how AI has the potential to revolutionize oncological procedures by facilitating more individualized and precise treatment plans. Subsequent studies ought to examine the long-term effects of treatment programs incorporating AI and investigate the combination of AI and genomes for enhanced treatment customization.

Introduction

The field of cancer has greatly benefited from the usage of artificial intelligence (AI), specifically in oncology, where it has shaped the field of diagnosis and treatment. Numerous methods have been used for cancer diagnosis and prognosis. These methods are successful, but they frequently do not take into consideration patient response and individual variability in disease progression. Recent developments in machine learning (ML), especially deep learning, opened the door to new possibilities in personalized medicine. Doctors can now better detect illnesses, anticipate cancer risk, and create personalized care for each patient. Numerous studies and experiments have reinforced the claim by showing how AI systems can provide fast and accurate diagnoses, much exceeding traditional methods in terms of speed, efficiency, and accuracy.

Although AI and ML have made significant progress recently, there are still several obstacles in the way of using these technologies consistently across different oncological illnesses. More specifically, healthcare practice has not completely incorporated AI's capacity to anticipate specific drug responses and tailor individual treatment plans. This gap points to an important area in oncology that could benefit from increased AI use. To address this, current

research is examining how AI can use historical treatment data to anticipate drug reactions and create diagnostic tools powered by AI that enable individualized and efficient treatment programs. Thus, the purpose and significance of this research is to provide an understanding of how AI can revolutionize oncological care through improved cancer diagnosis accuracy and customized treatment plans.

Through the utilization of AI's capacity to evaluate large amounts of medical data, this research seeks to advance the field's comprehension of AI's useful applications in clinical environments. Lowering the trial-and-error method of cancer treatment, lowering the probability of negative side effects caused by medication, and increasing the effectiveness of cancer treatment, may ultimately result in increasing patient survival rates and outcomes.

The primary objective of this research is to verify AI's effectiveness in enhancing diagnostic precision and individualized cancer care. Specific goals consist of (1) evaluating AI's capacity to predict cancer treatment outcomes based on historical data, (2) assessing how well AI-driven diagnostic tools work to develop tailored treatment programs, and (3) providing examples of practical applications of these AI tools in real-world clinical oncology settings. This study primarily focuses on the uses of AI in diagnosing and treating lung cancer and breast cancer due to its large incidence rates and substantial patient response variability. The results are mostly relevant to these forms of cancer, albeit they may point to more general uses in oncology.

The research is based on the personalized medicine and predictive analytics theoretical framework. This method tailors patient care based on unique genetic, environmental, and lifestyle characteristics by using computational algorithms to assess medical data and forecast outcomes.

Using a mixed-methods approach, the study combined qualitative reviews of patient outcomes with quantitative analysis of clinical data. The papers were chosen based on their applicability to AI applications in cancer prognosis, diagnosis, and treatment personalization from January 2010 to December 2022. Data sources included IEEE Xplore, PubMed, and Scopus.

AI in Cancer Diagnosis and Prognosis

AI's application extends across various sectors of cancer care, from risk assessment to prognostic evaluations. Machine learning (ML) has already been used to enhance performance in a variety of activities and tasks, such as predicting cancer risk, survival chances, cancer recurrence, cancer diagnosis, and cancer prognosis. This shows AI's capability as a useful tool in determining cancer diagnosis and prognosis[1].

The efficiency of AI in processing and predicting large amounts of medical data is a large advancement in oncology. Several experiments done by Vijayalakshmi A. Lepakshi demonstrated that AI-based image analysis systems provide rapid disease diagnosis accurately, and that, AI-based image analysis systems require only a few seconds whereas manual assessment can take up to 15 minutes[2]. This comparison illustrates the speed and efficiency with which AI algorithms can analyze medical images, providing a significant time advantage over

traditional manual assessments and further showing the benefits of its use in diagnosing cancer.

The speed and efficiency are also paired with high levels of accuracy in detecting various types of cancers from medical images. For example, in a study on the diagnostic accuracy of AI in comparing chest radiographs for the detection of lung cancer, AI algorithms demonstrated an ability to identify cancerous nodules with sensitivity and specificity rates often exceeding 90%[3]. This continues to show how AI can revolutionize diagnosis in the health industry with its high efficiency and accuracy.

Deep Learning AI Algorithms

One of the branches of machine learning called deep learning, has been particularly useful in identifying cancer with significant success. Deep learning algorithms are trained on a significant amount of data sets of images and use multi-layered neural networks to identify patterns. This has been used in the field of cancer diagnosis as deep learning modules can be trained on past imaging of numerous patients to identify malignancy patterns in ongoing cases. For instance, a type of deep learning program called convolutional neural network (CNN) was able to achieve an accuracy rate that rivals board-certified dermatologists in determining benign and malignant skin lesions, with a receiver operating characteristic curve of 0.94 (1.00 is perfect accuracy)[4].

Deep learning AI systems are trained on datasets containing thousands of images, allowing the AI to identify the patterns of different cancers using past precedents. An example application is in mammography, where AI has demonstrated its ability to detect early signs of breast cancer. By comparing past mammograms, AI can identify noticeable hints of malignancy that have a high chance of escaping human detection[5].

Using deep learning modules like convolutional neural networks, AI can determine the malignancy and aggressiveness of tumors using the comparison of the tumor's characteristics—such as size, shape, and texture—and the datasets the AI was trained on to predict its behavior and progression[4].

AI in Personalized Cancer Treatment

It is within AI's capability to also create unique and personalized treatments for every patient. By analyzing and comparing the imaging of ongoing cases with genomic and clinical data, deep learning algorithms can predict the probability of tumor recurrence and metastasis. For example, in lung cancer, AI is used, based on physical measurements, and medical imaging, to predict patient survival rates and tailor treatments[3].

AI algorithms used in creating personalized combinations of anticancer drugs use numerous factors, such as potential drug-to-drug reactions, the collective side effect, and the likelihood of drugs achieving the strongest matches, to determine the best personalized treatments that maximize success while minimizing toxicity[6].

AI in Lung Cancer Diagnosis and Treatment

Lung cancer remains one of the most challenging cancers to diagnose due to its subtle and random development. AI models equipped with deep learning have shown significant potential in improving early detection rates. For example, a study utilizing AI equipped with deep learning found that the system was able to identify small, easily overlooked nodules, improving early diagnosis and leading to improved survival rates[7]. Another study utilized AI to analyze historical treatment data and patient outcomes. The AI was then used to choose the most effective treatment regimen for individual patients[8].

Discussion

This review covered the significant role of AI and ML in enhancing cancer diagnosis accuracy, prognosis prediction, and personalization of treatment plans. Key findings include AI's high diagnostic accuracy, with sensitivity and specificity often exceeding 90%, and its ability to develop tailored treatment plans that reduce the likelihood of adverse drug reactions and increase treatment success. The findings show the high potential of AI and ML in oncology, particularly in settings where rapid and accurate decisions are critical. By speeding up and improving early detection and enabling personalized treatment plans, AI and ML can greatly alter patient outcomes, reducing mortality rates associated with cancer. The integration of AI into clinical practice is a large step towards more data-driven, precise oncological care.

The objectives of this review were successfully met, as the collected data provided clear evidence of the current capabilities and achievements of AI and ML in palliative care. The review confirmed that AI and ML could significantly improve the accuracy and efficiency of cancer prognosis and increase the treatment success rate with the personalization of treatment. Thus, showing its role in the prediction of cancer prognosis and treatment outcomes
Future research should focus on longitudinal studies to assess the long-term impacts of AI-integrated treatment plans on survival rates and quality of life. Additionally, exploring the integration of AI with emerging technologies like genomics could further improve personalized cancer therapy.

This review is restrained by the demographic and geographic diversity of study populations. Most studies that were used in this research were done on male, caucasian individuals in the United States. This presents the problem of an undiverse sample type limited to a certain group of individuals. The limited amount of clinical uses of AI was also an obstacle. Because of the limited amount of data about AI uses in real-world scenarios, the review must use the limited amount of information available.

As we are in an age of technological revolution in healthcare, the integration of AI into oncology will not only enhance patient outcomes but also go beyond the limits of what is possible in cancer care. This advancement is the first step into a new era of personalized medicine, where technology and humans, together, will combat and may solve the devastating cancer crisis that plague current-day society.

Methods

PubMed, Scopus, and IEEE Xplore were used to gather articles on the use of artificial intelligence (AI) and machine learning (ML) in cancer prognosis and treatment outcomes. The keywords used contained the combination of "artificial intelligence," "machine learning," "cancer prognosis," "treatment outcomes," "diagnostic efficiency," and "diagnostic accuracy." Only articles published in English from January 2010 to December 2022 were considered. The studies were selected based on their relevance to certain parts of AI and ML applications in cancer prognosis, diagnosis, and treatment personalization. The inclusion criteria were peer-reviewed articles reporting original research, reviews, and meta-analyses. The studies included clinical trials, prospective studies, and retrospective analyses to best analyze data in real-world scenarios.

Data was extracted systematically, recording the authors, year of publication, study design, type of cancer, AI or ML modules used, key findings, and the study's primary goal on prognosis, diagnosis, or treatment. A standardized form was used to guarantee consistency in data extraction, and recording all relevant details for a better comprehensive study. The extracted data were synthesized using a thematic analysis approach, where information was categorized based on the AI application — diagnostic, prognostic, and treatment-related AI modules. This organization then further allowed for a narrative synthesis, where common findings and trends were clearly outlined. The Critical Appraisal Skills Programme was then used to assess the quality of included studies. Each study was checked for bias and the applicability of results to ensure every piece of evidence was of the highest standard for this review.

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The Ethics of Human Enhancement: An Analysis By Anastasia Pentidi

Abstract

Recent advances in life sciences such as medicine, biotechnology, genetics, biology, and neurosciences raise serious moral concerns. Among the key issues is the one that concerns our genetic structure. Questions are continually emerging, regarding our genetic basis and its manipulation leading eventually to the enhancement of the human being through science. That said, transhumanists allege that for humanity to meet the demands of modern life, we have a moral duty to enhance ourselves and extend our lifespan, yet surpass the human condition as we nowadays appreciate. This paper presents ideas and evaluates transhumanism's propositions concerning philosophical views, like that of Michael Sandel, professor of political philosophy at Harvard University, and that of political economist Francis Fukuyama. The paper concludes that, although we should exploit the redemptive nature of technology to improve, intervention in our natural capacities, as it is being proposed, seems relatively unsound.

Keywords: bioethics, transhumanism, human enhancement, aging, immortality, the human condition, dignity.

Introduction

Technology with the pinnacle of artificial intelligence (AI) provides a practical means for humans to evolve in a multitude of forms that we cannot yet define. The use of term "enhancement" refers to the deliberate intervention aimed at improving a characteristic, selecting another desirable one, or creating a new trait in a human and encompasses biomedical and non-biomedical interventions. This paper discusses two aspects of human enhancement: moral enhancement and the pursuit of immortality.

According to the two bioethicists Julian Savulescu and Ingmar Persson, "Moral enhancement means the moral person to be distinguished from the predispositions that contribute, on the one hand, to the formation of correct judgments about what is right to do and, on the other hand, to the harmonization of his actions with these judgments" (Persson & Savulescu, 2008). In short, proponents of moral enhancement believe that humanity is bound by emotions, passions, and other physical urges, and to meet the ethical challenges of the era, moral enhancement is a viable solution. By moral enhancement, we generally mean the reduction of aggression and the elimination of violent behavior, as well as the promotion of empathy and the capacity for love. Our aggressive tendencies are rooted in biology and can be refined biotechnologically. This way, we can remain consistent with our ethical beliefs without deviating due to a lack of discipline and self-restraint. Pharmaceutical drugs can indeed influence our natural predispositions and affect our behavior. Understanding the effects of neurotransmitters, such as dopamine and serotonin, on mental disposition has led to the development of a plethora of drugs that allow for behavior control. Conversely, morality (in terms of what is considered right and wrong) is not determined by human biology. Therefore, to critically evaluate

interventions in human nature and psychological capabilities, a framework of evaluation and thus reasoning is needed. Moral enhancement is not reducible to biology but refers to values, many of which vary from era to era and from place to place. Enhancements could perhaps be considered moral, provided they are accompanied by a rational explanation of the reasons for seeking such enhancement. Here, one can argue that there is no timeless and definitive moral code, it is impossible to speak of the morality of human enhancement since there are no commonly accepted criteria by which to judge morality. However, we can argue that morality is a consensual contract with which people defend their interests by choosing to limit themselves for mutual benefit.

Another central claim of transhumanists is the pursuit of life extension through the suspension or even reversal of the aging process, ultimately aiming for immortality. The pursuit of immortality is of paramount importance to transhumanism because enhancements remain temporary as long as humans remain mortal. Being immortal, humans would be able to give meaning to their existence. Transhumanists believe that aging is a curable disease that can be treated, freeing humans from mortality.

Analysis of the Argument for Transhumanism

1. 1 Transhumanism Explained

Transhumanism does not adhere to fixed beliefs; what distinguishes it is not just its enthusiasm for technology, but the range of issues it explores. These include subject matter as far-reaching as the future of intelligent life and much more narrow questions about present-day scientific, technological, or social developments. In addressing these problems, transhumanists aim to take a fact-driven, scientific, problem-solving approach. They often embody "dynamic optimism", a mindset that desirable results can generally be accomplished, but only through hard effort and smart choices. By extension, they challenge perceived impossibilities and critically reassess all principles, including the necessity of death, the limitations of Earth's resources, and even the validity of transhumanism itself. Nick Bostrom writes in "Human Enhancements: A Transhumanist Perspective" that transhumanism is a "loosely defined movement" advocating for an interdisciplinary approach to understanding and evaluating opportunities to enhance the human condition and organism through technological advancements (Bostrom, 2003). It focuses on both current technologies, such as genetic engineering and information technology, and future ones like molecular nanotechnology and artificial intelligence. Potential enhancements include extending human health spans, eradicating diseases, eliminating unnecessary suffering, and augmenting intellectual, physical, and emotional capacities. Transhumanists see human nature as a work-in-progress, a preliminary stage that can be reshaped in beneficial ways. They believe that humanity has not reached the final stage of evolution. Just as we use rational means to improve the human condition and the external world, we can also use such means to improve ourselves, the human organism. In doing so, we are not limited to traditional humanistic methods, such as education and cultural development. We can use technological means that will

eventually enable us to move beyond what some would think of as "human". To a transhumanist, progress occurs when more people become more able to shape themselves, their lives, and the ways they relate to others, in accordance with their own deepest values. Transhumanists place a high value on autonomy: the ability and right of individuals to plan and choose their own lives; they seek to create a world in which autonomous individuals may choose to remain unenhanced or choose to be enhanced and in which these choices will be respected. They hope that by responsible use of science, technology, and other rational means we will ultimately manage to become post-human beings with vastly greater capacities than present human beings have.

   Bostrom explains the term post-human as the human being having at least one post-human capacity, which is a capacity greatly exceeding the maximum attainable by any current human being without remedy to new technological means. Such capacities revolve around health span, cognition, and emotion. As Bostrom sees it, we ought to pursue values that are important to us, and this will lead to a state of beneficence widely known as post-humanity, accommodating a variety of scenarios, but also open to the unimaginable. Bostrom highlights the importance of promoting enhancements that have "positive externalities": traits that derive into some social good, rather than a purely individual good. From this metaphysical framework that transhumanists create, their answer to "Why should we become post-human?" is clear: because post-humanity will be in a more beneficial state, better than present humanity (Vaccari, 2019). This is the Posthuman Beneficence Argument (PBA), which can be broken down into two wider transhumanist claims for the pursuit of post-humanity: a model of deliberate rationality, requiring reasons to endorse such claims, and the reasons themselves. The model of deliberate rationality involves a reasoned and reflective process by which individuals endorse the pursuit of human enhancement. This model consists of two key assumptions. Firstly, the "Continuity of Values" ensures that the post-human state aligns with the values and aspirations we currently hold dear. The idea is that if we can imagine posthuman capacities that fulfill our present values more comprehensively, then pursuing these capacities is rationally justified. Secondly, there must be "Reflective Endorsement" which requires human beings to deliberate about the desirability of enhancements. It means that they should carefully consider and voluntarily agree to the pursuit of enhancements based on their current values and rational deliberation. Next, we should consider the second claim of the Post Beneficence Argument: the reasons for pursuing post-humanity. Such reasons are quite straightforward and involve improvements in longevity, emotional well-being, moral behavior, and intelligence. The pursuit of knowledge, creativity, and happiness may be fully realized with enhanced cognitive abilities and emotional stability.

1.2 Moral Enhancement

   One of the most significant figures in the history of philosophical thought was Aristotle, who formulated a theory of moral improvement. He considered the moral elevation of its citizens to be a necessary condition for the well-being of a city. Living in an era of material prosperity where "having" is identified with "being" and moral values are increasingly deteriorating, one could hardly examine anything other than Aristotelian eudaimonia as the product of virtues.

According to Aristotle, the subject of ethics, just like the nature of man in the world, is unstable and uncertain. In his exploration of moral phenomena, he argues that we do not know the causal relationship of things but the data of raw reality offered by life. Thus, the way one can understand ethical issues is inductive, through experience and practice in life, relying on the opinions of authoritative philosophers or the prevailing perceptions of society. Additionally, in the Nicomachean Ethics, one of his three treatises, he formulates the conditions under which someone possesses moral virtues (e.g., justice, temperance, courage). He claims that someone who does something just and temperate is just and virtuous when they do it knowingly, guided by a stable disposition (Aristotle, Nicomachean Ethics, Book II). For example, if someone takes a drug that affects their behavior and then becomes particularly cooperative without their knowledge, we cannot speak of moral enhancement because their cooperative behaviour did not occur by their own choice, nor with their knowledge and disposition. Conversely, if someone takes a medication, of their desire, that affects their behavior by reducing their aggressiveness, then they meet the conditions of Aristotelian theory, and their action can be characterized as morally virtuous, and they as virtuous.

1.3 Life Extension

Professor of Evolutionary Biology at the University of California, Michael R. Rose, believes that the complexity of human physiology and therefore the difficulty in finding an anti-aging therapy can be addressed by using artificial intelligence to analyze the genome with the aim of developing new drugs (Panisch & Sorgen, 2014). However, based on historical experience, the increase in life expectancy is not due so much to technology but to public health policies. Continuing, Aubrey de Grey, a member of the American Aging Society, considers aging, as the biological, cognitive, and mental decline of the organism, not due to a genetic "clock" but reflecting accumulated damage and faults at the cellular level that are not repaired due to lack of organism resources. Therefore, he aims to treat it. Thus, according to this assessment, we can start to suspend aging despite ignoring many of the processes that cause it (de Grey and Rose, 2007). De Grey's anti-aging strategies include a plethora of cell-level therapies within the framework of a war against aging. The question that arises at this point is simple: Is it worth extending our lifespan, and if so, what are the consequences? In the scientific community, anti-aging strategies are considered, at best, extremely controversial and, at worst, pseudo-scientific. However, it should be noted that a special committee at the Massachusetts Institute of Technology, taking into account the criticism of de Grey's theory, could neither confirm nor refute his life extension strategies. This conclusion was published in the MIT Technology Review (Pontin, 2009) . The harmful effects are found in the need for dangerous clinical trials for the development of such methods. In this case, the participation of healthy middle-aged individuals is necessary. But how will they be convinced to participate, risking their normal life expectancy or even their lives? The motive will be financial reward. Financial rewards as a driving force will intensify social inequalities as the privileged class will indirectly force the weak to participate in trials exploiting their economic need. For this reason, research

into anti-aging therapies is seen as antideontological. However, these objections apply more broadly to experiments for human enhancement.

The fears and concerns about extending life take on other dimensions. We must first imagine our lives without a time limit. Is it possible to live for centuries without remembering our past selves? Will our future selves resemble our past selves? This also presupposes that our habits, preferences, and values remain unchanged, something that is likely impossible after a certain period. Therefore, the price of enhancement may be not enough to experience ourselves anymore. Here, the issue of self-loss arises. If this happens, we will not experience just a different life but an unknown one. Everything adjusts to the dimensions imposed by the time horizon of a generation. Being immortal, we will not need to wonder how we will live since we will have the opportunity to fulfill any desire at any time in our lives. Our goals and pursuits will not be limited to a timeframe, but we will have complete control over our actions. On the other hand, an extended life may not be a better version of the present but may involve abandoning beloved habits, activities, and pleasures (Tassis , 2021). For life to be successful, a person should not have exhausted the opportunities provided by their environment so that they can continue to explore and exploit them. The criteria for happiness are difficult to define but we could note that happiness involves enjoying our daily lives. Given what has been mentioned, we must point out that the allocation of resources, and new opportunities in our world is limited, as we have not been programmed to live longer than predetermined to adjust our needs accordingly. People shape their goals in such a way that they are achievable in their lifespan (we are not referring to issues that concern humanity and remain crucial to the scientific community). We conclude that happiness and success also have some limits. In the above reasoning, we assume that the individual has basic education and fundamental political rights, is not socially excluded, and is not a victim of discrimination. Also, we are not referring to someone who is indifferent to a content and successful life and prefers well-being. Our main question, whether radical life extension is beneficial, does not seem as clear-cut as a prudent extension. In conclusion, a maxim should be impressed upon us when contemplating the extension of the human condition: "We add years to our lives, but not life to our years."

Discussion

1. Accessibility

The term enhancement is extremely vague and susceptible to many interpretations of both positive and negative implications. At the same time, it is accompanied by a series of practical issues such as whether these enhancement technologies will be economically accessible to the general public. Could the inability of certain social groups to access these technologies pave the way for new forms of discrimination reminiscent of the old ones based on ideas of genetic superiority/inferiority? This concern is pervasive in the literature, and it is not unsupported. We could say that history has taught us that we cannot shake off the human tendency to dominate over someone inferior or at least whom we consider inferior based on evidence. Racist

perceptions and social divisions have never ceased to plague societies; the fear of an increase in such behaviours and manifestations reappears and evolves parallel to the advancement of scientific data. Many dystopian scenarios are mentioned regarding the transformation of societies for the worse, changes in the human species, and human evolution. The concern presented here has to do with how some will be positively affected by scientific developments and how others will remain in extremely disadvantaged positions (Chasapakou, Proikaki, Bobola, & Lambrou, 2018).

2. On Nature and Existence

Francis Fukuyama, political economist, presents in his book "Our Posthuman Future" a conservative critique of human enhancement, rejecting it as unethical and calling for its prohibition. He warns that human enhancement using genetic engineering will alter human nature, thereby risking the fundamental values of liberal democracy and inaugurating a post-human stage in history. Fukuyama defines human nature as "the set of behaviors and characteristics that are typical of the human species and are due to genetic rather than cultural factors (Fukuyama, 2002)." Violence indeed constitutes part of human nature and is as natural as its control through social rules and institutions. Furthermore, human nature does not dictate a uniform list of rights; it is flexible and complex as it interacts with various natural and technological environments. Bottom of FormFukuyama proposes recognizing human nature as a source of values that ensures the continuity of the human experience. We do not want to disrupt this continuity or its unity and therefore the rights based on it. While individuals may differ and vary across cultures, we share a common humanity that allows every person to communicate and form an ethical relationship with every other person on the planet. Thanks to this, we possess moral sense, social skills, and reflection. Fukuyama defines humanity as "a fundamental quality that has always grounded the sense of who we are and where we are heading despite changes in the human condition throughout history."

Furthermore, Fukuyama speaks of the state's responsibility to ensure that the cost of enhancement is not too high and guarantees its safety so that citizens can equally utilize it. Otherwise, the first victim of enhancement will be equality. This implies that genetic inequality will become the burning political issue of the 21st century. Fukuyama seeks to instill humility regarding human nature and respect for its fundamental characteristics. This, combined with culture, creates humans, endowing them with the ability to internalize values, acquire virtues, and be shaped by institutions. Francis Fukuyama attacks human enhancement, seeking to ground human rights in nature and protect human dignity (Fukuyama 2012).

Furthermore, Michael Sandel, professor of political philosophy at Harvard University, also presents a conservative critique of the ethics of enhancement. Once again, the ethical discomfort towards it stems from the threat it poses to humanity. Secondly, the difficulty in expressing this discomfort arises from the fact that it remains unseen how exactly humanity is endangered. Sandel argues that it diminishes the freedom to act, which is a central characteristic of the human condition. He believes that individual behavior would depend less on effort,

patience, and intelligence and more on enhancement. He also suggests that human abilities and powers are gifts, and human achievements are products of these abilities. More specifically, he states: "To recognize the giftedness of life is to recognize that our talents and powers are not wholly our own doing, nor even fully ours, despite the efforts we expend to develop them". He acknowledges enhancement as the pursuit of perfection through mastery over nature. Conversely, self-limitation is an attitude of gratitude, stemming from respect for the mystery of birth. Additionally, enhancement "fails to appreciate gifts and loses the part of the freedom that lies in an ongoing negotiation with the given"(Sandel, 2017). According to Sandel, the disregard for human abilities as gifts and the pursuit of perfection have detrimental consequences on solidarity and responsibility. He expands the boundaries of responsibility as the role of luck in how we behave is eliminated, and tolerance for mistakes in activities diminishes, as we possess predetermined abilities that make mistakes difficult. The issue for Sandel is not whether enhancement as a desire for mastery constitutes an ethical failing but the way of life it shapes. He argues that attempting to modify ourselves rather than change our world weakens "our orientation to the world we inhabit and the kind of freedom we aim to secure." Sandel brings to the forefront the issue of humanity, namely what makes life worth living. In his argumentation, he insists on the sanctity of nature, emphasizing that it is not simply an object subject to our desires (Sandel, 2017). Examining the perspectives of Fukuyama and Sandel, we conclude that human imperfections are not inherently negative elements but constitute a source of meaning, shaping human experience and identity.

The transhumanists believe that the sense of solidarity, as well as the sense of justice, have biological roots and developed in humans as necessary abilities for life in small communities through education and socialization. However, today, people, as inhabitants of megacities, are inadequately biologically prepared to meet the ethical challenges of modern life. There are still people who commit crimes, are racists, and sexists, expressing aggressive intentions. The only solution to this situation is the moral improvement of humans so that they can respond to the ethical challenges of contemporary life. Also, for humans to defend their primacy against artificial intelligence, to accept the inevitability of death deeply rooted in human thought, and thus to self-actualize, they have to prolong their lives. Examining aspects of transhumanism and opposing views, we conclude that it underestimates the complexity of organisms, their nature, and the rights based on it. Indeed, a central characteristic of human nature is self-improvement but not the only one. Furthermore, it does not concern itself with the history and humanity associated with mortality but examines the level of technical advancement with the culmination of artificial intelligence. It overlooks the major threat to itself and its uniqueness aiming at homogenization. Finally, it seeks to eliminate from human condition aggressiveness, pain, and mortality, dehumanizing the human species.

No one disputes that technology is simultaneously capable and incapable of everything, and its mediation can give a new flow to the sequence of things. Humans have so far led it, but gradually they are subject to its judgment and magnanimity. Balances, therefore, change, and thus we often move away from the human center. Machines are gradually creating a post-human

techno-reality that disrupts normalcy as humans have defined it. At the same time, values and norms are determined or influenced by normalcy, and when these are shaped by Machines, normalcy is not left unaffected. It is an irregular, unpredictable, and unusual reality that emerges through technology. These may seem distant, however, its evolution expands daily the scope of its applications, and only through alignment could the new reality reconcile with normalcy. At the core, the challenge of aligning technology with our values arises from the fact that algorithms do not interpret their operation or understand the meaning of the message. This results in them not always acting in line with our ethical, political, and social values. Furthermore, they do not possess, nor can they acquire, the sense, compassion, and wisdom that characterize human nature in decision-making.

Therefore, our first concern should be to firmly establish humanity within humans so that it does not sink within their constructions and from the wonders of their constructions. Humans should possess spirit, sensitivity, and virtue, values that refer us to the critical thinking that should be cultivated within our Education. Without a doubt, technological progress is a significant issue; however, its importance and imperative character should not stifle our reservations. Technology with its brilliant achievements has definitively entered our lives and has opened up horizons that will allow human activity to evolve indefinitely. However, this does not mean that humans can surrender and submit without resistance to it.

Conclusion

To conclude, it seems that the progress made in genetic engineering constitutes both a promise and a dilemma, on the one hand, it promises the treatment of diseases, while on the other hand, it allows interventions in humans. In this context, the moral enhancement of people emerges as necessary for the prevalence of order. Pain, effort, aggressiveness, and other discomforts that we seek to limit, cannot simply be erased from humans without changing a series of different things that shape the human species. Transhumanism does not seem to adequately support the view that the desire for self-improvement is a central characteristic of human nature, presenting the enhancement of humans as the destiny of history. Precisely because its arguments are exclusively anthropocentric, it underestimates the political and social consequences, such as widening inequalities and establishing unfree regimes. Even the most moderate approaches to enhancement are not convincing, as they deny the continuity of humanity in its present form and focus on the imperfections of humans that for others are gifts of imperfection.

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The genetic/environmental contributors of Type 1 Diabetes, and the use of CRISPR/Cas9, In vivo therapies, and SHERLOCK (Cas13) in its prevention by Nandika Devarajan

Abstract

In this paper we explore genetic and environmental contributors of Type One Diabetes, the role CRISPR can play in editing the targeted mutation, and the use of SHERLOCK to validate the transformation in the genome. The various demographics and age groups of higher incidences for developing Type One Diabetes are addressed, with recommendations for panel or comprehensive testing in infancy for all individuals to effectively target mutated genes and prevent T1D. Additionally, we investigate and analyze the nature of the mutations in the HLA, INS, PTPN22, and CTLA4 genes, proposing specific therapies to prevent provoking the development of Type One Diabetes. These treatments involve targeted gene therapy using the CRISPR/Cas9 technology (we provided a sample guide RNA for individuals with an HLA variant). Furthermore, we recommend the avoidance of food items that are recognized to evoke T1D in some individuals and encourage the consumption of vitamins that are proven to hinder T1D symptoms. Lipid Nanoparticles are suggested to transport the CRISPR complex into the pancreas for genetic editing. To affirm success in the genetic editing of Pancreatic Beta Cells the utilization of SHERLOCK/Cas13 is proposed, due to this mechanism's simplicity, effectiveness, and speed in deriving results.

Introduction – What is Type One Diabetes (T1D)

β-cells (or Beta cells), located in the pancreas, are classified as islets of Langerhans[1] which are a type of cells responsible for the control of glucose metabolism[1]. The majority of the carbohydrates we consume get broken down into a basic monosaccharide molecule called glucose (also known as blood sugar), which is then released into the bloodstream to be converted into energy. Insulin travels through the bloodstream to attract to the GLU4 transporter molecule in the blood cells[2] (this process is outlined in Figure one). The binding of Insulin to the insulin receptor on the surface of the cell causes a series of intercellular activities triggering the appearance of GLU4[3] as it rises to the surface in the presence of the hormone[2]. The channel protein, GLU4, facilitates the escort of the glucose molecule[2] through the semipermeable membrane of the cell.
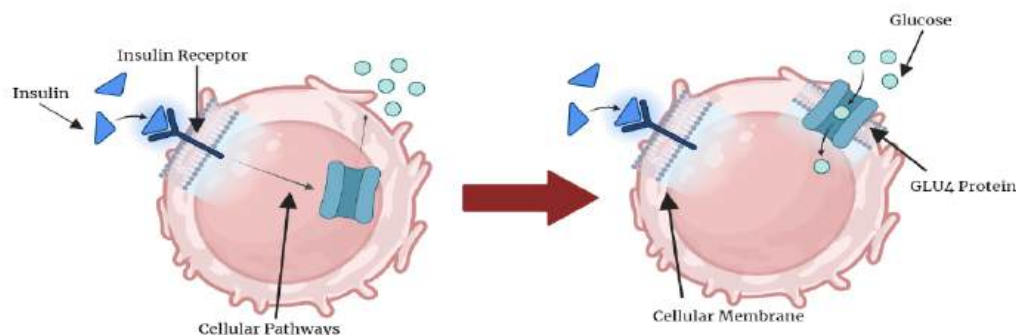
Fig 1: Insulin binds to the insulin receptor triggering intercellular pathways which provoke the GLU4 Channel Protein to rise to the surface. This protein acts as an escort, enabling glucose molecules to enter the cell. (Adapted from reference[4]). Image created using BioRender.

Both Type One and Two Diabetes are part of the Diabetes Mellitus class. However, they are derived from different factors involving various genetic/environmental triggers. Type One Diabetes (T1D) occurs when our body cannot produce insulin[5] for genetic or environmental reasons. Although similar, it is often mistaken with Type Two Diabetes, a condition obtained from old age or being overweight, where the pancreas is not able to create enough insulin, or the body cells resist insulin[5]. The lack of insulin or resistance of Insulin in Diabetes Mellitus sets off a chain reaction leading to the toxic buildup of glucose in the blood stream. Additionally, cells of individuals with Diabetes are not able to produce ATP which is a critical unit of energy and vital for our body to function.

Genetic and environmental factors can activate cellular pathways which intensify Endoplasmic Reticulum (ER) stress or set off a negative response as a reaction to ER stress[6], occurring during disturbances in the protein folding. To compensate for this stress, the cells activate a series of signal cellular pathways called UPR (unfolded protein response)[13]. This mechanism is designed to help the cell adapt to the stress and assist in folding and maintaining UPR homeostasis[7]. However, in some cases even with protective cellular pathway such as UPR, the cell still creates atypical proteins[7]. In this scenario, the cell itself recognizes the proteins as abnormal and engages in an immune response out of precaution to identify whether the cell has been infected by a virus.

A series of cellular pathways (including UPR)[8] induce an immune response of cytokines, which act as a homing beacon to attract T-cells[8]. Sent by the immune system, T lymphocytes (T-cells) follow the cytokines signal to examine the "foreign" cell[8]. Meanwhile, the pancreatic β-cells release autoantigens which are an identification protein created by the body cells. The T-cells use autoantigens to identify whether the cell is foreign, infected with a virus, or normal. If recognized as abnormal, T-cells trigger the Beta-cells to undergo apoptosis[9]. Often, in individuals with T1D, a mutation in the presentation of autoantigen proteins causes the T-cells to incorrectly identify the β-cells, this reaction will be explored further in this paper.

In brief, Type 1 Diabetes is developed when T-cells are provoked to check on Pancreatic Beta cells for reasons such as ER stress. Beta cells undergo apoptosis if identified as abnormal by the T-cells. When insulin (produced by the β-cells) is not produced, body cells are not able to intake glucose from the bloodstream and convert this vital molecule into energy.

Genetic and Environmental Factors Behind Type 1 Diabetes

The source of Type One Diabetes is still heavily studied and not fully understood due to its incredible complexity with various environmental and genetic factors that trigger the development of this disease. Furthermore, there are over 50 susceptible regions (and genes within these regions)[10] which can trigger Type One Diabetes. These genetic mutations significantly increase the chance of developing this disease, but often environmental factors are

what trigger these mutations leading to the development of T1D. The four genetic mutations which most increase the risk for developing Type One Diabetes[11] occur in the HLA, INS, PTPN22 and CTLA4[11] genes.

Fig 2: Displays the percentage of individuals who develop Type One Diabetes when the listed genetic mutation is present. (Adapted from reference [12] [13] [14] [15]). Image created using BioRender.

Genetic Mutation	Percentage Range
HLA-DR3/HLA-DR4	20-40%
INS	5-10%
PTPN22	2-5%
CTLA4	1-2%

Frequently, the augmented number of genetic mutations exponentially heightens the likelihood of triggering T1D. The genes act "multiplicatively[11]," meaning that when two of the four genetic mutations mentioned above are present in an individual, the chance of developing T1D multiplies. Although it is common for individuals to have two mutated genes, it's incredibly rare[11] for all of the 4 mutations to be present in an individual. This phenomenon of genes acting multiplicatively occurs in every scenario except in the case of the combination of HLA and PTPN22 genes[11].

HLA (Human Leukocyte Antigen) and variants in this gene are known to provoke numerous autoimmune diseases. They play a crucial role in assisting the immune system identify foreign/abnormal cells from an individual's own body cells[12]. In Type One Diabetes, the variants in this genome associated with triggering this disease are HLA-DR3/HLA-DR4[12]. Recall that ER stress in pancreatic Beta cells can lead to the production of autoantigens[12], which are recognized by T-cells. HLA genes are responsible for encoding the proteins of the autoantigens which present themselves to T-cells[12]. Old proteins produced by the cell are broken down into peptides and attached to the HLA proteins whom, are in charge of binding the peptide onto the surface of the T-cells [12] to identify the condition of the cell. However, the HLA-DR3 and HLA-DR4 variant proteins present and bind the peptides in a contrasting manner from the non-variant HLA proteins. The higher affinity in the peptides binding causes the T-cells to think the autoantigen is foreign. Hence, the presentation of the peptides seems inconsistent with the T-cell's classification of normal[12], triggering T-cells to eliminate the pancreatic Beta cells.

As the INS gene is responsible for providing instructions to create Insulin[16], a mutation in this gene can prevent the production of the vital hormone. The INS genetic variance alone can cause T1D, making it prevalent in young children and remains the most common mutation which causes Diabetes in infants[17]. However, due to the versatility of this gene there are numerous forms of mutations and thus can be triggered at any age. Infact, a mutation in INS ranks the second most prevalent genetic alteration present in individuals with T1D spanning all ages[18]. As an example, a modification in this gene may not completely prevent the production of Insulin.

Instead, it could cause abnormal protein folding of Insulin leading to ER stress[17] and intracellular UPR reactions which attracts T-cells.

Converse to the HLA and INS mutation, The PTPN22 genetic mutation stems from the T-cells. Specifically, this PTPN22 genome sequence provides instructions for the immune system response against foreigners and infections[23]. Due to the PTPN22 mutation, the T-cells cannot recognize autoantigens[19] presented by the non-variant HLA gene. Similarly, the CTLA4's gene codes for the protein meant to regulate and prevent excessive immune response[20]. However, the CTLA4's mutation disables the T-cell from correctly identifying the autoantigens and diagnoses the β-cells as abnormal.

Although many genetic mutations can aid in the development of T1D, environmental factors, such as viruses and diet, often trigger or even cause T1D. Viruses, particularly enteroviruses (e-viruses) [21] carry chronic effects which can persist in various tissues in the body, including the pancreas[21]. E-viruses holding the Pancreatic β-cells as a host can trigger ER stress. If an individual in this situation has a genetic mutation causing T-cells to falsely identify the Beta cell as abnormal, the immune system will destroy these valuable β-cells. Additionally, viruses dysregulate immune cells, leading to derailed immune system response[21], evoking irregular reactions such as unjustifiably attacking the Beta cells.

Furthermore, the timing of when a food is introduced into an infant's diet (such as higher intake of oats, gluten-based cereals, and gluten particularly before the age of 4-6 months[22]), can trigger an immune response or dysregulate immune cells. As mentioned above, diet can negatively impact ER stress. For example, the consumption of excessive lipids (specifically trans fats and saturated fats) can buildup in the pancreas. This exerts pressure in the ER[23] triggering the incorrect formation of proteins and causing ER stress. Diet can negatively impact gut microbiota which could trigger incorrect functionality of autoimmune regulations and incorrectly target β-cells[24]. Although diet can trigger autoimmune reactions it can also subdue them. Vitamin D can moderate immune systems activity and recent studies have shown that they can suppress unnecessary autoimmune reactions[22]. This discovery could help those with T-cell genetic mutations limit the susceptibility of triggering this mutation to attack Pancreatic Beta cells.

Age of Development of Type One Diabetes (when treatment for prevention should be administered)

Considering that the various genetic mutations and environmental factors can be triggered throughout life or even develop during infancy, it is crucial that an individual acts quickly in order to successfully prevent Type One Diabetes. For instance, the INS mutated gene is commonly found in infants with T1D. The exact age for symptoms to start showing can vary depending on the person. However, if a child has the INS mutation, they will develop Type One Diabetes before the age of 25[25]. The reason why individuals with INS mutation will develop T1D later is still under research, but scientists predict variations of this genetic mutation and environmental factors may also play a role in the trigger of this disease[16].

Although this holds accurate for the INS genetic mutation, other mutations may never be triggered and show symptoms. As an example, the HLA genetic mutation alone cannot directly cause Type One Diabetes because all it does is present the autoantigens of the Beta cells in a foreign manner to the T-cells. It doesn't trigger the Endoplasmic Reticulum stress, which is what leads the T-cells to inspect the Beta Cell. This stress is caused by various environmental factors such as various viral infections and diet choices as well as other genetic mutations. Therefore, the HLA genetic mutation could be shown at any point in life like other genetic mutations and only increase the risk of developing T1D.

However, it is also important to note the incident age peaks associated with disease due to hormonal and bodily changes occurring during that period time7[26]. Peak One of developing Type One Diabetes is age 4 to 7[26]. The second peak in present in adolescents entering puberty around ages 10 to 14[26] as many children undergo puberty at this age and have hormonal changes. After the second peak the rates of development of Type One Diabetes drop in female adults but remains high in males up to the ages 29 to 35[27]. As there are various genetic and environmental factors that may or may not act upon each other to develop Type One Diabetes, there isn't one solution that can be used as a treatment for all. Hence, it would be best to test for this disease using paneling testing, which this paper will explore, as early in life as possible to prevent the symptoms and triggers of genetic mutations for T1B.

Treating this disease is based on combining information to create the best possible treatment and plan for an individual. Specifically, if an individual has genetic mutation(s) in the pancreatic beta cells, using CRISPR to address this susceptibility would be most effective. The application of the CRISPR/Cas9 mechanism will be explained further in this paper. However, if a person has one or multiple mutations involving the immune systems and the T-cells, due to the difficulty of editing the T-cells, it would be wise to plan a well-structured diet so the pancreas beta-cells don't experience any stress which can provoke T-cells. For example, vitamin D has been proven to help with reducing the risk. Additionally, if an individual is known to have a mutation in either the T-cell of Bet cell, it would be wise to take extra protection when contracting a virus or e-virus so the Beta cells aren't infected with the virus and are susceptible to attack by the T-cells.

What is CRISPR/Cas9 and How Can this Technology Prevent Type 1 Diabetes:
To prevent Type One Diabetes, other than taking caution of symptoms, a feasible and highly effective solution is physically editing the mutated genes in human cells, so Beta cells are not destroyed, and Insulin is produced for the body. Due to the complexity of the pancreas along with the difficulty of obtaining, editing, and inserting cells into this organ, it would be most effective to perform this edit in-vivo. To accomplish this task the precise and effective gene-editing mechanism CRISPR/Cas9 (Clustered Regularly Interspaced Short Palindromic Repeats) can be employed.

In the natural CRISPR process, the Cas9 protein combines with the important tracrRNA (trans-activating CRISPR RNA) and crRNA (CRISPR RNA) to form a remarkable complex[28].

The tracrRNA provides the necessary support and structure for the Cas9 while the crRNA includes crucial information about the specific location of the nucleotides. The tracrRNA and crRNA combine with Cas9 to form a complex[29]. This structure travels around the cell, the Cas9 protein scans the genome to find the PAM site of the virus's DNA. A PAM site is basically an identification tag and consists of the sequence NGG, "N" stands in for any of the nucleotide base pair (A,G,T,C)[29]. Followed by the NGG is a short DNA sequence which is then recognized by the tracrRNA and CrRNA complex. Once Cas9 identifies an NGG sequence it unravels the crRNA from the complex to verify whether this is the correct DNA sequence. Once the complex reaches the designated DNA site the Cas9 protein cuts the DNA around 3 base pairs upstream of the PAM site[36]. This incredible CRISPR defense system was adapted to produce the genetic editing system that is used today.

Scientists modified this process to create the gRNA, a combination of the tracrRNA and CrRNA.[30] Using the National Center for Biotechnology Information FASTA format, the specific nucleotide information can be found for a specific gene. This information can then be inserted into online tools such as the CRISPR RGEN database to derive various gRNA for a specific locus. Researchers must look through the numerous gRNA's provided to find the most effective sequence. One such gRNA sequence for the HLA-DR3/HLA-DR4 gene is: CTTCTGGCTGTTCCAGTACTCGG. The Pam sequence of CGG is at the end of this sequence. This gRNA can be combined with a Cas9 protein and inserted into the cell for a genetic edit.
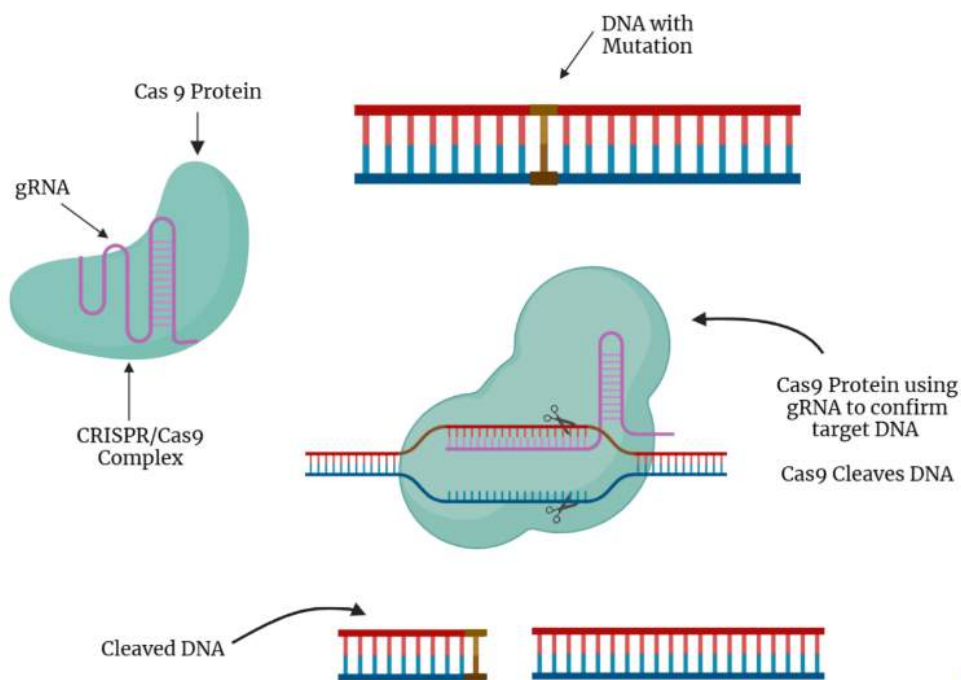
Fig 3: The CRISPR/Cas9 Complex scans the genome for every PAM site. Once it identifies an NGG sequence (the PAM site) it unravels the gRNA in the complex to check for a match in the Target DNA. If a match is confirmed Cas9 cleaves the DNA. (Adapted from reference[31]). Image created using BioRender

Once Cas9 cuts the DNA site complementary to the gRNA, genetic editing happens[30] in one of two methods: Non-Homologous End Joining (NHEJ) and Homologous Recombination (HR). Through NHEJ cells repair a double stranded break in the DNA in a procedure that knocks

off the function of the mutated gene, altering the genome[32]. Specific to the HLA genetic variant, it would be most effective to shut down the function of HLA-DR3/HLA-DR4 part of the gene which would prevent the production of these proteins. The elimination of these proteins would not be harmful for the body because other HLA based proteins can step into the role of the HLA-DR3/HLA-DR4 variant without triggering apoptosis in Beta cells. Once the Cas9 introduces a break in the DNA the cell works to repair this damage and fix the break. If the cell correctly repairs the damage, Cas9 cleaves the target DNA again. This process of cutting and repairing continuously occurs until the cell incorrectly repairs the genome, introducing an insertion or its deletion mutation[32]. The instigation of a mutation can knock out the function of the gene[32].

HR is most effective for single nucleotide mutation diseases. If there is one single base pair mutation that needs to be fixed, and individual must use CRISPR to continuously edit the genome in a trial-and-error technique[32], until the cells replace the current incorrect nucleotide with the correct one[32]. However, as this method is error prone, causing insertions or deletions engendering other mutations. Thus, to prevent further mistakes or mutations in genetic sequence scientists will often engineer or attach a short DNA template for the cell to easily incorporate into the locus[28], instead of the cell manually repairing the DNA break.
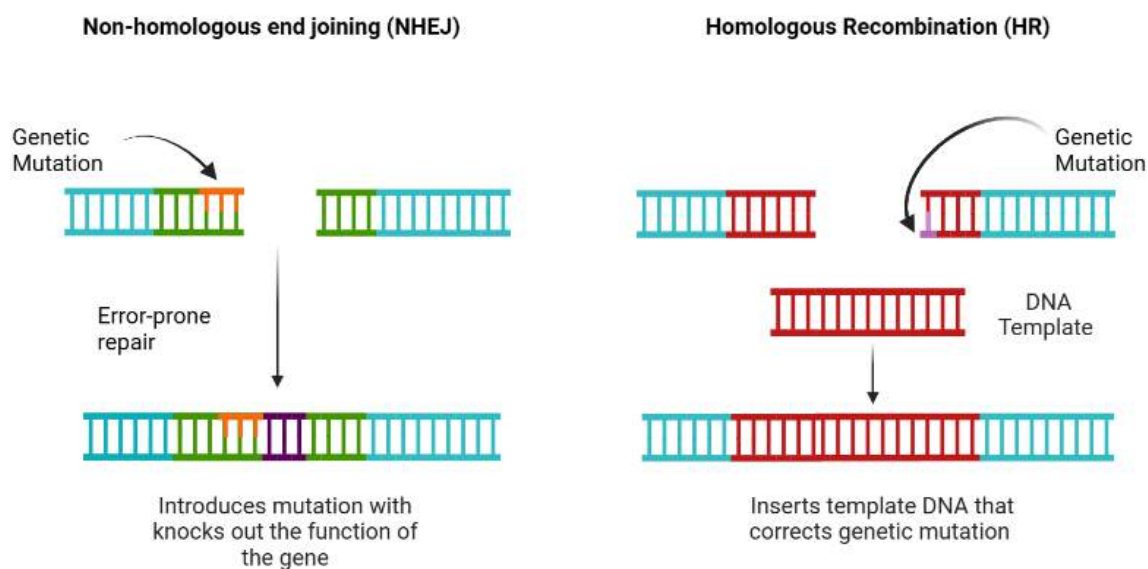
Fig 4: Represents Non-Homologous End Joining (NHEJ) and Homologous Recombination (HR), NHEJ is typically used to knock out gene that creates problems and isn't completely vital to the cell's function. However, HR is used to fix a mutation presenting a problem yet the correct function of the gene is critical for proper function. (Adapted from reference[41]). Image created using BioRender.

In vivo CRISPR delivery
After designing a guide RNA (paired with a Cas9 protein) for a specific T1D mutation, a major problem is the delivery of this CRISPR mechanism into the pancreas to complete the

intended edit. The pancreas is a complex organ and difficult to reach for various reasons. For instance, it is located near the back of the abdomen and is a part of the digestive system[33]. Additionally, the consistency of the pancreas is characterized by its fatty infiltration and fibrotic tissue[1], therefore is often referred to as "soft." Due to this unstable liquid-like texture and its intricate location in the body, the pancreas is often hard to operate on during surgery. Thus, it is vital that an alternate method is used to effectively deliver the CRISPR/Cas9 mechanism into the pancreas (in vivo) for genetically modifying the organ to prevent Type Ones Diabetes. Currently, a viable technology which is still undergoing study is Lipid Nanoparticles (LNP).

Lipid Nanoparticles are an emerging field and are an active area of research. These particles are characterized by 4 various types of lipids[23] that combine to create a positive charge. LNP cannot directly be injected into the blood stream as they would become trapped in the liver. Thus, a viable option is administering these LNP in the peritoneal cavity[34]. Located near the abdomen and pelvis, this cavity is separate from the circulatory system but near the pancreas[35], avoiding the problem of entering the blood stream and being filtered.

In one paper[34] researchers studying the effective delivery of CRISPR Lipid Nanoparticles into pancreatic cells determined a feasible solution[34]. Following multiple rounds of testing, they found an effective composition involving a mixture of the four lipids: Phospholipids, Cholesterol, Cationic Lipids, and PEGylated Lipids. After administrating LNP into the Pelvic Cavity of rodents, in the span of three hours 52% (intraperitoneal) and 2% (intravenous) of the genetic cargo successfully reached the pancreas[34], proving that providing the treatment through the peritoneal cavity is functional. Furthermore, this LNP composition proves to hold up to three samples of mRNA[34]. Hence, these Lipid Nanoparticles can carry the Cas9 mRNA, the gRNA, and an additional gRNA if there are multiple mutations or a template DNA molecule for Homologous Recombination. According to the study[34], white blood cells called macrophages aid the delivery of LNP to the pancreas[34]. These cells operate the role of a trash can, they float around the pancreatic cavity and consume as well as digest all the molecules that they deem "trash". The Lipid Nanoparticles are a part of this category. However, instead of being digesting by the macrophages, LNP are hauled around the peritoneal cavity and the pancreas attracts these molecules due to its composition[34].

Use of SHERLOCK to confirm genetic edit:

Once LPN are administered a technology that can be used to confirm the whether the pancreas have been successfully edited is SHERLOCK (CAS 13). Once entering the DNA sample, the Cas13 proteins will bind to the specific DNA site of the genome, guided by the gRNA[56]. When the protein successfully binds to the targeted DNA site it becomes activated and expresses a non-specific cleavage site (meaning it will cut all the RNA in its path at a specific regardless of whether it is the target RNA). The Sherlock (Cas13) reporter molecule and quencher molecule react differently based on what it perceives. Specifically, when Cas13 cleaves the target RNA, it releases the reporter molecule from the quencher.[36] This liberation of the report molecule releases a signal that is measure as a color change[36] which scientists use to

identify whether a mutation in the particular genome is present. In the SHERLOCK test Individuals apply their DNA, usually in the form of saliva, a strip of paper coated with a Cas13 containing solution. Depending on if the Cas13 protein cut the targeted RNA releasing the quencher molecule, the paper will stain a different color indicating whether a genetic mutation is present in an Individual[37].

Conclusion

Type One Diabetes (T1D) is a disease most often characterized by the destruction of the Beta-cells in the pancreas by the immune response involving T-cells. However, occasionally it is distinguished by the dysfunction of the Pancreatic Beta cells which fail to create the vital hormone Insulin. Type One Diabetes is an incredibly complex disorder due to its various genetic factors and environmental triggers. As a consequence of T1D's complexity, it is difficult to cure this disease because of its versatility and variation between every individual. Thus, averting Type 1 Diabetes before its development may be more effective because prevention ensures less harm inflicted on the pancreas. In this paper we propose a strategy to prevent Type One Diabetes by first identifying the risk for developing this disease in an infant or newborn. This can be accomplished by collaborating with a genetic counselor and undergoing Panel testing to identify specific mutations. After this crucial step and if mutations are found in the T-cells, planning an effective diet such as increasing intake of Vitamin D and monitoring environmental triggers for is crucial. However, if genetic mutations are present in the pancreatic Beta cell, genetic modification via in vivo approaches, such as the administration of Lipid Nanoparticles through the peritoneal cavity, will display effective results in preventing T1D. Employing the use of CRISPR for editing the genome will derive the most precise modifications and can be approached by designing a guide RNA with the Cas9 protein to escort this complex to the mutation in the genome. In order to reach the pancreas, inserting this complex into Lipid Nanoparticles (engineered to travel to the pancreas) will help deliver this genetic editing mechanism. The SHERLOCK (Cas13) technology can be used to confirm whether these approaches worked, and the targeted genome mutation was successfully edited.

In the future, additional required steps necessary to successfully employ this proposal involve expanding research in the utilization of Lipid Nanoparticles in the pancreas and exploring more in vivo options for CRISPR based genetic editing treatments. Additionally, as CRISPR edits are most commonly made in vitro and later inserted into the body, it would be most constructive to investigate the possibility of in vivo edits as it would be more impactful, time efficient, and easier to track.

Currently, In the United States alone over 64,000[38] people are diagnosed with T1D and reports of over 8.4 million individuals worldwide living with this disease[39]. The number expected to increase by 2.9 percent a year[38]. In the year 2040, it is expected that over 2.1 million individuals will be diagnosed with Type One Diabetes[38]. With the cost of insulin ranging several thousands of dollars (approximately 6,000)[40], many people can simply not afford this medication and must choose between living or having food on the table. With no treatment in sight for these

individuals but to painstakingly control measure their blood sugar levels often having to self-inject insulin in order to survive. However, all hope has not been lost because the potential to prevent this disease is right around the corner. Together with more research we can prevent tens of thousands of individuals a year from developing Type One Diabetes.

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Exploring the Educational Needs and Characteristics of Twice Exceptional (2e) Students By Shuojia Chen

Chapter I: Introduction

1.1 Research Background

In modern education, there is a growing focus on a specific group of individuals who possess exceptionally high intelligence but also experience one or more learning disabilities simultaneously. This group, known as the 2e group, typically outperforms the average population in intelligence tests but faces significant challenges in academic performance, social skills, and daily life independence. Scholars both domestically and internationally are conducting extensive research on the 2e group to uncover their distinct psychological mechanisms and educational requirements.

At the national level, as the concept of education is being redefined and special education is being developed, there is a growing focus on addressing the educational needs of the 2e group. Scholars have conducted empirical studies to examine the cognitive, emotional, and social interaction characteristics of the 2e group and have proposed specific educational strategies. Furthermore, research conducted abroad is more comprehensive and thorough, encompassing not only the psychological characteristics and types of learning disabilities of the 2e group but also various educational intervention methods and strategies for family support.

1.2 Problem Statement

In general, recent research indicates that 2e groups encounter distinct difficulties in the educational process. Their learning disabilities not only hinder academic success but can also detrimentally affect their mental well-being and ability to adapt socially. Consequently, it is crucial to have a thorough comprehension of the learning traits of 2e groups and to offer them tailored educational assistance in order to foster their holistic growth.

The main objective of this study is to thoroughly investigate the learning characteristics of 2e groups, which consist of individuals with an intellectual disability and one or more learning disabilities. As society becomes more aware of individual differences, there is also a growing focus on understanding the specific needs of this particular group. Despite their high intellectual abilities, 2e individuals face significant learning challenges that are often beyond the comprehension of typical students.

Through in-depth research, this paper is expected to accurately identify the learning characteristics of 2e groups, including their specific performance in different disciplines, different learning stages, and their psychological and behavioral responses when facing learning disabilities. This paper will also focus on how these learning traits affect their academic achievement, social interaction, and self-awareness. The study is also dedicated to analyzing the educational needs of 2e groups, in particular their learning barriers, and to proposing practical educational strategies and support measures.

1.3 Research Significance

Through research, we aim to provide educators, parents, and policymakers with valuable references to better meet the learning needs of 2e groups and promote their comprehensive development. This has profound significance not only for the 2e group itself but also for the improvement and development of the education system as a whole.

In-depth study of the learning characteristics of 2e groups is crucial for both individual development and educational practice. For the 2e group, understanding their learning characteristics helps them to better understand themselves, identify their learning needs and advantages, and develop more effective learning strategies to improve learning efficiency. It also aids in building self-confidence, reducing learning anxiety, and promoting physical and mental development.

From the perspective of educational practice, an in-depth study of the learning characteristics of the 2e group can provide educators with more scientific and reasonable educational guidance. Educators can design more personalized and differentiated teaching programs based on the learning characteristics of the 2e group to meet their learning needs and promote their comprehensive development. This can also foster innovation in educational models, promote educational equity, and improve the quality of education.

The role of 2e groups, who possess high intelligence and specific learning disabilities, is becoming increasingly prominent in society due to the growing diversification of societal talent needs. Conducting a comprehensive study on their learning characteristics will not only contribute to their personal development but also enable the cultivation of individuals with an innovative mindset and practical skills, thereby advancing societal progress and development. Therefore, conducting an in-depth study on the learning characteristics of the 2e group holds significant practical and far-reaching developmental importance.

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1.4 Research Objectives

This paper aims to explore in depth the learning characteristics and educational needs of the 2e group, that is, individuals with an intellectual disability but with one or more learning disabilities. An overview of the mental hyperactivity of the 2e group and its characteristics is provided to identify their high scores in intellectual tests as well as the creative thinking and problem-solving capabilities that may accompany these abilities. Next, we analyze the types of learning disabilities that are common in this group, such as difficulties in reading, writing, and math, and explore their specific manifestations in the learning process.

After understanding the basic characteristics of the 2e group, this article will discuss in detail how to identify and evaluate their learning characteristics. We will explore challenges and difficulties in the identification process, as well as current available assessment tools and methodologies. The article will then analyze the impact of learning barriers on the learning and development of 2e groups in order to better understand and address their educational needs.

1.5 Focus and Structure of the Paper

This paper will focus on the practical aspect of understanding the learning characteristics of 2e groups by examining personalized teaching strategies. We will evaluate collaborative models between schools and families in 2e group education, as well as the significance of establishing professional support teams. Additionally, the paper will discuss the necessity of promoting appropriate education policies to support 2e education.

This paper presents the key findings of the study and offers insights into the future trajectory of the research, aiming to serve as a significant point of reference for future studies on the learning traits and educational requirements of the 2e population.

Chapter II: Intellectual Characteristics and Learning Disabilities of the 2e Group

2.1 Intellectual Characteristics

Chapter II explores the intellectual characteristics and learning disabilities of the 2e group. Section 2.1 focuses on the characteristics of intellectual exceptionality in this group, referring to individuals who possess high intelligence, fast learning ability, excellent logical reasoning, and problem-solving skills, but also experience learning difficulties. Despite their challenges, these individuals often demonstrate exceptional talents in various fields such as mathematics, science, art, or music.

Super intellectual 2e individuals possess exceptional memory capabilities, enabling them to rapidly assimilate and analyze vast quantities of information. They demonstrate agility in executing intricate logical operations and reasoning within a brief timeframe. They exhibit a profound curiosity and enthusiasm for acquiring new knowledge and skills, displaying a willingness to dedicate substantial time and effort to exploration and learning.

2.2 Learning Difficulties of the 2e Group

However, although the 2e group demonstrates strong intellectual abilities, they frequently encounter difficulties in their learning process. These difficulties can stem from specific learning disabilities, such as dyslexia, dysgraphia, dyscalculia, or attention deficits. These obstacles can significantly hinder their academic performance, making it challenging for them to reach their full academic potential.

Thus, it is essential to comprehend the cognitive challenges faced by 2e individuals, along with the educational obstacles they might encounter, in order to assist them in overcoming learning challenges and fully harnessing their intellectual capabilities. This necessitates a collaborative effort among educators, parents, and society as a whole to provide tailored educational support and access to resources that cater to their unique requirements.

The common learning disorder types in the 2e group encompass a variety of cognitive, emotional, behavioral, and other aspects.

In the cognitive domain, individuals may encounter reading difficulties, such as slow reading and difficulty in comprehension; mathematical impediments, which can manifest as poor computational ability and problems with logical reasoning; and writing difficulties, including spelling errors and slow writing speed. On the emotional side, they may suffer from issues such as anxiety and depression, which can affect their learning motivation and interest. At the behavioral level, Attention Deficit Hyperactivity Disorder (ADHD) is a more common type, characterized by issues with concentration, excessive activity, and impulsive behavior.

The manifestations of these learning disabilities vary from person to person, but they often negatively impact academic achievement and social adaptation within the 2e group. Individuals may experience frustration and confusion in traditional educational environments because their learning needs and difficulties are often overlooked or misunderstood. Therefore, educational strategies and methodologies for 2e groups require special attention to their learning characteristics and must provide personalized support and services to promote their comprehensive development.

2.3 Learning Characteristics of the 2e Group

The 2e group exhibits unique performance and needs during the learning process. Due to their extraordinary intelligence, they often have a deeper desire for knowledge than typical students, frequently demonstrating enthusiasm and focus on deep learning in specific areas. However, the presence of learning barriers also complicates their learning experience.

On the one hand, 2e individuals may struggle with attention, memory, and performance, leading to challenges in processing information and organizing learning materials. These difficulties can make it hard for them to maintain concentration for extended periods during classroom learning, impacting their learning efficiency and outcomes. On the other hand, because of their intellectual exceptionalism, their desire and pursuit of knowledge often extend beyond conventional teaching methods. Consequently, they may have higher expectations for

the depth and breadth of the curriculum and require more challenging and stimulating content to meet their learning needs.

Additionally, 2e individuals may encounter difficulties in self-awareness during the learning process. They might experience confusion, frustration, or heightened awareness regarding their learning disabilities, necessitating extra psychological support and emotional care. Furthermore, their distinctiveness may lead to social and emotional challenges, requiring additional training in social skills and emotional support.

The distinctive abilities and needs of 2e groups necessitate that educators and families fully understand and focus on them to provide more suitable and effective educational assistance. The impact of learning disabilities on 2e individuals is complex and far-reaching. These obstacles not only limit their performance in specific subjects or skills but can also adversely affect their self-esteem, motivation to learn, and social aptitude.

2.4 Impact of Learning Disabilities on the 2e Group

Learning disabilities can lead to academic setbacks among individuals in the 2e group. These individuals often have elevated expectations for their learning abilities due to their intellectual prowess, but the presence of learning obstacles impedes their ability to meet these expectations, resulting in frustration and anxiety.

The 2e group may also face challenges with their social capabilities due to their learning disabilities. These difficulties can make them feel different from their peers and hinder their ability to integrate into social groups, leading to social isolation. Additionally, societal misunderstandings and prejudices toward learning disabilities can expose them to discrimination and social pressure.

Learning obstacles can have a lasting effect on the career advancement of individuals who are intellectually gifted but encounter difficulties in specific areas. These obstacles can restrict their career options and impact their professional performance, creating challenges in the workplace.

For second language learners, it is crucial to identify and address learning barriers at an early stage. This approach not only helps them overcome difficulties in learning but also enhances their overall quality of life and potential for development.

Chapter III: Identifying and Assessing the Learning Characteristics of 2e Groups

3.1 Identifying the Challenges of 2e Groups

This chapter discusses the difficulties and challenges encountered when identifying the learning characteristics of the 2e group. One of the main challenges is the presence of concomitant intellectual exceptionalism along with learning disabilities, which complicates the identification process. Traditional intelligence tests provide only a general measure of an individual's intelligence and fail to accurately differentiate between intelligence and specific learning disabilities. As a result, educators need to possess a higher level of professional

knowledge and utilize various evaluation tools and methods to comprehensively and precisely identify the learning characteristics of the 2e group.

The 2e group encompasses a wide range of learning disabilities, making identification challenging. These disabilities, such as difficulties in reading, writing, and mathematics, can significantly impact an individual's learning outcomes. Therefore, educators must have a thorough understanding of the distinct characteristics and manifestations of different learning disabilities to accurately assess them during the identification process.

Identifying the learning characteristics of the 2e group can be time-consuming and resource-intensive. Learning disabilities in this group may become apparent at different stages or in various environments, necessitating continuous observation and evaluation. Additionally, due to the unique educational needs of the 2e group, personalized teaching programs and resource support may be required, further complicating and increasing the cost of the identification process.

The limited social and school awareness of 2e groups contributes to the challenge of identifying them. Consequently, it is crucial to enhance public awareness and comprehension of 2e groups, as well as to reinforce schools' focus and assistance in educating these individuals. These measures are essential prerequisites for effectively carrying out the identification process.

3.2 Assessment Tools and Methods

To accurately and effectively assess the learning characteristics of 2e groups, a variety of professional tools and approaches are necessary. Standardized intelligence tests, such as the Wechsler Intelligence Scale for Children (WISC), are commonly employed to identify intellectual anomalies and provide detailed information on individual performance across different areas of intelligence.

Evaluating learning disabilities is a complex process that requires the use of multiple assessment tools. Developmental assessments can identify learning difficulties at specific stages of development, while functional assessments focus on an individual's performance in daily life and learning environments. For specific types of learning disabilities, such as reading disability, mathematics disability, or writing disorder, specialized assessment tools like the Woodcock-Johnson Tests of Cognitive Abilities and Diagnostic Reading Assessment can provide a thorough evaluation.

3.3 Observation and Evaluation Methods

Observation is a crucial method for assessing the learning traits of 2e groups. By closely observing individuals' behavior during the learning process, including their attention span, problem-solving approaches, and other relevant factors, one can gain a deep understanding of their learning characteristics and specific needs. To obtain a more comprehensive evaluation, it is beneficial to combine feedback from both teachers and parents.

To accurately evaluate the learning characteristics of the 2e group, it is necessary to employ a combination of tools and methodologies. This approach ensures that the assessment

results are scientific and precise, providing solid support for the development of personalized educational programs.

Individualized educational programs tailored to the learning characteristics of 2e groups require a thorough examination of students' intellectual abilities, learning disabilities, and personal interests and needs. These programs should be developed based on a deep understanding of students' unique differences and should accurately identify their learning obstacles and potential through the use of professional evaluation tools and methodologies.

When designing a program, it is important to prioritize the intellectual strengths of twice-exceptional (2e) students and utilize their exceptional learning abilities to provide stimulating and extensive learning tasks. To address any obstacles they may encounter, individualized teaching strategies should be employed. This may include adapting teaching methods and providing supportive learning tools or software to minimize disruptions to the learning process.

3.4 Implementing Individualized Educational Programs

Individualized educational programs should encompass all aspects of a student's learning process, including classroom instruction, extracurricular counseling, and family education. In the classroom, teachers can employ differential teaching methods to create tailored curricula and activities for 2e students, addressing their unique needs. Additionally, one-on-one or group coaching can be offered outside of regular class hours to assist students in overcoming specific learning challenges. It is also important to enhance family education guidance, enabling parents to gain a deeper understanding of their children's learning and provide appropriate support.

Establishing effective communication channels between parents, teachers, and 2e students is essential for the successful implementation and timely adjustment of educational programs. Regular parent meetings and teacher seminars should be conducted to promptly identify students' learning progress and challenges. By collaboratively discussing solutions, robust support can be provided for the holistic development of 2e students.

Providing sufficient educational resources and support measures is crucial for facilitating the learning and development of 2e groups. To cater to the unique learning needs of these groups, it is imperative to create personalized learning plans and teaching materials that align with their intellectual capabilities and effectively address any learning obstacles. Schools should offer a range of learning aids and technical assistance, such as specialized educational software and reading tools, to help 2e students overcome learning challenges.

3.5 Mental Health Support and Resource Integration

Support for mental health should be prioritized for the 2e group. Schools can create specialized counseling rooms to offer psychological counseling and support services, fostering a positive learning attitude and emotional well-being. Regular parental training and effective school communication will enhance parents' understanding and support for the 2e group, creating a conducive environment for inclusive education.

Integrating and utilizing social resources is crucial for supporting education for 2e groups. Governments and social organizations can create dedicated funds to finance educational projects and research for 2e groups. By establishing a resource-sharing platform, educational resources can be allocated and utilized efficiently, providing more comprehensive and professional support for 2e groups.

Chapter IV: Educational Intervention Strategies and Practices

4.1 Personalized Teaching Strategies

The development of personalized learning strategies for 2e groups necessitates a thorough understanding of each individual's intellectual strengths and the corresponding learning disabilities . Given that 2e students typically possess advanced cognitive abilities but may encounter challenges in certain domains (e.g., reading, writing, mathematics, or social skills), teaching strategies must be tailored to meet their specific needs.

Personalized teaching strategies for 2e students involve creating an individualized education plan (IEP) that is tailored to their specific learning needs and goals. This plan should clearly outline short-term and long-term objectives, as well as the specific teaching strategies required to achieve those objectives. For instance, if a student has difficulties with reading, multi-sensory teaching methods can be implemented, such as incorporating images, audio, and tactile materials to enhance their learning experience.

Personalized teaching strategies should prioritize flexibility and adaptability. Educators must continuously monitor students' learning progress and modify teaching methods and content accordingly. This flexibility is also evident in the utilization of diverse assessment tools to accurately gauge student progress. Incorporating modern technological tools is also a crucial aspect of personalized teaching strategies. For instance, employing an intelligent learning platform can offer customized learning resources and exercises based on students' individual learning styles and progress.

Effective teaching strategies should incorporate the cultivation of students' autonomy and problem-solving skills. By fostering independent thinking, promoting project-based learning, and facilitating collaborative learning, educators can enhance students' capacity to adapt to diverse learning environments and overcome challenges.

4.2 Cooperation Between Schools and Families

Cooperation between schools and families is essential for the education of the 2e group. The 2e group, characterized by high intellectual abilities but also learning difficulties, requires individualized and timely educational strategies. Schools, as the main educational institutions, should offer specialized teaching support and psychological counseling services to ensure that 2e students receive the necessary attention and support in the classroom.

Within the cooperative model, it is imperative for families to actively engage in educational activities within schools, maintain open lines of communication with teachers, and

collaborate to create a tailored learning plan for their children. As the primary environment for a child's growth, parents must comprehend and embrace their children's unique requirements, offering emotional support and understanding, while also aiding in the development of their confidence and ability to overcome challenges.

It is important for schools and families to prioritize the mental health of the 2e group and promptly recognize and address any psychological issues that may arise. By conducting regular psychological assessments and maintaining open communication with families, schools can gain a better understanding of the psychological well-being of 2e students and offer them the necessary support and assistance.

The school has the responsibility of offering professional educational resources and methodologies to ensure that 2e students have access to educational opportunities that align with their intellectual abilities. On the other hand, the family plays a crucial role in providing a strong foundation for the growth of 2e students through their education and care in daily life. By working together, the school and family can leverage their respective strengths and promote the holistic development of the 2e group.

4.3 Establishing a Proficient Support Team
Composition of the Support Team

To effectively facilitate the learning and growth of the 2e (twice-exceptional) population—individuals with intellectual disabilities and learning impairments—a well-rounded support team is essential. This team should consist of:

- **Psychologists**: To address emotional and behavioral issues, conduct psychological assessments, and provide therapy.
- **Educators**: To offer specialized teaching strategies and create inclusive learning environments.
- **Special Educators**: To design and implement individualized educational programs tailored to the specific learning needs of 2e students.
- **Medical Experts**: To evaluate and manage any medical conditions that may impact learning and development.

Responsibilities of the Professional Support Team

Comprehensive Assessment: The primary responsibility of the support team is to conduct thorough evaluations of the 2e group's learning disabilities. This involves assessing various aspects:

Cognitive Abilities: Understanding intellectual strengths and weaknesses.

Emotional State: Identifying any psychological or emotional challenges.

Learning Style: Determining how students learn best and what specific challenges they face. The evaluation should be comprehensive, ensuring that all aspects of the student's abilities and needs are accurately understood.

Individualized Educational Plans (IEPs): Based on the assessment, the team will develop tailored educational programs that include:

Teaching Strategies: Customized methods and techniques to address the unique learning characteristics of each student.

Supporting Tools: Resources and aids designed to support the student's learning process, such as specialized software or learning materials.

Ongoing Monitoring and Evaluation: The team should regularly review and assess the effectiveness of the educational plans. This involves:

Monitoring Progress: Tracking the student's development and adjusting the plan as needed.

Timely Adjustments: Making modifications to teaching strategies and resources based on regular evaluations to ensure continuous improvement.

Connecting Stakeholders

Professional support teams also play a crucial role in bridging the gap between various stakeholders involved in the education of 2e students:

- **Parents**: Providing guidance and support to help them understand their child's learning needs and how best to support them at home.
- **Schools**: Collaborating with educators to ensure that classroom strategies are aligned with the student's individualized plan and that necessary resources are available.
- **Society**: Offering advice and promoting awareness to create a more inclusive and supportive community for 2e individuals.

Goals and Impact

By establishing a proficient support team, the aim is to:

- **Provide Specialized Support**: Ensure that 2e students receive the tailored help they need to succeed academically and emotionally.
- **Promote Overall Development**: Enhance the holistic growth of 2e individuals by addressing their unique learning and developmental needs.
- **Create an Inclusive Environment**: Foster a supportive and understanding educational atmosphere that accommodates the diverse needs of 2e students.

In summary, the establishment of a proficient support team is critical for providing comprehensive and effective support to the 2e group. Through detailed assessments, individualized plans, and ongoing collaboration with parents, schools, and society, these teams can significantly contribute to the success and well-being of twice-exceptional individuals.

4.4 Education Policy Advocacy

Importance of Education Policy Advocacy

Education policy advocacy is crucial for addressing the needs of the 2e (twice-exceptional) group, individuals who possess both intellectual abilities and learning disabilities. As awareness of the unique challenges faced by this group grows among educators and policymakers, it becomes increasingly important to develop and implement policies that support their educational needs.

Objectives of Policy Advocacy

- **Enhancing Educational Equity**: Ensure that 2e individuals have equal opportunities to achieve their intellectual potential despite their learning difficulties.

- **Promoting Inclusivity**: Foster an educational environment that is adaptable to the diverse needs of 2e students.
- **Facilitating Effective Learning**: Implement policies that support tailored educational strategies and resource allocation to address the specific challenges faced by 2e students.

Key Areas for Policy Development

a. Curriculum Design
- **Specialized Courses**: Develop policies that encourage schools to offer specialized courses or programs tailored to the unique learning needs of 2e students. These courses should align with the intellectual strengths and address the learning difficulties of 2e individuals.
- **Flexible Curriculum**: Promote flexibility in curriculum design to accommodate various learning styles and needs, allowing 2e students to engage with the content in ways that best suit their abilities.

b. Resource Allocation
- **Targeted Resources**: Allocate funding and resources specifically for 2e students, including specialized teaching materials, learning aids, and technological tools.
- **Training and Development**: Provide financial and logistical support for professional development programs aimed at equipping educators with the skills needed to support 2e students effectively.

c. Teacher Training
- **Specialized Training**: Develop and implement training programs for teachers that focus on understanding and addressing the needs of 2e students. This training should include strategies for differentiating instruction, managing learning difficulties, and fostering an inclusive classroom environment.
- **Ongoing Support**: Ensure that educators have access to continuous professional development opportunities and resources to stay updated on best practices for supporting 2e students.

d. Educational Evaluations
- **Comprehensive Assessment**: Advocate for policies that mandate thorough and ongoing evaluations of 2e students to accurately identify their learning needs and monitor their progress.
- **Inclusive Evaluation Methods**: Promote the use of diverse and inclusive evaluation methods that consider both the intellectual strengths and learning challenges of 2e students.

e. Family and Community Involvement
- **Engagement Policies**: Develop policies that encourage and facilitate active family and community involvement in the educational process. This includes creating channels for regular communication between families and schools and involving families in the development of individualized education plans (IEPs).

- **Awareness Programs**: Implement programs to raise awareness among families and communities about the needs and strengths of 2e students, fostering a supportive environment for their development.

f. Long-Term Commitment
- **Sustained Support**: Ensure that policies and initiatives for 2e education are sustained over the long term, providing consistent support and resources.
- **Periodic Review**: Establish mechanisms for the periodic review and updating of education policies to adapt to new research findings and changing needs of the 2e population.

5. Conclusion

Advocating for appropriate educational policies is essential for enhancing the learning experience of 2e students and improving educational equity. By focusing on curriculum design, resource allocation, teacher training, and comprehensive evaluations, policymakers can create a supportive environment that enables 2e individuals to thrive academically and reach their full intellectual potential. The collaboration between policymakers, educators, families, and the community will be key to achieving these goals and ensuring that the needs of 2e students are effectively addressed.

Policy-makers should prioritize the involvement of families in 2E education and create policies that support effective communication and collaboration between families and schools. This will ensure that 2E education is well-supported and guaranteed. Policy advocacy should also emphasize long-term commitment and sustained support for 2E education, ensuring that policies and measures are firmly established and provide reliable support for the growth and development of 2E.

Advocating for appropriate educational policies to assist twice-exceptional (2E) education not only enhances the overall growth of 2E individuals but also plays a crucial role in fostering an inclusive learning environment that recognizes and nurtures their unique talents and needs.

Chapter V: Conclusions and Perspectives

5.1 Summary of the Study

This study explores in depth the learning characteristics and educational needs of the 2e group, which comprises individuals with an intellectual anomaly but one or more learning disabilities . The research clarifies the strengths of 2e groups in intellectual performance and the diversified learning challenges they face through an examination of relevant studies both domestically and internationally. These challenges include, but are not limited to, difficulties in reading, mathematics, and inattention, which significantly affect their learning efficiency and academic achievement.

The study found that 2e groups exhibit unique learning advantages, such as high curiosity, rich imagination, and innovative thinking. However, due to the presence of learning barriers, these advantages are often difficult to fully realize. Therefore, the paper emphasizes that the learning characteristics of 2e groups should be fully recognized and respected in educational practice. It advocates for personalized teaching strategies and resource support to cater to these unique needs.

The study underscores the crucial role of both schools and families in the education of 2e individuals. Schools are encouraged to establish professional support teams to provide the necessary educational assistance to 2e students, while families should actively engage in their child's learning process by maintaining open communication with educators and collaboratively designing tailored educational programs.

This study provides valuable insights into understanding the learning traits and educational requirements of 2e populations. It also offers a theoretical foundation and practical recommendations for improving their educational settings and learning experiences.

5.2 Future Directions

Future research should further investigate the cognitive mechanisms and learning processes specific to 2e groups. It is anticipated that advanced technological tools, such as functional magnetic resonance imaging (fMRI) and brain electromagnetism (EEG), will be employed to uncover distinct patterns of brain activity and learning processes in 2e individuals. This approach will leverage rapid advancements in neuroscience and educational psychology to deepen our understanding of 2e learning characteristics .

Additionally, the development of sophisticated analytical models using big data and artificial intelligence (AI) is expected to enhance the precision of identifying learning characteristics and predicting learning performance in 2e groups. By harnessing these technologies, educators can offer more tailored support, addressing the diverse needs of 2e students.

At the educational policy level, it is anticipated that future policies will further support the creation of comprehensive and inclusive learning environments for 2e groups. Improving collaboration between schools and families will also be essential to ensure the consistent and effective delivery of education tailored to the needs of 2e students .

5.3 Recommendations for Future Research and Practice

1. Establishing a Proficient Support Team

To support the education and growth of the 2e group effectively, it is essential to establish a proficient support team. This team should include trained teachers, psychological consultants, and special education experts with the expertise to provide comprehensive support. Emphasis should be placed on enhancing their training to ensure they possess the necessary skills and knowledge to address the unique needs of 2e students. Additionally, fostering

interdisciplinary exchanges and collaboration is crucial for advancing research and practice in 2e education. By bringing together diverse perspectives and expertise, these collaborative efforts can drive deeper insights and more effective interventions for the 2e population .

2. Developing Individualized Educational Programs

Individualized educational programs tailored to the learning characteristics of 2e students must involve a thorough examination of each student's intellectual abilities, specific learning disabilities, and personal interests and needs. These programs should be based on a comprehensive understanding of students' unique differences and should utilize professional evaluation tools and methodologies to accurately identify their learning obstacles and potential. It is vital to prioritize the intellectual strengths of 2e students, leveraging their exceptional learning capabilities to provide challenging and stimulating tasks. Personalized teaching strategies should be employed to adapt teaching methods and provide supportive learning tools or software, minimizing disruptions to the learning process .

3. Prioritizing Mental Health Support

Mental health support is a critical aspect of addressing the needs of 2e students. Schools should establish specialized counseling rooms to offer psychological support and counseling services, fostering a positive learning attitude and emotional well-being. Additionally, regular parental training and effective communication with schools will enhance parents' understanding and support of their children's mental health needs. Creating a supportive environment that includes mental health resources is essential for the inclusive education and overall development of 2e students .

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African Bird Conservation By Aayush Butala

Due to environmental changes and global industrialization, animals are dying off at drastic rates, with around 41,000 animals on the red list. In Africa, around 26,000 animals are endangered with approximately 245 species of birds facing extinction throughout the African landscape ("IUCN Red List of Threatened Species"). The loss of birds has affected the biodiversity of many ecosystems and food chains. According to Emmanual Okeke from the Department of Biochemistry at the University of Nigeria, "The food chain is the sequential steps through which energy or nutrients are transferred from primary producers through the elementary consumers to the decomposers in an ecosystem; the food chain is pivotal to the sustenance of life" (Okeke et al. 1). As birds continue to perish across Africa these food chains suffer as animals who feast on birds proceed to face a lack of food, while the prey of birds grows exponentially in population causing significant ecosystem imbalances. Concerns for the populations of birds have been expressed as S.R. Wotton, senior researcher for the RSPB, states, "Countries need to conserve biodiversity and utilize natural resources wisely if they are to avoid, halt and reverse ongoing environmental degradation." (Wotton et al. 3). Without conserving biodiversity throughout Africa birds and many other animals will face a large decline in population. The prominent decline of birds can be attributed to many factors, such as pesticide use, urbanization, and habitat loss. Even though preserving the biodiversity of birds throughout Africa should be the priority, people constantly argue against it. Due to the economic benefits of urbanization and hunting, many African residents believe these economic benefits outweigh the negatives of biodiversity loss. To combat the issues that birds go through, increasing biodiversity indicators would allow scientists and institutions to conserve birds effectively. With all these negative impacts in mind, the question to be proposed is: To what extent can scientists preserve the biodiversity of birds in Africa?

Habitat loss is a considerable issue for birds because new buildings are constantly being constructed whether it's for urbanization or other commodities, causing eminent biodiversity loss for birds throughout Africa. According to Jafari Kideghesho, core contributor to the Faculty of Forestry and Nature Conservation at the Sokain University of Agriculture, "Human population growth has profound direct and indirect effects on consumption patterns of land and wild resources and is one of the major challenges facing wildlife-rich areas in Africa" (Kideghesho 2). Africa is one of the fastest-growing countries as it is only in stage 2 of the demographic transition model. As Africa continues to grow at a very fast pace habitats will be destroyed affecting the nesting sites in which birds reside. Pepper Trail from the United States Fish and Wildlife Service affirms Jafari's claim by stating how the populations of Hornbills were negatively affected by habitat destruction throughout Africa. Both have shown the impact of habitat destruction as human interference has affected wildlife-rich areas, including the Hornbill population throughout Africa. Pepper states, "The drastic decline of Yellow-casqued Hornbills in Nigeria was attributed to forest destruction (Kemp 1995), and loss of gallery forest

in the savanna zone was associated with the disappearance of the species in a protected area of Ivory Coast" (Trail 610). As the surface area of forests declines, the population of birds declines, as seen through the African Hornbill. Christos Memmidas from the nature conservation unit at Frederick University contributes to the previous claims by further stating that shorter habitat distances have possessed a negative effect on most bird species across Africa. As the previous authors stated the negatives of habitat destruction, Memmidas further contributes by posing the data he found on the effects of habitat destruction on birds in Africa. "The negative effect was mediated through changes in the forest's vegetation structure and composition. Shorter distances to the forest edge also hurt all bird categories" (Memmidas et al. 2). As stated by the claims above, habitat destruction is a common negative to most birds and wildlife in Africa. As it continues to happen, it harms the biodiversity of many species. The loss of habitats prevents birds from gathering food causing mortality rates to rise. Hence habitat loss is extremely injurious to birds' populations as many necessities are lost.

        Urbanization has negatively affected birds throughout Africa; though many birds can often adapt to urban environments, it doesn't come without long-lasting negatives. Caroline Isaksson, from the Department of Biology at Lund University, states, "in warmer or tropical regions, the urban heating effect can be devastating for birds, leading to heat stress and dehydration" (Isaksson 236). Africa is a very tropical area, and as urbanization rises in Africa birds will be devastated by the effects of dehydration and heat stress. Sanjo Rose, a researcher at UCT, agrees with Isaksson by further stating how urbanization constantly affects birds throughout the African landscape. With the constant difference in urban areas, many different factors can enormously affect birds, whether it's nesting sites or problems with heat. Rose states, "Key processes that contribute to the impact of urbanization on birds include vegetation changes, habitat fragmentation, the introduction of exotic species, changes in food abundance and quality, and novel predator assemblages" (Rose et al. 1). With how different urban areas are for birds the plethora of confounding factors will cause bird populations in urban environments to decline at alarming rates. With all these different factors, birds are strongly impacted by growing urban environments. Eric Bender, an accredited scientific writer, clarifies Rose's and Iskasson's evidence by stating how genetic biodiversity dwindles in Urban areas because as biodiversity dwindles, it becomes a constant detriment to birds as the species they feast on die, causing birds to die as well since they can't find food. Unfortunately, the genetic biodiversity that can fuel adaptation often dwindles in urban areas. (Bender 8). Urbanization is an extensive issue throughout Africa as it lacks nesting sites making it hard for birds to adapt to new circumstances. As birds face constant detriments throughout the Urban landscape, breeding rates are lowered along with the fact that temperature changes cause issues among birds as well. With Africa continuing to urbanize birds will die off causing harm to other species and predators throughout African urban areas.

        As the agricultural and hunting industry grows in Africa, it is poisoning populations of birds via pesticides and lead. Poisoning in birds leads to neurological and tissue failure in birds. "PbB compared in wild and captive birds. 31% of wild birds appeared to be exposed to an

additional source of lead than purely environmental presumed to be ammunition" (Pain et al 941). Deborah J Pain from the Department of Zoology at Cambridge University found an overwhelming amount suffered from lead poisoning. Even if birds aren't killed by bullets the lead in ammunition can harm birds. Furthermore, Julia Watson, TED Talk speaker, and architect builds on the previous claim by providing evidence on how fish help prevent poisoning in the water, yet governments are preventing it from occurring. She states, "lanked by a smoking escarpment of the city's trash and ribboned by its highways, an Indigenous technology of 300 fish ponds cleans its water while producing its food" and "Calcutta is now struggling to save it from being displaced by development." (Watson 00:03:59-00:04:22). With the fish providing fresh poisonless water other factors are preventing it from staying affecting the birds' populations and city infrastructure. Darcy Ogada, an ornithologist for the National Museums of Kenya, agrees with these previous claims by adding ways that pesticide poisoning has caused a prominent decline in the duck population. By further supporting these claims, she strengthens the argument against the adverse effects of pesticides on birds. Ogada claims, "for over 20 years, bird poisoning in Kenya's rice schemes originally targeted ducks. However, many species of ducks have been significantly reduced and/or eliminated in Kenya's rice schemes, likely because of pesticide poisoning" (Ogada 12). With the increase of pesticide use throughout the world and especially in Africa, where the agriculture sector is prominent, continued pesticide use will cause a major decline in bird biodiversity. Poisoning affects birds in many ways and causes a multitude of issues for other ecosystems as well.

Bird conservation provides a multitude of benefits to African ecosystems, but with increased conservation comes negative effects on the African economy. Melville Sayaans a tourism researcher at NorthWest University found that "In total, it can be said that trophy hunting supports 17,685 job opportunities in South Africa, with 46.2% of these opportunities being in the agricultural sector. This is very important since agricultural activities are concentrated in rural areas where there is a dire need for employment" (Sayaans 10). Every year thousands of animals, including birds, are hunted across Africa, leading to major population declines but with how many jobs the hunting industry provides, it is key to the African economy. With the number of people that hunting helps throughout the African landscape. P.A. Lindsey from the Tropical Resource at the University of Zimbabwe adds to the previous claim by further stating the economic benefits it brings to the African economy. "Trophy hunting is permitted in 23 sub-Saharan African countries. Using the most recent estimates for the countries with significant hunting industries, where estimates are available, we estimate that trophy hunting generates gross revenues of at least US $201 million per year in sub-Saharan Africa: from a minimum of 18,500 clients" (Lindsey et al. 457). The economic benefits that hunting provides to the African economy are vital to fighting poverty and unemployment rates in Africa. Africa is in its very early stages of growth, meaning the hunting industry's economic benefits are vital for providing jobs and fighting poverty. This is why a mass of people argue for hunting in Africa, even if it harms the economy. Though the African hunting industry provides money to

the economy, the loss of birds is too detrimental as it harms many other ecosystems and can lead to environmental issues.

With the constant turmoil that birds face throughout the African landscape, increasing biodiversity indicators for birds would allow scientists to conserve birds at a greater rate. Increasing biodiversity indicators for birds allows scientists to gather more accurate and feasible data on population trends for birds across Africa. By using technology, scientists will be able to gain a better understanding of the population trends that birds are facing. This allows them to find the main reason why birds are dying, allowing them to act upon it rather than allowing birds to steadily decline in population. SR Wotton senior researched this solution and stated, "Programmes to monitor populations of breeding birds, covering predominantly terrestrial habitats, have become established in many European and North American countries since the 1960s. Across Europe, there are currently 39 national monitoring schemes, and the Pan-European Common Bird Monitoring Scheme (EBCC 2017) uses species indices from annual surveys of breeding birds in 28 countries to produce European and European Union (EU) bird indices. " (Wotton et al. 4). As seen in Europe, this solution works and can help institutions and laboratories preserve the biodiversity of birds and even other species. Though this solution would be extremely efficient, the amount of money and technology it would take to run this solution would be a limitation. But with adequate funding, interns, and volunteers across the world, this solution could be implemented seamlessly. Hunters would be greatly impacted. As population statistics become more readily available, different policies will be implemented to prevent the overhunting of animals. This will affect the amount of money and jobs that are present for hunters. Due to how this solution would greatly impact ecosystems, the economic negatives are not enough to outweigh the positive implications proposed by this solution. As birds continue to die off, it affects many other species as food chains are greatly disturbed, and biodiversity is lost. This affects ecosystems due to the exponential decline of species-affected trees and animal growth. But if biodiversity indicators for birds are increased, these issues can drastically decline, and solutions for birds can be properly implemented.

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The Formation, Growth, and Evolution of Supermassive Black Holes Across Cosmic Time
By Sarang Athani

1. Introduction

Black holes, the mysterious yet fascinating objects that dot the universe, are becoming increasingly important to study in modern physics and astronomy. Black holes play an important role in galaxy evolution and controlling cosmological debris within galaxies, along with defining the shape of galaxies and manipulating the space around them.

In order to understand the significance of these black holes, first one needs to understand the foundations. The first black hole, Cygnus X-1, was discovered in 1971 (Colin Stuart, 2024). Black holes such as Cygnus X-1 are made up of several parts: there is the accretion disk, which is a collection of very hot gas and dust that rotates around the black hole and helps grow it; there is the event horizon often called "the point of no return"; and there is the singularity which resides at the center of a black hole.

The outermost layer of the black hole is called the event horizon. Once anything passes the event horizon, it cannot escape it. For example, let us say a particle crosses this boundary. The gravity is so strong that the particle's velocity would need to exceed the speed of light in order to escape. General relativity concludes that as an object moves faster, its mass would increase as well which correlates to an infinite energy, which is not possible. These constraints make it impossible to exceed the speed of light; thus, the particle would be stuck within the event horizon. This is why it is often called "the point of no return". In fact, the gravity is so strong that not even light can escape a black hole's event horizon. It is also important to consider what happens when one approaches the event horizon but does not cross it. This is when properties such as time dilation show up. As an observer moves closer to the event horizon, time appears to slow down due to the extreme curvature of space-time (Neil Asbhy, 2003).

The singularity is a point of infinitely small volume where all the matter gets directed to. Because all matter that enters the black hole is pushed into an infinitely small point in space, all laws of physics break down. This is what makes black holes especially interesting. Black holes are very important to study because of their interesting qualities such as extreme time dilation, and serve as a way to experimentally test scientific theories such as Einstein's Theory of Relativity and learn more about the physical laws that govern the universe.

There are two basic types of black holes in the universe: supermassive black holes (SMBHs) and stellar-mass black holes. Supermassive black holes are significantly different from their counterparts because of their size. SMBHs are classified by having a mass larger than 10^5 solar masses , which is significantly more massive than an average stellar black hole. For example, a typical stellar black hole's mass could be about 3 to 4 solar masses while a supermassive black hole's mass could be more than 10^8 times the mass of the sun (Swinburne

University, n.d.). The average size for an SMBH is typically just above 10^5 solar masses. Along with the differences of mass, supermassive black holes form differently than stellar black holes (SMBHs typically form from the combination of stellar black holes while stellar black holes form from the death of massive stars).

Before exploring black holes, it is important to consider the basics of how scientists observe them. Black holes manipulate the space around them because of the intense gravity. This causes stars and gas around black holes to act differently. By observing the orbits of stars near the center of galaxies, scientists are able to conclude that black holes indeed do exist, and new theories can be made about them.Through closely studying black holes, scientists have come to several conclusions. First, nearly every large galaxy in the universe has a SMBH in its center. This point has raised many questions about galaxy and black hole coevolution. In this review, we explore the formation of black holes in the early and modern universe along with the observation of black holes, the evolution of black holes, the growth of black holes, and many theories that revolve around black holes relating to their host galaxies.

2. Black Hole Formation

Black holes can form as the result of many different cosmic events such as the explosion of large stars at the end of their lifetimes, the merging of certain types of stars such as white dwarfs and neutron stars, and even through the collapse of dense pockets of gas in the early universe (M.A Latif et al., 2018). Before exploring these channels, we first explore the formation of a star. Star formation typically occurs in large and massive clouds of gas and dust called molecular clouds (e.g. the Carina Nebula). In these large molecular clouds, gas and dust gradually collapse due to the pressure of gravity. Over a long period of time, the accumulation of dust and gas at extremely high temperatures creates a star.

2.1 Standard formation mechanism: Stellar Explosions

Typically, stars throughout most of their lifetime remain hot enough which produces a high pressure through the process of nuclear fusion. This pressure acts as a counter-force to gravity which pushes inwards on a star. The star maintains this high pressure (remains stable) for millions or even billions of years. This high pressure is from the fusion happening within the star. The process of nuclei mergers to create heavier nuclei happening rapidly in the sun's surface exerts the outwards pressure which pushes on the star to counteract the gravity (DOE n.d.).

Fig. 1: Diagram representing the balance of forces keeping a star stable. Figure taken from (Olson, 2011).
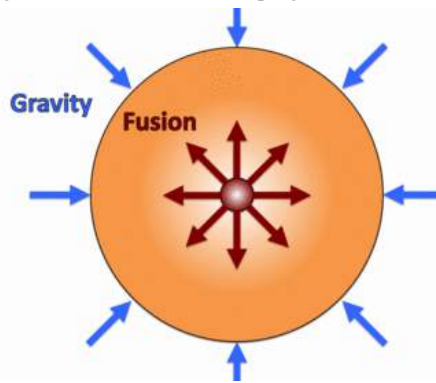
As seen in Figure 1, the fusion reaction created by the nuclei mergers balances out with the gravitational forces pushing into a star. This balance of gravity and fusion reactions allows a star to remain stable.

Of course, the star eventually burns through all of its fuel and starts its cooling process. The processes that fuse hydrogen into helium are limited. Pressure within a star decreases, and gravity prevails as the stronger force in the system; the star becomes unstable. When this happens, the force of gravity can cause the star to collapse on itself which results in the explosion physicists call a supernova. These supernovae leave behind a black hole. Of course, the star needs to be massive enough for a black hole to form. For example, the star could be very massive but not massive enough to go supernova. This could create a neutron star. If a star is even less massive, the star can become a white dwarf. Stellar explosions are the most common black hole formation processes that happen in the universe.

2.2 Binary Evolution and Formation Pathways

Stars do not always end in supernovae at the end of their lifetimes. Depending on the mass of the star, many different outcomes can occur. Typically, when a star is at a low mass to begin with, when it reaches the end of its lifetime, it expels some of its mass, more specifically its outer layers, into space. The resulting astrophysical object, which is the carbon/oxygen rich core left behind, is called a white dwarf. There is also the possibility that a star that is very massive, not massive enough to result in a black hole, however, exhausts all of its fuel and becomes a neutron star. A neutron star is created when a star begins its collapsing process as any other star would do but instead of going supernova, all of the protons and electrons in the core get crushed together into neutrons (NASA, 2017). The resulting object after these events is the Neutron Star. When these stars are simply created without being locked into a binary, the stars will usually remain stable and last for a very long time. When the two star creating processes happen very close to each other, the two stars that are created can become gravitationally locked in a system called a binary (Harvard CFA, n.d.). There are many different possibilities that can take place in these binaries. One situation is when a white dwarf is locked into a binary with another star. Sometimes when two stars are created in a binary system, one star could be more massive than another star causing it to be further on its evolutionary cycle.

This can allow a white dwarf-red giant binary to occur. In these binaries, the white dwarf can actually accrete gas from its red giant companion causing it to grow.

Fig. 2: White dwarf accreting gas from its red giant companion star in a binary star system. Figure taken from Chandra XRay Observatory, 2018

In Figure 2, the white dwarf is seen accreting gas from its red giant companion in the binary system. Through this process, the white dwarf can gain enough mass and exceed its Chandrasekhar limit (the maximum mass a white dwarf can obtain before going supernova) (Daniel Blatman et al., 2024). This scenario does not create a black hole since white dwarfs are not massive enough. However, there is also the possibility for neutron stars to be locked in a binary. When any star is locked in a binary, eventually the stars lose energy through gravitational waves and slowly reach close enough to collide. When neutron stars collide, their combined mass can be large enough to create black holes. There are rare situations in which a neutron star and white dwarf binary can create black holes as well. For example, if a white dwarf is near its Chandrasekhar limit and a neutron star is close to its critical mass threshold, this system could have enough mass to result in a black hole. Through the same process of gradual energy decline, the two stars can reach collision and coalescence (the merging of objects to form a whole). The resulting astrophysical object can be a star massive enough to create a black hole when going supernova.

2.3 Direct Gas Collapse

In the early universe, there was the possibility for large, dense clouds of gas to have imploded on themselves (in the early universe, the collisional excitation of the H_2 molecules is the only way for dense and hot gas to cool and collapse (Kohei Inayoshi et al., 2019)) which in result, would have created a black hole "directly". This process is only possible in a low metallicity universe, as the presence of metals provides more efficient cooling channels, leading to fragmented, efficient collapse.

In the early universe, large clouds of gas could have slowly interacted and accumulated because of gravity into a very dense, larger cloud of gas. Because of the dense nature of these clouds, the gravity could have caused these clouds to collapse on themselves. As these clouds imploded on themselves, large amounts of heat, because of kinetic energy, would have been generated which would have also created large amounts of outward pressure. In order for a black hole to form, this outward pressure cannot be present so the gas needed to have cooled down. In terms of metallicity, because metals have a lot of electrons, many new processes are

enabled such as metal line cooling which facilitates the cooling of gas. Metal line cooling facilitates this process because it fragments gas into lower masses which remain fairly small which in turn, can collapse faster. In the early universe, there was little to no metallicity which means that gas cooling would have been a lot more slowed down because of the lack of metal line cooling. As a result, instead of small fragments of gas which would have created many low mass stars, the gas would have resulted in one, very massive star. These are known as Population 3 stars which remain very arcane to scientists today (Bernard J. Carr, n.d.). The direct gas collapse could have also created a black hole by skipping all of the star formation processes. This resulting black hole would have a mass that is higher than one that was created by stellar explosion for example.

Scientists have observed galaxies at fairly high redshifts which they suspect host black holes that could have been created from direct gas collapse in the early universe. At the redshifts observed, black holes created from stellar explosions would not have obtained the very high masses observed, so they suspect these galaxies host direct gas collapse black holes.

3. Black Hole Growth and Evolution

Black holes, both supermassive and stellar, have many different ways of growing. The most basic of these methods is accretion. Along with accretion, large astronomical events such as the collision of galaxies with supermassive black holes can cause brief periods of growth. Also, binary systems with a black hole and a neutron star for example can cause stellar black hole growth (NASA JPL, 2022).

3.1 Galaxy Collisions (SMBHs)

Over long periods of time, large astrophysical objects such as stars, dense clouds of gas, or even galaxies can come together and collide because of gravity. The growth of black holes can be seen when two galaxies collide (Harvard CFA, n.d.). Galaxies always have angular momentum present. This is what keeps the galaxy itself rotating along with the accretion disc. When galaxies such as the Milky Way and the Andromeda collide, their black holes merge together. When two supermassive black holes merge, the mass of the new black hole is almost twice the mass of the original black hole. Along with this period of black hole merging, the accretion discs orbiting the black holes for the respective galaxies can actually collide and cause disturbances to the angular momentum keeping the gas and dust orbiting the black hole. These events cause large amounts of gas and dust to flow into the black hole at once which causes large periods of accretion. With both the black holes merging along with gas and dust flowing into the center, the supermassive black hole can grow to extremely large masses.

3.2 Growth from Partner Star (Stellar Black Holes)

Stellar black hole growth is quite different from SMBH growth because stellar black hole growth is not affected by what the galaxy as a whole is doing. Stellar black hole growth typically happens when a black hole and a star are in a binary system. This could be a neutron

star and black hole binary or a white dwarf and black hole binary for example. As a star goes through its evolutionary cycle, it goes through a period of expansion. In the binary, with an expanding star and a black hole, the gas from the expanding star's surface can be gravitationally pulled towards the black hole causing the star to be deformed. The shape of the gravitationally affected star is often described as a teardrop shape. As the star continues to expand, the gas can be transferred into the accretion disk of the black hole in the binary system which can lead to black hole growth.

Black holes can evolve in several ways. A standard way a black hole can evolve is simply by continuing its accretion and growing processes. During these periods, black holes can emit x-rays which are observable along with creating large jets which can be detected. Black holes can also be in a state of quiescence meaning it is in a period of no accretion or growth. When talking specifically about supermassive black holes, black holes and host galaxy coevolution can be seen. Supermassive black holes are so large that during periods of accretion, they can affect their surroundings. This can be seen when black holes inject heat into the surroundings which can limit star formation processes throughout the galaxy (Kohei Inayoshi et al., 2019). Unlike stellar black holes, SMBHs have observable effects on their host galaxies.

4. Black Hole Observation

Black holes manipulate the space around them because of their large gravitational force. This causes large amounts of gas and dust to orbit around the black holes at intense speeds. The reason why the gas and dust orbiting the black hole does not all collapse into the center of the black hole is because of angular momentum. As the gas and dust particles interact through friction, large amounts of light is released. The ring that is formed around the black hole due to the large amounts of gas and dust orbiting around it is called an accretion disc. Accretion is simply when a black hole consumes matter around it which causes the growth of a black hole. Smaller accretion disks typically correlate with smaller black hole masses, and larger accretion disks correlate with greater black hole masses. Accretion discs are very important when studying black holes because we rely on them to detect black holes. Because the processes that happen within an accretion disc result in extremely hot byproducts, these discs emit x-rays that can be observed. Along with helping with detection, accretion discs can help us measure the mass of a black hole. Scientists take advantage of the Doppler Effect, which describes how the wavelength of a wave can change as its source moves towards or away from an observer. The Doppler Effect consists of two categories of wavelength shifts: redshift and blueshift. Redshifting is the result of objects moving further away from an observer, which causes the wavelength of the light being emitted from said object to be stretched. The opposite happens when an object moves closer to an observer. As the wavelength gets shrunk, frequency increases which results in the perception of a blue light on the visible light spectrum.

The Doppler Effect suggests many interesting conclusions about the universe and objects within it. For instance, it suggests that black holes are spinning. Through observation, it is seen that some of the light in front of a black hole turns blue while the light on its opposite

side turns red. This simultaneous moving towards and away from an observer indicates that the black hole is spinning. In relation to accretion disks and black hole masses, the Doppler Effect can be used to find the velocity of the accretion disc indirectly using spectroscopy, more specifically, reverberation mapping. Reverberation mapping is a technique used by scientists to solve for the mass of black holes using emission lines (B.M Peterson et al., 2004). In order to understand this, the equation

$$GM_\odot = fR(\Delta V)^2 \tag{1}$$

needs to be considered. The ΔV in the equation is the change in velocity which can be solved for using the doppler effect and analyzing the broadened emission lines. When measuring the value, ΔV, the accretion disc itself cannot be measured because it is too small. It simply produces ionizing radiation which spreads out into nearby gas clouds that encompass the accretion disc. These gas clouds are what is measured with spectroscopy which gives the value for ΔV. Along with this value, measuring the radius is also a factor to measuring the mass of the black hole. The problem with simply measuring the accretion disk is, it is too small to measure. For example, it would be similar to measuring a grain of rice in Argentina, from China (antipodal countries, direct opposites on Earth). The way scientists measure the radius of the accretion disk is using the emission lines from both the accretion disk and the ionized gas clouds surrounding the disk. If the accretion disk suddenly gets brighter, the emission lines of the disk would also get brighter. If the light from the disk hits the cloud first and then hits earth, there would be some delay. By observing these emission lines, an estimated radius of the disk can be solved for. Using the values for velocity and radius, the mass of the black hole, $M_\odot$, can be solved.

Another aspect of black holes that is important to observe is the luminosity of the accretion disc. Luminosity is simply the measure of how much energy an astronomical body can radiate. Luminosity helps one figure out how much a black hole can accrete. This is because accretion and luminosity are directly proportional (Kim Coble et al., n.d.). As the black hole accretion rate rises, so too does the luminosity. As luminosity and accretion increase, the amount of material accreted eventually reaches a maximum. This maximum is called the Eddington Limit or Eddington Luminosity (Kohei Inayoshi et al., 2019). At this point, the radiation force, which pushes outwards from a black hole, reaches its equilibrium with the gravitational force pulling inwards. This is known as hydrostatic equilibrium. The Eddington Limit is a very important property of black holes that scientists want to observe because it helps set a limit on a black hole's mass, which can further inform scientists about the environment surrounding a black hole and the formation of the black hole.

5. Summary

In this review, we have covered the basic foundations of black holes along with the growth of supermassive and stellar mass black holes through galaxy collisions and binary systems, the formation of black holes throughout cosmic time with processes such as direct gas collapse, large stellar explosions, white dwarf/neutron star interactions, and the way black holes evolve throughout time. We have also discussed the way scientists observe black holes with the

Doppler Effect and observing emission lines through spectroscopy and reverberation mapping, along with observing black hole luminosity and the way scientists use luminosity to figure out Eddington Limits and the general mass of black holes.

6. Acknowledgements

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Satellite Position and Velocity Prediction Using ML
By Atishay Jain

Abstract

This research investigates the use of machine learning (ML) models to improve the accuracy of satellite position and velocity predictions, crucial for space collision prediction and prevention. The study explores various ML techniques, including Random Forests, Support Vector Machines (SVMs), Support Vector Regression (SVR), and Gaussian Process Regression. By analyzing historical satellite data, these models demonstrated significant improvements in aligning predicted positions with actual data, thereby enhancing collision risk mitigation in Low-Earth Orbit (LEO). Theoretical foundations include the integration of ensemble and kernel-based methods to manage complex, non-linear satellite trajectory relationships. The methodology encompasses literature review, data analysis, and model evaluation. The findings suggest that combining multiple ML techniques, such as Recurrent Neural Networks (RNNs) and Convolutional Neural Networks (CNNs), may offer further predictive accuracy improvements. This research underscores the potential of advanced ML models in ensuring the safe and sustainable operation of satellites, essential for global communication and scientific exploration.

Index Terms - Machine Learning, Satellite Position Prediction, Space Collision Prevention, Low-Earth Orbit

I. Introduction

Background

In this new age of humanity where information is paramount, satellites play a critical role in facilitating global connectivity and exploration of the cosmos. Satellites transmit data essential for internet connectivity, entertainment, communication, and scientific research. However, ensuring the safety and integrity of satellites is imperative for the continuous progression of mankind. One of the primary challenges in safeguarding satellites is the risk of collision with other satellites, space debris, or celestial objects like asteroids. To address this challenge, innovative solutions leveraging technologies such as Machine Learning (ML) are being explored. ML, a subset of artificial intelligence, empowers computers to learn from data patterns, enabling computers to predict potential collision risks and optimize satellite maneuvers to mitigate these risks effectively. By integrating ML algorithms into satellite collision avoidance systems, the safety and longevity of satellite missions can be enhanced, ensuring the pivotal role of satellites in shaping the future of humanity's exploration and connectivity endeavors and predicting the Probability of Collision of a Satellite in Space.

Research Question

How can machine learning be employed to more accurately calculate the anticipated position of a satellite using its previous position and velocity, to enhance space collision prediction and prevention research?

II. METHODOLOGY

Machine learning (ML) has revolutionized many fields by creating more accurate predictions from complex data. In space research, particularly satellite orbit prediction and collision prevention, ML shows great promise. This section discusses using ML models to enhance the accuracy of calculating a satellite's position from its historical data. The primary research question is: How can ML be used to improve the accuracy of satellite position calculations, thereby enhancing space collision prediction and prevention?

This research aims to advance satellite orbit determination, crucial for space safety. The following subsections cover the selection, description, implementation, and evaluation of various ML models tailored to this challenge, highlighting both theoretical foundations and practical applications in space science.

Random Forest Regression Model

[5] Random Forests are advantageous for improving satellite position prediction in space collision prevention due to their ability to handle complex, nonlinear relationships in orbital dynamics. This ensemble method aggregates predictions from multiple decision trees, reducing overfitting and enhancing robustness against noise and outliers, improving generalizability to unseen trajectories.

Additionally, Random Forests effectively capture variable interactions, modeling intricate gravitational forces and orbital perturbations for accurate satellite position forecasts based on historical data. This capability is vital for precise space collision prediction and prevention.

However, challenges include the computational complexity of training with large datasets and numerous features, making rapid predictions difficult. Furthermore, interpreting results is challenging due to the model's black-box nature, unlike simpler models of linear regression.

Gaussian Model

[6] Incorporating Gaussian models, such as Gaussian Process Regression (GPR), alongside Support Vector Machines (SVMs), can enhance satellite position and velocity predictions for space collision prevention.

GPR offers a probabilistic approach, modeling complex nonlinear relationships in satellite orbits and providing uncertainty estimates alongside predictions. This is crucial for risk assessment and decision-making in orbit prediction. GPR's flexibility allows it to handle various data types and incorporate prior knowledge through covariance functions (kernels), accurately modeling intricate satellite dynamics and providing quantifiable uncertainty, which improves collision probability assessment and avoidance reliability.

GPR is also effective with small datasets, common in satellite prediction tasks. Its Bayesian framework updates predictions as new data becomes available, enhancing accuracy over time, which is beneficial for real-time applications needing frequent updates. However, GPR's computational complexity is a challenge, especially with large datasets, as it involves covariance matrix inversion that scales cubically with data points. Sparse approximations and optimization techniques can mitigate this to some extent. The choice of kernel and hyperparameter tuning is crucial for GPR's performance, and while it provides uncertainty estimates, its interpretability can be complex due to its probabilistic nature.

Support Vector Regression Model

[7] Support Vector Regression (SVR) enhances satellite position prediction in space collision prevention by effectively modeling complex, nonlinear relationships, such as gravitational interactions and orbital perturbations. SVR uses kernel functions to map input data into higher-dimensional spaces, allowing it to identify linear relationships even in nonlinear data. SVR's principle of structural risk minimization finds a hyperplane that maximizes the margin between support vectors, improving prediction accuracy and robustness against overfitting. This focus on critical data points helps generalize well to unseen satellite positions. Additionally, SVR's flexibility in handling diverse satellite trajectory data ensures accurate forecasts, crucial for collision prediction and prevention.

However, challenges include selecting appropriate kernel functions and tuning hyperparameters like the regularization parameter (C) and kernel parameters (e.g., gamma). These choices significantly impact SVR's performance, requiring thorough experimentation and cross-validation. SVR can also be computationally demanding, particularly with large datasets or complex kernels, as training involves solving a quadratic programming problem. Efficient algorithms and parallel computing can help mitigate these challenges, improving SVR's scalability for large-scale satellite trajectory datasets.

III. RESULTS

The outcomes of the study aimed at improving space collision prediction and prevention achieved by using machine learning (ML) models are presented in this section. The rise of satellite numbers around the world for purposes like global communication and science has created a need to protect them from crashes with space debris or other celestial bodies. The research sought to increase the accuracy of predicting satellite positions using past data, which is vital in LEO risk mitigation and ensuring the continuity of satellite missions. In particular, various ML techniques including Random Forests, Support Vector Machines (SVMs), and Multi-Layer Perceptron (MLPs) were evaluated to improve the knowledge base and building capacity on space collision avoidance. It is in these following parts that we learn about what happened regarding their performance, and what they meant for safe sustainable utilization of the outer Earth surface.

In this section, results from using the Random Forest machine learning model to improve space collision prediction and prevention are explained. Concerning satellites as a mainstay for global connections and scientific explorations, more efforts have been put in place within a short period to help hinder their vulnerability from colliding with space debris or planetary bodies. To avoid Low-Earth-Orbit risks due to collisions between satellites it was necessary to get more accurate satellite position estimates based on historical observations. Various methods such as Random Forests, Support Vector Machines (SVMS), Multi-layer Perceptron (MLPS), etc were examined with a view of informing better understanding & ability to avoid accidents happening in the universe. These sections discuss how well they performed, as well as what their achievements meant concerning safer sustainable exploitation of space resources.

With the help of the Random Forest machine learning model outlined hereunder some results can be seen regarding enhancement in forecasting so that there are fewer incidents leading up to harmful events involving spacecraft being hit by meteoroids or space debris items falling off into outer space. Satellites have been utilized to provide global connectivity and carry out scientific research, thus rendering these resources highly vulnerable to cooperation with damage from debris or other celestial objects. The following, sections give a deeper view into how much they scored in their use and applicability towards making space safe and sustainable.

Random Forest Regression Model

The study aimed at enhancing space collision prediction and prevention through machine learning (ML) models, specifically focusing on the data range of 1-200. The comparison between predicted satellite positions and ground truth positions revealed that the Random Forest ML model did not perform well. The predicted positions showed significant deviations from the ground truth positions, indicating poor accuracy in satellite position predictions.

For the larger data range, the results were similarly disappointing. The predicted satellite positions often diverged from the ground truth, showing that the Random Forest ML model is currently inadequate for providing reliable satellite position predictions. This inconsistency highlights the need for further refinement of the model to improve forecasting accuracy.

Gaussian Model
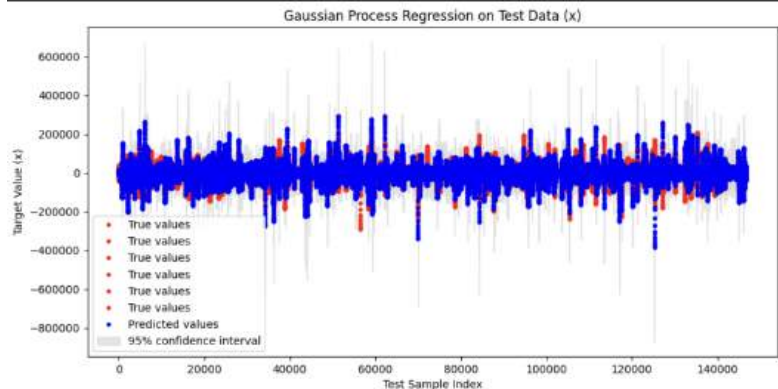
The graph, titled "Gaussian Process Regression on Test Data (x)," compares true satellite positions (red dots) with predicted positions (blue dots) across a wide range of data points, with a 95% confidence interval represented by the grey shaded area. The y-axis represents the target value (x) of satellite positions, while the x-axis represents the test sample index. The close alignment between the true values and predicted values within the confidence interval indicates that the Gaussian Process Regression model effectively improves the accuracy of satellite position predictions. This accuracy is crucial for mitigating Low-Earth Orbit (LEO) risks, ensuring the continuity of satellit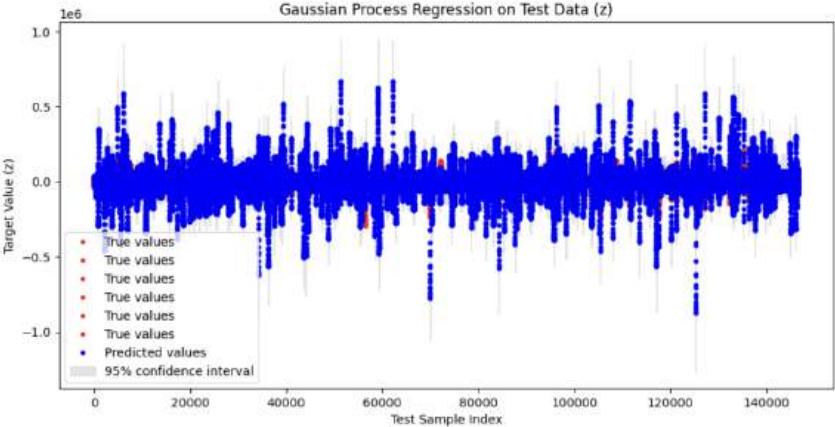e missions, and preventing harmful collisions. Enhanced forecasting accuracy contributes significantly to the safe and sustainable use of space resources.

The graph, titled "Gaussian Process Regression on Test Data (y)," compares true satellite positions (red dots) with predicted positions (blue dots) across a wide range of data points, with a 95% confidence interval represented by the grey shaded area. The y-axis represents the target value (y) of satellite positions, while the x-axis represents the test sample index. The dense clustering of blue dots around the true values within the confidence interval indicates that the Gaussian Process Regression model effectively improves the accuracy of satellite position predictions. This accuracy is crucial for mitigating Low-Earth Orbit (LEO) risks, ensuring the continuity of satellite missions, and preventing harmful collisions. Enhanced forecasting accuracy contributes significantly to the safe and sustainable use of space resources.
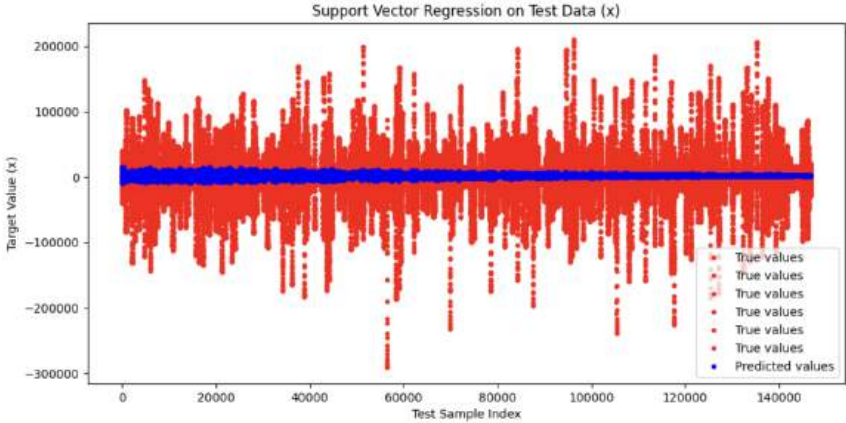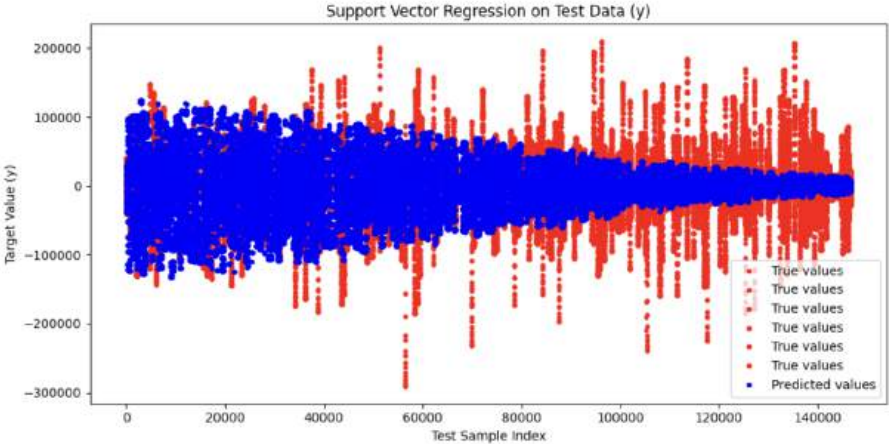
The graph, titled "Gaussian Process Regression on Test Data (z)," compares true satellite positions (red dots) with predicted positions (blue dots) across a wide range of data points, with a 95% confidence interval represented by the grey shaded area. The y-axis represents the target value (z) of satellite positions, while the x-axis represents the test sample index. The close alignment between the true values and predicted values within the confidence interval indicates that the Gaussian Process Regression model effectively improves the accuracy of satellite position predictions. This accuracy is crucial for mitigating Low-Earth Orbit (LEO) risks, ensuring the continuity of satellite missions, and preventing harmful collisions. Enhanced forecasting accuracy significantly contributes to the safe and sustainable use of space resources.

The graph, titled "Support Vector Regression on Test Data (x)," compares true satellite position values (red dots) with predicted position values (blue dots) across a wide range of data points. The y-axis represents the target position value (x) of satellite positions, while the x-axis represents the test sample index. The dense clustering of blue dots along the true values indicates that the Support Vector Regression model effectively improves the accuracy of satellite position predictions. This accuracy is crucial for mitigating Low-Earth Orbit (LEO) risks, ensuring the continuity of satellite missions, and preventing harmful collisions. Enhanced forecasting accuracy significantly contributes to the safe and sustainable use of space resources.

The graph, titled "Support Vector Regression on Test Data (y)," compares true satellite position values (red dots) with predicted position values (blue dots) across a wide range of data points. The y-axis represents the target position value (y) of satellite positions, while the x-axis represents the test sample index. The dense clustering of blue dots along the true values indicates that the Support Vector Regression model effectively improves the accuracy of satellite position predictions. This accuracy is crucial for mitigating Low-Earth Orbit (LEO) risks, ensuring the continuity of satellite missions, and preventing harmful collisions. Enhanced forecasting accuracy significantly contributes to the safe and sustainable use of space resources.
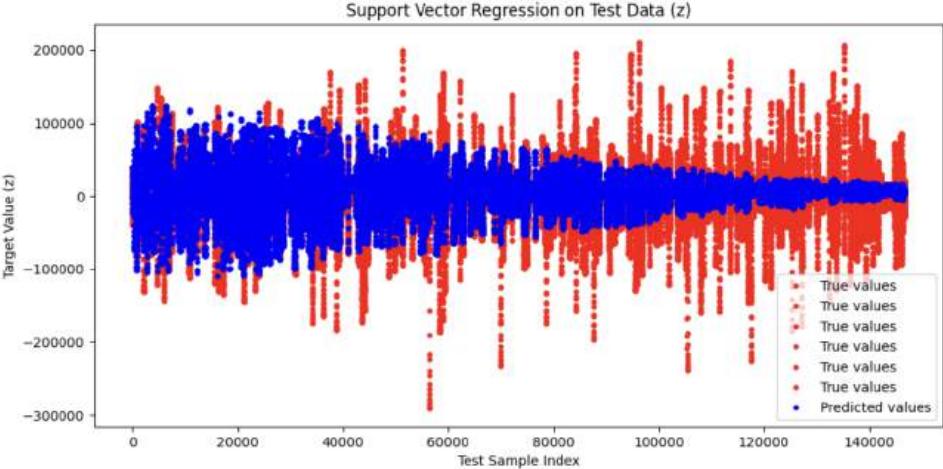

The graph, titled "Support Vector Regression on Test Data (z)," compares true satellite position values (red dots) with predicted position values (blue dots) across a wide range of data points. The y-axis represents the target position value (z) of satellite positions, while the x-axis represents the test sample index. The dense clustering of blue dots along the true values indicates that the Support Vector Regression model effectively improves the accuracy of satellite position predictions. This accuracy is crucial for mitigating Low-Earth Orbit (LEO) risks, ensuring the continuity of satellite missions, and preventing harmful collisions. Enhanced forecasting accuracy significantly contributes to the safe and sustainable use of space resources.

IV. DISCUSSION

The study highlights the transformative potential of machine learning (ML) models in improving the accuracy of satellite position predictions, crucial for space collision prevention. By using Random Forests, Support Vector Regression (SVR), and Gaussian Process Regression, the alignment of predicted values with actual satellite data improved significantly, marking a pivotal step toward more reliable space traffic management.

A key finding is the superior performance of ensemble and kernel-based methods in handling complex, non-linear satellite position data. The Random Forest model, for instance, captured position intricacies by averaging multiple decision trees, reducing overfitting and improving generalization. Similarly, SVR models demonstrated high predictive accuracy, managing high-dimensional and non-linear data effectively.

The study extends prior research by providing a comparative analysis of different ML models, revealing that ensemble methods and kernel-based approaches like SVR consistently outperformed others. This suggests that integrating multiple ML techniques could enhance predictive accuracy and reliability.

However, the study noted some limitations. Gaussian Process Regression showed occasional prediction inaccuracies under conditions of extreme variability, indicating a need for hybrid models to mitigate individual weaknesses. The findings also point to significant potential for improving satellite mission continuity and reducing collision risks in Low-Earth Orbit (LEO). As satellite numbers grow, accurate position predictions become increasingly critical, with advanced ML models playing a central role.

Despite promising results, limitations include the influence of historical data quality and quantity on prediction accuracy, and the computational complexity of some ML techniques, particularly Gaussian Process Regression, which can hinder real-time application in space traffic management.

V. CONCLUSION

In summary, this research highlights the significant impact of advanced machine learning (ML) models on improving the accuracy of satellite position predictions, crucial for preventing space collisions. By utilizing models such as Random Forests, Support Vector Regression (SVR), and Gaussian Process Regression, the study achieved notable improvements in aligning predicted satellite positions with actual data. These advancements are vital for reducing collision risks in Low-Earth Orbit (LEO), ensuring the continuity of satellite missions, and preventing collisions with space debris.

The study underscores the superior performance of ensemble and kernel-based methods in handling the complex, non-linear relationships in satellite trajectory data. For instance, the Random Forest model reduced overfitting by averaging multiple decision trees, while SVR demonstrated significant predictive accuracy in managing high-dimensional and non-linear data.

Additionally, other ML models like Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) networks are well-suited for sequential data and time series analysis, potentially offering more accurate predictions by capturing long-term dependencies. Convolutional Neural Networks (CNNs) could be adapted to analyze spatial patterns in satellite trajectory data. Hybrid models combining different ML techniques could provide superior results by leveraging the strengths of each approach, such as integrating RNNs or LSTMs with CNNs to capture both spatial and temporal dependencies.

The research also identified areas for improvement, such as the need for high-quality historical data and addressing the computational complexity of some ML techniques for real-time applications. Future research should explore a broader array of ML models, including ensemble methods, RNNs, CNNs, and hybrid models, to enhance predictive accuracy and reliability further.

These findings have practical applications for improving satellite mission continuity and reducing collision risks in LEO. As the number of operational satellites grows, accurate trajectory predictions become increasingly critical. Integrating advanced ML techniques into space traffic management systems can significantly contribute to the sustainable exploitation of space resources, ensuring the safe operation of satellites essential for global communication and scientific research. By developing hybrid models and addressing identified limitations, future research can advance space collision prediction and prevention, contributing to safe and sustainable space exploration and use.

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The Salt March's Contribution to Indian Independence By Jayen Patel

Introduction

The Salt March, spearheaded by Mahatma Gandhi in 1930 stands as a watershed moment in India's journey for independence from British rule. This paper seeks to explore the extent to which the Salt March contributed to Indian Independence. The March symbolized a mass movement of citizens committing civil disobedience and resistance against British oppression and rule, particularly targeting the unjust Salt Tax imposed on Indian citizens. The Salt Tax was a levy on salt production and sales that disproportionately targeted the poor who relied on salt as a fundamental ingredient of their diet. Given the essential role of salt in human consumption, the Salt Tax burdened every individual in India, underscoring the widespread impact of colonial policies on the Indians. Many other scholars have tried to determine the reason for British withdrawal from India often concluding that the political climate of the world during the mid-1900s with rising tensions in Europe led to the dissolution of the British Empire (Louis). This essay evaluated evidence by comparing and contrasting the points of view of the Indians and British during this time of turmoil. Evidence used to answer the research question was mainly a collection of primary sources. The choice of primary sources was made because they give the most insightful and authentic evidence as to what viewpoints were during the time. This research is crucial due to ongoing scholarly debates concerning the driving forces behind Britain's decision to withdraw from India (Phillips). Moreover, these factors significantly influenced the reason the British executed their withdrawal and the subsequent partition of India, which resulted in widespread turmoil in both India and the newly formed Pakistan. The repercussions of Indian independence reverberated across various segments of society, affecting not only the British and Indians but also Hindus and Muslims in diverse and profound ways.

Section 1: Widespread Public Support

Gandhi's appeal to the lower-class Indians through the Salt March was strategic, recognizing that they were a majority within the population. He understood that gaining their support would greatly accelerate the movement towards independence. In a letter to the Viceroy, Lord Irwin, Gandhi states, "The Independence movement is essentially for the poorest in the land the beginning will be made with this evil… I hope that there will be tens or thousands ready, in a disciplined manner, to take up the work after me, in the act of disobeying the Salt Act" (Gandhi). As shown in this evidence, Gandhi's primary aim with the Salt March was to mobilize mass participation, particularly among the individuals most adversely affected by the Salt Tax. Gandhi's emphasis on aiding the poorest people of the land exemplifies his commitment to addressing the issue of the unfair treatment of the Indians by the British. Creating a grassroots movement for independence was crucial thus, persuading the biggest social class was vital. In rallying the poorest people of India, he had garnered the support of the majority of Indian society particularly those most enraged by the treatment of the British. By uniting these people with

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Gandhi, he formed a powerful opposition to the British, signaling widespread disapproval that ultimately led to India's independence.

Gandhi's act of protest, the Salt March, garnered the attention of the masses in India, leading to a public display of civil disobedience throughout the country. The March's destination was the beach city of Dandi where in an act of civil disobedience Gandhi planned to make salt out of the sea water. Gandhi creating his own salt illegally by the ocean led to, "Disobedience across the land, with millions of people following Gandhi's example by breaking the salt laws" (History, Sky). After marching from Ahmedabad to Dandi, Gandhi created his own salt from the ocean by evaporating the water, leaving a salt product. Along the way, he made many stops in villages speaking about his mission and trying to convince the masses of the people to join his cause. By marching across India, he developed a large following, who, after seeing him finally break the law, chose to break the law as well. His followers broke the Salt Laws all around India, taking a step for India towards independence. Gandhi helped the people see what was wrong with how they were being treated with the Salt March, leading the people to defy the Salt Laws. Gandhi in his Salt March wanted Indians with government positions to give up their jobs because they were working for the British, who were hurting them. Gandhi asked in Nadiad during his march, " 'What is government service worth, after all?'…'A government job gives you the power to tyrannize over others.'" (Gandhi). Gandhi believed that working for the British government as an Indian was allowing the British more authority to tyrannize over the Indian population. Gandhi wanted these Indians in the government to come to his side in the fight for independence. Gandhi tried to unite all Indians, poor or rich, and make them realize what the British were doing to them and why they should stand up for their rights. However, from Gandhi's perspective as a member of the higher class, he may not have fully considered the impact of his actions on the livelihoods of government workers. The government workers were working to make money for their families and asking them to leave their jobs in support of the Independence Movement was no small favor. By gaining the support of those who worked in the government, Gandhi weakened the British from the inside so that the Indians could establish their independence.

While Gandhi relied on the non-violence movement to rally the Indians against British rule in a peaceful way, many political leaders and young Indians did not agree with Gandhi's approach to non-violence. Bhagat Singh was a "martyr to the minority who believed in violence, he spearheaded the Hindustan Republican Association who planned to singlehandedly bring down the British government with the use of violence" (Chandra, 250). Gandhi's approach to non-violence was not accepted by everyone in India because of other world events during the time that inspired groups of Indians of how to gain independence from previous successes. An event for example that Singh sought inspiration from was the 1917 Russian Revolution, specifically the Bolsheviks (Chandra, 250). Singh's movement shows that despite Gandhi's best efforts to secure widespread public support, the entirety of the public would never agree with his approach. Even after Singh was executed, his followers named him a Shaheed or martyr.

Section 2: Start of the Civil Disobedience Movement

The Salt March launched India into the Civil Disobedience Movement, a widespread resistance to British rule in India. Gandhi in a letter to Lord Irwin states, "Before embarking on Civil Disobedience and taking the risk I have dreaded to take all these years, I would fain approach you and find a way out." (Gandhi). Gandhi stating "embarking on Civil Disobedience" shows the strategy to not just protest but to start the planned initiative to sweep across India. By planning the Salt March, Gandhi knew the effects would be more people joining his movement of civil disobedience. Once Gandhi succeeded with the Salt march more people started committing acts against the British government showing their dissatisfaction with the British rule in India. These acts of civil disobedience led to the British government straining to keep its grip on India and the arresting of thousands of Indians. The British government had to crack down on the civil disobedience by the Indian citizens. "Wave after wave of civil resisters were severely beaten and then replaced in a spectacle that captured the attention of the world's media… more than 60,000 people were arrested for civil disobedience in the first nine months of 1932." (Kurtz, Lester). Gandhi's Salt March was only the beginning of the Indians' resistance against the British government. The British government was overwhelmed by the amount of people disobeying the law which led to the weakening of its grasp over the people of India. While these people protested, the British law enforcement was brutal with their choice of punishment for the Indians; the punishment was brutal to convey a message of the British's grip on India. The mention of the world's media shows the international repercussions of the British's treatment of the Indians. The substantial figure of 60,000 detainees illustrates the British government's efforts to increase arrests in order to manage the growing number of disobedient Indians and quiet the rebellion. The staggering number of individuals, more than 60,000, who emulated Gandhi's civil disobedience sparked a movement that continued to grow until the British eventually granted independence to India.

A secret memo from a British general exemplifies the effects of civil disobedience on the British government. A British general wrote to the British War Office, in a secret cipher, "tendency noted for trouble to spread to rural areas in parts of Madras, Bengal, and U.P. Indications of planning in sabotage and suggestion that forward bloc or other subversive organisation behind it in Eastern India… Signs that people beginning realize troops mean business. Aircraft flights over disturbed areas having good effect." (UK Government Web Archive). This document shows the British government recognizing that they were going to have a problem with the disobedience by the Indians. This illustrates the strength of the civil disobedience, as even the massive British Empire, one of the most powerful forces of its time, faced difficulties in keeping control over the Indian populace. Also, with the statement, "indications of planning in sabotage" the British government shows its anxiety of a widespread organized rebellion. The British government also had a plan to intimidate the Indians which was working but this shows the evolving frontier of this conflict from physical to mental. The Civil Disobedience Movement is shown to be a growing threat to the British with their attempts at

suppression because there would be incapacitating consequences for the British losing power over India.

While the Salt March helped spark the civil disobedience movement historians argue that the Non-Cooperation movement contributed more to the spread of civil disobedience. The Non-Cooperation movement is described as two mass movements, the Khilafat and Non-Cooperation, which were formed to oppose British rule. The Khilafat was a Muslim movement over British policy against Turkey and the dismemberment of the Ottoman Empire. The movement was launched by Mahatma Gandhi in 1920 to mobilize the Indian masses to peacefully resist British rule through rebellion against British institutions, laws, and policies." (Non-Cooperation Movement - Causes, Impact, Short Note). The Non-Cooperation movement was millions of Indians boycotting institutions the British government created in India. The Non-cooperation movement was an organized resistance against the British government well before the Salt March. By looking at the Non-Cooperation movement it is made clear that the civil disobedience wasn't solely rooted from the Salt March but a multitude of factors leading up to the period. While the Non-Cooperation movement was a part of the civil disobedience movement the actions taken by the protesters during the Non-Cooperation movement has a huge distinction compared to the actions taken during the Salt March. Gandhi speaks about the "crime of Chauri Chaura" one of the attacks by Indians during the Non-Cooperation movement by saying, "The mob… set fire to the Thana." (Dalton). Gandhi first refers to the group of Indians as a "mob" therefore separating himself from the mob because of his strong beliefs in non-violence. Gandhi rooted the entire Salt March in efforts aligned with non-violence, demonstrating how the Non-Cooperation Movement deviated from Gandhi's vision and teachings. Unlike the Salt March which stayed relatively non-violent and stayed in line with Gandhi's beliefs, the Non-Cooperation movement didn't. While the Non-cooperation movement had a profound effect on starting the road to the civil disobedience movement the Salt March was had an effect in agreement with what Gandhi would have wanted it to be.

Section 3: Weakening of British Economic Infrastructure in India

Gandhi's Salt March was aimed at attacking the British salt monopoly which was a seemingly minimal part of the British's grip on India. The Salt tax was a high tax that affected every Indian in all classes. Gandhi's Salt March called on all the people with resentment towards the tax which was every single Indian. Salt starvation in India during the time of high salt taxes is explained by Roy Moxham as, " The high Salt Tax would only increase the number of those who were unable to purchase salt and perished due to susceptibility to disease and minimal salt intake." (Roy Moxham). The Indian people were becoming weak and, in some cases, dying because of the high salt taxes imposed by the British. Salt is a necessary nutrient for humans and because prices were so high for salt, Indians were unable to purchase salt. Some Indians would have to give up buying other items in order to afford salt. This created a large underground market of salt which was illegal per British laws. The monopoly that the British created in the Indian economy played a significant role in their unrelenting power in/ India. With the

dissolution of the monopoly over the Indian people, the British found yet another compelling reason to withdraw from India. Once British economic infrastructure in India was destroyed the British's grip on India loosened.

To combat the British's economic infrastructure, "The Indian National Congress set up its own salt depot, and groups of organized activists led nonviolent raids on the government salt works, blocking roads and entrances with their bodies in an attempt to shut down production." (Engler). By blocking roads and entrances to the British salt factories, the Indians were able to hinder the British production of salt. These actions happened around India virtually shutting down British production and export of salt. The Indians were weakening the British monopoly over the salt industry in hopes of stopping an important revenue stream for the British. The National Congress's establishment of their own salt depots exemplified a unified national rebellion against the British stranglehold, which prevented Indian companies from producing and selling salt. The National Congress was finally able to start their own depots giving the Indian people access to salt at fair prices compared to the British production of salt.

Some may argue that the political developments after World War 2 such as, self-determination, nationalism, and anti-colonialism prompted the British to pull out of India. Behind these anti-colonialism ideas were political leaders like Mahatma Gandhi, Jawaharlal Nehru, and Subhas Chandra Bose who spread these ideas of self-rule across India through civil disobedience and political negotiations. With heightening tensions of World War 2 on the international level, Britain declared India's participation in World War 2 against Germany. The members of the Indian National Congress were outraged, and members of Congress passed the Quit India Resolution of 1942 demanding an end to British rule. (History.com Editors). The Quit India resolution led to the Congress members being imprisoned by British officials the next day, but it signified to the British that their rule in India was ending soon. The Indians were tired of being treated like puppets by the British because they had no say in British affairs. The British declaring Indians against the Germans in World War 2 magnified the problem that Indians were out of control of their own country.

While the Quit India Resolution and the spread of self-rule ideas helped move India towards independence from Britain it was the work of the civil disobedience movements like the Salt March that made the British pull out of India. Gandhi spearheaded the Salt March, which, "In defiance of British authority, Gandhi led thousands of people on a 240-mile March to the sea where he picked up a pinch of salt. This sparked a mass movement among the people all over the country to gather and make their own salt." (Bria). The Salt March had a much bigger impact on the public and the British because the British were losing control over the citizens which was more important than losing control over the Indian officials. While the British could imprison the Indian officials imprisoning mass amounts of the citizens was hard because it would cause more outrage. The Salt March also significantly altered the British perception of their rule in India, as they witnessed the erosion of their peaceful control and the refusal of citizens to accept the unjust rule imposed upon them.

Section 4: International Attention and Global Support

The Salt March captivated the attention of the international community, drawing extensive media coverage and fostering diplomatic relations that contributed to the advancement of the independence movement. The March which was in protest of the British salt monopoly and unfair rule in India brought journalists from all over the world to cover the protest against the British's atrocities committed in India. The ideas of why Gandhi was leading the March were also spread across the world fostering many different peaceful protests to come in the upcoming years. The international attention gained by the Salt March led to intellectuals and people in power taking stances on the situation and trying to act on it. John Haynes Holmes wrote, "In the interest of India, Britain and the world, we beg you to seek the way to an amicable settlement with Gandhi and his people. As ministers of religion who cherish the principles of democracy, freedom and brotherhood which you represent, and who believe in the spiritual ideals which Gandhi sublimely embodies, we refuse to believe that you and Gandhi cannot work together. We look to you who hold power and authority in this crisis to avoid the tragedy of a conflict which would mean a catastrophe for Britain, India and mankind." (Holmes). The British were being increasingly pushed to give the Indian people independence because of what the international community saw in the Salt March and its outcomes. Gandhi and the Salt March brought enough attention for people in power and intellectuals to create opinions about British rule in India. The encouragement by many different sources of British withdrawal from India pushed the British to start considering their options of removing themselves from India because the international community was not taking it well. This created the movement for the British to start pulling out of India and give them their freedom. An article in the New York Times was Titled, "GANDHI OPENS DRIVE FOR INDIA SELF-RULE", goes on to say, "Gandhi leads volunteers to march to start civil disobedience" (New York Times). Another Article by the New York Times states Gandhi's words as, "I hold British rule to be a curse, but I do not intend to harm a single Englishman or any legitimate interest he may have in India." (New York Times). This shows the clear international spotlight that was shined on Gandhi's Salt March. The New York Times publishing multiple articles about Gandhi and the March shows the impact the March and the work towards independence had on the international journalist community. The New York Times most likely published this article because of the growing conflict during the times and the interest in Indian independence among the international audience. Gandhi's peaceful approach to Indian independence showcased his moral integrity and the ethical approach to gaining Indian independence.

Some may argue that there was limited coverage of the Indian independence movement, and it was drowned out by other world events happening at the same time. The large economic depression and growing tensions in Europe during World War 2 drowned out the Indian Independence movement from press because large media outlets were focusing on more worldly topics. Despite focus on so many different world news, the Indian Independence movement garnered widespread awareness because it had an emotional impact on many different people because of the atrocities they were witnessing in India under British rule. Despite media outlets

focusing on worldly politics, the Indian Independence movement remarkably cut through the noise of these narratives and found its place in international headlines. Albert Einstein wrote to Gandhi expressing his admiration, "A leader of his people, unsupported by any outward authority: a politician whose success rests not upon craft nor the mastery of technical devices, but simply on the convincing power of his personality; a victorious fighter who always scorned the use of force; a man of wisdom and humility, armed with resolve and inflexible consistency, who has devoted all his strength to the uplifting of his people and the betterment of their lot; a man who has confronted the brutality of Europe with the dignity of the simple human being, and thus at all times risen superior." (Labh). Albert Einstein one of the greatest scientists of the time writing to Gandhi about his actions shows how important Gandhi's actions towards independence were and how much of a profound impact around the world they were having on people. Einstein must have learned about Gandhi's actions through the press, indicating that the media was indeed covering and emphasizing the Indian Independence movement. This coverage gave Indians the international stage they needed to fight back against the British who had control over them for such a long time.

Conclusion

The Indian Independence was achieved through a multitude of factors but the contribution of the Salt March to Indian Independence is unmatched. The salt march brought widespread media attention, united the people of India, broke down British economic infrastructure, and started the Civil Disobedience Movement. The Salt March contributed to a greater extent than any other attempts at gaining Indian Independence. While scholars may interpret evidence differently and engage in debate, the irrefutable contribution of the Salt March lies in its role as the catalyst that ignited the fight for independence, setting the stage for subsequent developments in India's quest for freedom. If a strict reason that the British pulled out of India existed, it would require explicit statements from the Indian Viceroy and the British Crown during the time. Many different viewpoints arose through research because of how multifaceted the British withdrawal was within Britain and India. The Salt March was a spectacle witnessed around the globe, showing the discontent of the Indian people towards British rule. It was a catalyst, instilling the Indian public with the confidence and determination to confront the British oppressors and ultimately secure independence. Gandhi planned the Salt March in such a way that it could make the greatest impact on the British government. He often did this by weakening the British government's ability to be in India by causing public outrage against their government through the Salt March. The evidence has pointed in many directions of what truly caused the British withdrawal from India, but the evidence was evaluated in a way that proved the thesis, but counterclaims were addressed and accepted. Many further questions have risen from the research conducted, such as to what extent did the economic strain of World War 2 on Britain lead to Indian independence, to what extent did Indian independence leave India unstable, and to what extent did Indian Independence benefit India. These questions are very

broad and would not fit under the scope of this research question but one of the topics is addressed in a counterclaim to this research question.

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Distortion and Rights:
A Study of Women's Rights Based on Public CommunicationBy Siqi Huo

Abstract

This essay examines the evolution of women's rights in modern China, focusing on the political and social dynamics that have influenced their development. Through the case studies of the personal self-media account "Song Qingfeng" and the feminist bookstore "La otra", it examines how internet-based gender antagonism intersects with grassroots feminist initiatives. A gender dichotomy is created by emphasizing the economic pressures faced by men in Song Qingfeng and contrasting these with perceived female privileges. This narrative attracts significant viewership but exacerbates gender antagonism and distorts public understanding of feminism and gender equality. In contrast, "La Otra" promotes gender equality and women's rights through public events and discussions, while maintaining operations by adhering to regulatory frameworks, aligning with mainstream values, and leveraging online marketing despite cyber violence and opposition from society at large. In a conservative public authority and traditional social norms, grassroots cultural enterprises face challenges and can advance social change. For the effective promotion of gender equality and women's rights in China, the study emphasizes the multifaceted nature of gender issues and advocates for a holistic strategy that integrates online activism with offline educational and policy efforts.

Key Words: Women's rights;Double standards; Misreading;Logic confusion;Good wives and good mothers

1. Evolution of women's rights in modern China

Since mankind entered a patriarchal society, women have long been in an unequal position of being deprived of all kinds of rights, a phenomenon that continues to this day. In political science, women's rights are usually defined as women's ability to participate, express and enjoy their rights in the political sphere. This includes a focus on women's participation in political decision-making, holding public office, and enjoying the right to vote and to be elected. The political science definition of women's rights and interests emphasizes the application of the principle of gender equality in the political system and the importance of eliminating gender discrimination and promoting women's participation in politics.

The understanding of women's rights has evolved as society has progressed and understanding has deepened. In the early part of the 20th century, the political science definition of women's rights may have focused more on appeals to the basic rights of women to participate in politics, such as the right to vote and the right to be elected. However, in the second half of the 20th century, this definition gradually expanded to a broader scope, including a focus on gender equality, gender consciousness, and gender justice. In 1949, the United Nations promulgated the Universal Declaration of Human Rights, which explicitly included a statement guaranteeing equal rights for women. This initiative signaled the international community's formal attention and commitment to

women's rights. Prior to this, however, women had long been exploited.Since the reform and opening up of China in 1978, research on women and gender studies has been active in Chinese intellectual circles, but limitations remain. Although there has been much interpretation and discussion of Western feminist theories, scientific analysis and theoretical generalization of the problems faced by Chinese women are still insufficient .

2. Challenges to women's power

The development of Chinese women's status took an important turn at the World Conference on Women held in 1995. The Beijing Declaration adopted by the conference explicitly put forward for the first time the proposition that "women's rights are human rights", providing important support for the universal recognition of women's rights. At the same time, the Declaration states that "equality between women and men is a condition for human rights and social justice, and an essential prerequisite for equality, development and peace". This evaluation criterion is extremely important for the promotion of global gender equality. However, Hong Lida points out that in the era of post-socialist reforms, the various benefits that women have gained in the historical stage have been undermined . In recent years, feminist actions in China have become increasingly "politically sensitive" and even suppressed by public power.

From 1995 to the present, the suppression of women's rights in China has gone through several core stages. First, the collapse of government credibility marginalized gender equality issues, resulting in a lack of strong political support for women's rights advocacy. Second, between 2014 and 2018, the Chinese government swiftly banned many non-governmental organizations (NGOs), especially those working on gender equality and women's rights. This action not only weakened the civil power of women's rights defense, but also limited society's open discussion and research on gender issues. At the same time, the high-handed management policy has, to a certain extent, stimulated the awakening of women's consciousness. In the face of repression and injustice, more and more women have begun to pay attention to their rights and express their demands through social media and other channels. However, this awakening has also been accompanied by a retreat of women's rights, and many women have faced social and legal pressures after speaking out publicly, making their situation even more difficult.

2.1.Chinese-style male-female antagonism (Internet misogyny)

The Fourth World Conference on Women (FWCW) held in Beijing in 1995 was a turning point in the rise of Chinese non-governmental organizations (NGOs). Promoted by the FWCW's Independent Forum of Non-Governmental Organizations (IFNGO) and funded by overseas foundations, the first generation of feminist NGOs in China began to form and flourish. Since then, the feminist movement has usually been considered politically safe. However, after a brief boom, feminist activism in China is once again in the doldrums.

In 2012, a new feminist movement was sparked by a younger generation of feminists who created news and attracted public attention through street performance art such as "Occupy Men's Restrooms",pushing the government to increase the ratio of pitches in male and female toilets by

making their own foam toilets. Since 2014, however, the feminist movement has faced greater challenges due to increased media control, with media in Guangdong province explicitly banning coverage of feminist topics. In addition, certain controversial issues among women themselves, such as the discussion on the bride price, have also had an impact on the advancement of the feminist movement. The controversy mainly focuses on the heavy financial burden that the high bride price imposes on the man's family in some areas.

In summary, the early controversies are generally accepted in society where the debates are mainly focused on the online community. Whereas the male and female side of the marriage, the parties' attitude was to solve the problem and consummate the marriage. However, with the blooming of social media, the aggressive viewpoints on such platforms as opposed to reality, transformed into completely unjustified arguments.

2.2. Timeline study of male-female antagonism (network development)

In recent years, the rapid development of Internet platforms and social media has contributed to the spread and popularization of feminism in China, enabling a younger generation of feminists to use these platforms to promote feminist views. This trend has contributed to the development of so-called "neoliberal feminism", which has exposed younger women to feminist culture. At the same time, however, it has also contributed to a culture of hate speech and misogyny. Meanwhile, the government's selective deletion has had a very negative impact on the overall communication which reflects the government's attitudes .

Since 2014, non-governmental organizations (NGOs) in China have faced severe policy pressure, especially those working to promote women's rights. Government censorship and regulation have led to the closure or restricted activities of several NGOs that support women's education and rights. Against this backdrop, the Internet has become a new battleground for the younger generation of women to explore and express their gender consciousness. Although the Internet provides a relatively free space for discussion, the lack of systematic gender education and authoritative guidance has caused this generation of young women to encounter many challenges in the process of gender awakening on the Internet.

Discussions on the topic of 'rural feminism' on Zhihu (知乎), a platform that has been popularized by the Internet, have further exacerbated online misogyny and male-female antagonism. The 'idyllic feminism' categorizes feminists into 'real feminism' and 'fake feminism'. 'True feminism' emphasizes individual efforts and encourages equal opportunities with men through one's own efforts. That is to say, 'true feminism' is 'equal employment, equal sharing of responsibilities, equal sharing of obligations, and equal sharing of rights'; men and women 'enjoy equal rights and interests, equal obligations, and equal moral standards'; and to achieve true gender equality, it is necessary to 'give both genders the same abundance of choices and the same basic obligations'. True feminism pursues "equality between men and women" rather than "female supremacy". At the same time, the "equality" pursued is equated to "equality" by encouraging equalization of monetary aspects, such as buying a house, household chores, and family financial expenditures, and the absence of bride price and dowry. False feminism, also known as "idyllic feminism", is summarized as a combination of

rights without obligations, i.e., a subtle blend of traditional Chinese family values and Western feminist ideology, but only enjoying the rights and benefits of both models without fulfilling the obligations of either, a 'double standard'. 'double standard'. The rights that "idyllic feminists" aspire to enjoy include, but are not limited to, men earning money to support their families, a high bride price, signing real estate certificates, and high holiday gifts. Obligations that they do not fulfill include what traditional Chinese women are called 'obligations', i.e., family responsibilities within the traditional Chinese family, such as household chores, raising children, and selflessly sacrificing their careers to serve the family.

Social media platforms such as Weibo and Zhihu have become a major venue for young women to discuss gender issues. On these platforms, female users actively share their personal experiences and initiate online discussions on issues such as gender discrimination and domestic violence. However, this spontaneous online activity also exposes problems caused by a lack of education, such as polarized views, immature strategies and internal divisions. More seriously, the phenomenon of "blowing up" on the Internet, in which accounts of certain viewpoints are blocked through a large number of reports, reflects the confrontational and exclusive nature of the online discussion space.

In addition, research has shown that although the Internet provides a new platform for women to express and interact with each other, this digital gender awakening has not necessarily led to actual policy changes or fundamental shifts in social attitudes . This suggests that future gender education and promotion of women's rights need to rely not only on the expansion of cyberspace, but also on the combination of physical educational resources and policy support to form a comprehensive promotion strategy that combines online and offline.

In such a social structure, men at the bottom not only have to bear the economic exploitation from the capitalist mechanism, but also have to face the competitive pressure from the same sex. Their social status and self-worth are often based on the suppression and control of women, a phenomenon that is particularly evident in online misogynistic behavior. At the center of this logical chain is gender competition, reflecting the complexity of the underlying male perspective on feminist issues under social pressure.

Under the neo-liberal capitalist system, men at the bottom are themselves in a disadvantaged position, facing multiple dilemmas such as unstable jobs, insufficient income and psychological pressure. In their efforts to maintain their social status, they often target women, who are even more vulnerable in the social structure, and wrongly attribute their personal struggles to women's "privileges" and "advantages". This strategy of shifting focus is not only a self-protection mechanism, but also inadvertently supports and perpetuates socio-economic inequality and patriarchy.

3. A case study of the personal self-media account Song Qingfeng

3.1 Basic informatio

"Song Qingfeng" Account Details: Formerly known as "Song Qingfeng, the No. 1 Anti-Punching Man". The account is operated by an individual named "Song Qingfeng", who uses his personal background as an IP and is active on the WeChat video platform, a typical virtual individual who spreads his personal views through the Internet, opens a window for merchandise after accumulating a period of traffic, and conducts occasional live broadcasts to bring goods. Due to the special mode of WeChat video number that does not count the number of fans following the account, the number of followers of the account cannot be seen at present. As of February 14, 2024, the account has produced a total of 443 pieces of original content. The operator of this account also operates the WeChat public number "Song Qingfeng's Nest", which shares occasional essays and has produced a total of 23 pieces of original content, and is currently certified by WeChat as an "Emotional Self-media".

Based on the statistics of 443 original videos on this account, the subject categories of the videos cover a wide range of areas such as emotions, values, marriage, work, and so on. The keywords and tags of the videos mainly focus on 'gender topics' 'gender equality' 'male and female topics' 'emotion' 'female fist' 'female fist' and 'female fist' and 'female fist' ' 'female fist' 'relationship view' 'fairy' 'double standard'.

The account takes a male perspective, and by emphasizing the plight and pressure faced by men in marriage and family, contrasting with the so-called privileges enjoyed by women, such as financial strength and full-time motherhood, and subtly 'grafting' negative behaviors made by some women onto all women, highlighting the various unfair treatments of men in society. It attempts to evoke anger and empathy in the male audience. In fact, most of the women in the extreme cases cited by the blogger do not have the status of feminist, but are just ordinary women, and do not represent 'radical feminists', let alone all women. The blogger's behavior, on the surface of attacking 'extreme feminism', actually stigmatizes all women. Lastly, by creating so-called male-female dichotomies and contradictions, the blogger shifted the focus from male oppression under the capitalist system to blaming women, thus achieving the goal of attracting viewers and gaining traffic and money.

By describing and discussing the pressures and dilemmas faced by Chinese men, such as the house, bride price, and sense of responsibility, Song Qingfeng triggers empathy and concern among male viewers. And cleverly attributes the gift of men to women in the process of relationship to 'sense of responsibility'. In fact, men's gift to women is misunderstood as an exchange of value that should be worth more than what it is worth, but in reality, men are often unwilling to fulfill their due responsibilities and use it as an excuse for exploitation.

This content echoes the impact of conservative public power on men's social status, emphasizing the responsibilities and pressures on men in the family and society, but at the same time deflects attention by focusing on complaints about women.

Song Qingfeng's short videos often use compelling titles and keywords, such as 'Chinese men's unique thoughts' and 'Men can't earn waste for 20w', to attract viewers' clicks and attention. These headlines tend to exaggerate the plight and victimization of men, thus winning more traffic and attention. By creating public opinion and provoking confrontation between men and women,

men are viewed as a vulnerable group exploited by "women", and by comparing men in overseas countries where there is no pressure to pay a bride price or buy a house, they highlight the "suffering" of Chinese men and try to capitalize on such emotional resonance to He tries to capitalize on this emotional resonance for his own benefit. He chooses to contrast the plight and struggles of men with the 'privileges' and 'advantages' of women, thus reinforcing his position and the appeal of the topic. This approach is not only a misinterpretation and distortion of feminist issues, but also a misrepresentation and misunderstanding of social reality.

Song Qingfeng's videos usually adopt the following logical model:
1) Creating virtual "suffering": By bringing up the problems faced by men in marriage and family (such as bride price, mortgage, unreasonable demands from partners, etc.), it creates emotional resonance in the viewers.
2) Reinforce the empathy of male viewers: Focus on the economic pressures and challenges of men's lives in a capitalist society to create empathy.
3) Shift the perspective to gender dichotomy: By showing the so-called inequality between men and women, the viewer is led to blame women for the problem, especially by wrongly generalizing the extreme behaviors of some women to that of all women.

Gaozhan Video Analysis (WeChat Video No. Platform)
Highly Liked Video 1: 2.4w
Emphasizes the economic pressure and social expectations faced by Chinese men, who need to prepare a house and a bride price in order to gain women's respect.
Points out that women generally believe that men should take on this responsibility, but will not show the appropriate respect.
Emphasizes the importance of men working hard, but also points out that even if they do, the bride price is still a social norm, and the lack of a bride price may affect a marriage.

Highly Liked Video 2: 2.7w
Referring to quarrels between couples, emphasizes that love runs both ways and mutual tolerance. Calls on men not to lose their temper over trivial matters, while emphasizing that men should not occupy the position of the humble inferior in a relationship.

Highly Liked Video 3: 1.2w
Criticizes the unfair expectations of men, such as the belief that not having enough financial strength is a sign of incompetence.
Emphasizes the pressures and burdens that men bear in the family, such as having to work and earn enough money to get married.
Points out that men face pressure from society and family to meet certain economic conditions in order to be seen as successful men.

Highly Liked Video 4: 1.3w

Criticizes public opinion's entertaining treatment of male tragedies and emphasizes that men's plight and struggles should be taken seriously.

Points out that public opinion's entertaining treatment of male tragedies is a gender dichotomy, with men seen as objects of jokes or farce.

The due respect and care for male tragedies is emphasized against gender bias and double standards.

3.2 Analytical study

Within the framework of patriarchy, men are usually regarded as the pillars of the family, a role that gives them a certain amount of power but also puts them under tremendous economic and social pressure. Especially in rural areas, this pressure is more pronounced and often manifests itself in the economic exploitation of males as well as the unfair distribution of educational resources. For example, boys are often expected to take on the responsibility of being the breadwinner, which not only limits their access to education, but also increases the pressure they face in the future.

However, despite the heavy economic burden placed on men, patriarchy has not been challenged as a result. On the contrary, it is often strengthened by shifting the focus to more vulnerable groups - children and women. In many rural areas, "patriarchal" attitudes remain deeply entrenched, and the exploitation of women and girls in terms of educational and social opportunities is commonplace. In addition, this gender bias is reflected, for example, in marriage practices, where women are often seen as part of the economic exchange between families.

Through the observation of several male accounts on social media that hold similar views to Song Qingfen, such as "Sugar Gekko 01 Big Blue Book" "Damon Kochi Male Emotional Counselor" and others it can be seen that these accounts often disseminate information about how men are neglected or exploited in society and in the family. While these narratives shed light on the problems faced by men, they tend to ignore the broader societal structural issues of how patriarchy itself maintains male dominance at the expense of women's rights.

3.3 Underlying Logic of Account Generation

To summarize, Under the influence of neoliberal capitalism, the intertwining of socio-economic structures and patriarchy in Asia has intensified the competitive relationship between genders, especially the complexity presented between underlying Asian men and feminist issues. Neoliberal capitalism emphasizes market freedom, individualism, and competition, which not only leads to significant socio-economic inequalities, but also enhances the pressure on men to compete for economic and authority. In this environment, the traditional patriarchal system is used as a tool to maintain the existing class and gender order, reinforcing men's gender role identity as the pillar of the family and representative of authority.

This content strategy not only reflects the disadvantaged position and pressure of men in society, but also reveals that under the influence of conservative public power, some disadvantaged groups may choose to maintain their social status by exploiting more disadvantaged groups. By doing so, Song Qingfen attracts viewers and increases traffic and financial gains, but this may at

the same time exacerbate gender antagonism and distort the public's understanding of gender equality and feminism. While this tactic may be effective in the short term, it may have a negative impact on gender relations in society in the long term.

3.4 Diffusion of influence from private to public domains

In the digital age, the influence of private accounts to the public sphere is increasingly significant. Content creators with low education and weak logical thinking skills, such as Song Qingfeng, are not only limited to the private sphere in the content they publish through their personal accounts, but are also able to widely disseminate to the public sphere and influence public opinion. In this process, the mechanisms of communication science exacerbate the male-female dichotomy, especially when content creators emphasize the gender dichotomy to attract viewers and increase traffic, which in turn drives economic benefits. For example, attracting attention by showing inequality between men and women in life and work, or by exploiting images of women, while these practices can bring short-term attention and financial gain, they may have a negative impact on the improvement of gender relations in the long run.

This proliferation from the personal sphere to the public sphere demonstrates the important role of social media platforms in modern societies, but also reflects how modern communication tools can be used to reinforce or challenge existing social structures and gender roles.

4. A case studies of La otra-the first feminist bookstore in Beijing

4.1 Basic Information about La otra

La otra was established at the end of March 2023, with a start-up capital of 100,000 RMB. The bookstore has a floor area of about 60 square meters, the old location was in the alley space, and the new location is in the Cultural Park of No. 1, Halfbidian, Chaoyang District, Beijing. According to the owner, Cui hisself, the initial motivation for the bookstore was twofold: 1) He wanted to promote the status quo of gender equality in the country, and 2) the owner, Cui was raised by his mother, growing up in a so-called single-parent family, and rebelling against his stepfather, and so he felt that it would have been a good idea if his mother had been able to see more when he was younger and had more knowledge, for example, of the world. able to have more knowledge, such as being exposed to feminism, perhaps she could have had more choices in her life. In addition, the bookstore's function is close to that of a "transit point," i.e., it serves as a platform for discussion of cultural and social issues through the organization of lectures, seminars, and other public events. Cui's bookstore is not only a commercial entity, but it also tries to be a force for social change. Although the bookstore makes a profit, its main goal is to influence and educate the community.

When the bookstore was launched, the store's manager,Cui, received a lot of publicity, mainly focusing on his male identity. According to Cui, "Many readers who enter the store are curious and careful to ask the question - why are you, a man, opening such a bookstore". At the same time, the network platform on the attack on Cui did not stop. In the face of cyber violence, Ah Cui said, 'the emotional level is definitely hurt, and then rationally can also understand. Because for

many people nowadays, gender has become an outlet for people to vent, and in the past years, the male group also has a certain degree of oppression and injury to the female group, so people may naturally produce a kind of unfortunate feeling, this kind of unfortunate feeling first of all is understandable. Secondly, the Internet is not a particularly good place for discussion and communication in an anonymous environment, so people may amplify some of their daily lives, whether it's malice, bad opinions or anger, and they may express it more recklessly. And in a way, gender for an outlet, so that I can understand everyone's such a number of views. Because. It's true that, number one, it's true that a lot of men did roll over doing things like this before, and it's true that men have oppressed and victimized women for a long time before, and it's also true that this exists.

Evaluation and Revenue:

La otra has received positive reviews from some segments of the population in the region, especially those who support gender equality and women's rights. However, commercial profitability is not its main pursuit, so it may not be as financially viable as a purely commercial bookstore. In addition, the operation of the bookstore depends on community participation and support for its cultural activities.

4.2 Analyzing Research:

In early 2024, the first feminist bookstore in Shenzhen closed for political reasons. Compared to Half, a feminist bookstore in Shenzhen, the fact that La otra was able to survive can be attributed to the following three points:

1) Staying in touch with political power: To ensure that its activities and operations do not touch the red line of policy, La otra reports every social activity with the community where it is located and passes through the approval process to ensure that its activities are carried out within a safe range. Meanwhile, La otra is governed by the Office for the Administration of Overseas Non-Governmental Organizations of the Beijing Municipal Public Security Bureau (under the Ministry of Public Security).

Events hosted or organized by La otra are particularly tightly regulated during the sessions and Pride month.

2) Endorsement of mainstream values: While promoting gender equality, Cui's strategy is to engage in a modest renewal of social attitudes without overly challenging mainstream values.

3) Online attraction to promote physical consumption: Attracting customers to physical stores through online marketing and social media campaigns is a common way of survival for modern independent bookstores.

In emphasizing gender issues, La otra may be attacked by negative feedback or opposing views in cyberspace, and these oppositions sometimes evolve into an anarchic and intense male-female dichotomy. This phenomenon is not promoted in a substantive way and is a mere formality: despite the bookstore's commitment to educating and promoting gender equality, its impact may be limited by the constraints of a strong conservative public authority and social traditions that make it difficult to achieve broader social change.

5. Conclusion

The case of La Otra reflects the dilemma of how a more idealistic social enterprise tries to survive and have a voice in the real world. Cui's experience and the way the bookstore operates provide a powerful case study of the challenges and opportunities in transforming impact from the private to the public sphere. Such attempts to move from small-scale private activities to influence the wider public sphere, while difficult, show the potential role and value of cultural entrepreneurs in driving the process of social civilization. Through such practices, we can gain a deeper understanding and assessment of the effectiveness and limitations of the tools of public communication in contemporary societies, and how they can be more effectively utilized to promote social justice and equality. Aimless opposition only leads to the collapse of human rights, impacting the effectiveness of bookstores advocating for women's rights and suppressing the rights of everyone except those with vested interests.

6. Challenges and Opportunities

In 2024, the spectrum of pan-feminism is becoming increasingly complex, with internal tensions and external conflicts causing significant concern. Current challenges faced by women's rights include government suppression of non-governmental organizations, media censorship of feminist issues, and society's limited understanding and acceptance of gender equality. On internet platforms, discussions about feminism often encounter hostility and misunderstanding from male users, which not only exacerbates gender antagonism but also weakens the voice of women's rights. Additionally, traditional views and conservative forces remain strong, restricting women's full participation and development in political, economic, and social spheres.

However, despite these challenges, there are many opportunities and prospects for the future. Firstly, the proliferation of digital platforms offers new channels and interactive spaces for feminism. Through social media and online communities, women can more widely share experiences, express opinions, and organize collective actions. Secondly, with the progress of globalization, international attention and support for women's rights in China are increasing, providing more resources and opportunities for collaboration. Furthermore, advances in education and economic development will help elevate women's social status and self-awareness, advancing the realization of gender equality.

The key to advancing women's rights in the future lies in the comprehensive utilization of both online and offline resources and strategies, forming a broader and more effective social movement. This includes policy support and protection, strengthening public education, and fostering international cooperation and exchange. These efforts can enhance societal recognition and acceptance of gender equality and effectively address and resolve the existing gender antagonism and conflicts.

Overall, the path of pan-feminism in China remains long and arduous, but its potential and promise are equally significant. Through continuous effort and innovation, we can aspire to create a more just and equal society in the future, ensuring that everyone's rights are no longer undermined by purposeless antagonism, and truly promoting the progress of social civilization.

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Exploring Optimal Decision-making in Diverse Stochastic Environments with Multi-armed Bandits By Shivansh Goel[1] and Sam Showalter[2]

Abstract

Every day, people, businesses, and governments must make decisions under uncertainty. Generally, we can group decisions into *exploiting* a previously known option or *exploring* a new one. Multi-armed bandit (MAB) problems, popular in statistics and machine learning, formalize this setting and explore optimal strategies. Named after the "one-armed bandit" moniker for slot machines, MAB problems utilize multiple theoretic "arms" to represent the different available options that can confer a reward, where each arm has a different degree of success. However, each arm's success rate is unknown *a-priori,* and the aim is to find the arm that gives the greatest average cumulative reward over time. Finding an efficient approach is helpful in areas such as recommender systems, advertising, and portfolio selection (Bouneffouf et al.). While many MAB methods have been explored in previous work, few studies examine their robustness as the hyper-parameters of the MAB setting (e.g. number of arms, time horizon, reward distribution) vary. We fill this gap and discover that the success of many approaches is highly sensitive to these hyper-parameters, particularly the reward distribution and number of bandit arms. Thus, we contribute a general litmus for understanding the robustness of different MAB methods.

Introduction

MAB problems represent a dilemma between exploration and exploitation that occurs when choosing between many options to maximize a predefined reward given limited information. The options are represented by "arms" - hence the name multi-armed bandit. Relatable examples of this problem include choosing between restaurants and coffee shops when you are on a budget. For example, you could go to a new café (exploration) and potentially get a terrible coffee, or the same café as usual (exploitation) and potentially miss out on a new favorite. Given limited previous experience with these options, we need to decide if we will solicit a greater reward by exploring or exploiting; this is known as the *explore-exploit tradeoff.*

Having an effective general approach to the MAB problem allows for maximizing rewards (e.g., in slot machines) or enhancing experiences (e.g., when going to cafés). We intend to outline which MAB algorithms are superior as the pretenses of the explore-exploit problem change. There are many applications of this problem, but they are all formulated as sequential decision-making tasks: the next action depends on previous experiences. MAB problems can also be formulated as simple Markov Decision Processes (MDPs).
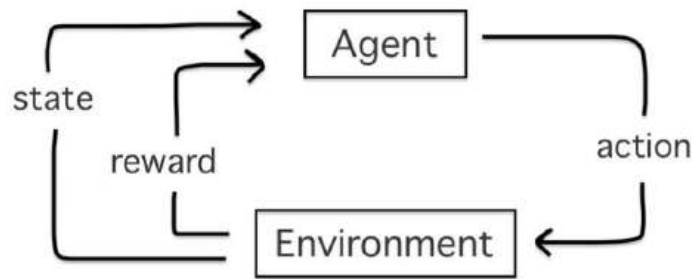
Figure 1: Markov Decision Process - Agent interacting with an environment.

Figure 1 shows a simplified diagram of how an agent interacts with its environment in the MDP setting. Here, the agent makes an action (selecting an 'arm' or option) and is subsequently conferred a reward from that action by the environment. Based on this reward, it updates the state, which corresponds to current knowledge about the reward probabilities of each arm. In our setting, MDPs are simplified to having a single state, as the latent reward likelihood of each bandit arm is unchanging.

There are many approaches to this problem that adhere to MDP dynamics; our aim is to find the most effective one under various different scenarios, including varying numbers of options, reward probabilities, and sequence lengths. Next, we explain how each of our evaluated algorithms works.

Methodology

We will focus specifically on five methods: ϵ-greedy, Upper confidence bound (UCB) (1-4), Thompson sampling (TS) (1, 4-5), full greedy and random (full exploration); Each will be simulated in Python. For our experiments, we impose a Bernoulli distribution - a tuple of $(A,\ R,\ \theta)$ - will be used to parameterize the reward probability θ of each bandit. A refers to the set of actions with each bandit (in this case "pull" or "don't pull"), and R is the reward size. This is a specific but popular instantiation of the bandit problem. Next, we assume the presence of K "bandits" with unknown reward probabilities $\{\theta_1,\ \theta_2,\ ...,\ \theta_K\}$. At each time step t, we perform an action $a\ \in\ A$ that selects a bandit and receives a reward $r\ \in\ R$. The expected reward of this action is $Q(a) =\ E[r|a]$, which estimates the reward size, calibrated by its probability of occurrence. Conveniently, Bernoulli bandits possess the equivalence that $\theta_i\ =\ E[r|i]$. Reward function R gives us a reward in a binary structure where the outcome is $r_t\ =\ R(a_t)$ at time step t. Hence, an action a_t on the i-th machine has an expected reward of $Q(a_t) = \theta_i$. The aim is to maximize total cumulative reward $\sum_{t=1}^{T} r_t$ or minimize regret L (for loss). In this setting, regret is the loss by not taking the optimal action a^* in hindsight with the optimal reward probability θ^*:

$\theta^* = Q(a^*) = max\ \theta_i$. The total regret at time step T is $L_T = E[\sum_{t=1}^{T} (r(\theta^*) - r(a_t))]$. The method with the smallest total regret will be concluded as the most effective approach to addressing the multi-armed bandit problem among the options considered in that setting.

In the first basic approach, **full greedy**, the agent first explores every bandit and then enters its exploitation phase where it picks the bandit with the highest reward probability. In the next naive, **random** approach, the agent perpetually explores randomly. Here, a random number generator (RNG) is used to arbitrarily choose a bandit. Due to this, all bandits are equally likely to be chosen and we infinitely explore. Hence, we expect poor performance from this method as it ignores the cumulative reward probabilities of each arm.

In the final three approaches we discuss, bandit reward distributions are progressively learned. In ϵ-**greedy**, the agent exploits the best option most times but sometimes explores other options with probability ϵ. The belief probabilities of the best action are calculated by normalizing the cumulative rewards that have been received from a bandit up to the current time step t: $\hat{Q}_t(a) = \frac{1}{N_t(a)} \sum_{\tau} r_{\tau} \mathbb{1}[a_{\tau} = a]$. Here, $\mathbb{1}$ is a binary indicator, and $N_t(a)$ is the number of times action a has been chosen until time step t: $N_t(a) = \sum_{\tau}^{t} \mathbb{1}[a_{\tau} = a]$. The agent explores with probability ϵ, and exploits with probability $1 - \epsilon$ the bandit with the best cumulative reward: $\hat{a}_t^* = \arg\ arg\ max_t\ \hat{Q}(a)$. A decay parameter can be used to decrease ϵ over time. However, we leave exploration of this to future work and instead explore Upper confidence bounds as a means of addressing this pathology.

Our next approach, **Upper Confidence Bound** (UCB), is quite similar to ϵ-greedy, but addresses the problem of naive exploration. UCB and ϵ-greedy exploit in the same way, though the key difference between these two methods is how they explore. In particular, UCB explores options for which it has the least knowledge (highest uncertainty) and also may confer the highest reward. Thus, we add an upper confidence bound $\hat{U}_t(a)$ to the bandit's expected average reward, essentially raising it to $\hat{Q}_t(a) + \hat{U}_t(a)$ based on how much the bandit has been visited.

To calculate this upper limit, we use this formula: $\hat{U}_t(a) = \sqrt{\frac{2log(t)}{1+N_t(a)}}$ derived by the original authors to confer theoretical guarantees. If option a has relatively few visits (small denominator), while all options collectively have many visits (large numerator), we would expect a large upper limit. Since we are taking the log of t in the numerator, the rate of increase of the UCB will be tiny as we approach large values of t. This shares properties with decayed ϵ-greedy sampling. Given UCB's theoretical guarantees, we expect it to outperform ϵ-greedy sampling over long horizons.

The final approach we explore is **Thompson sampling** (TS). Here, the agent selects options depending on their history of successes and failures in a Bayesian fashion; a Beta distribution is used as a prior and placed over each individual bandit. Beta priors are conjugate to Bernoulli likelihoods, leading to a closed-form Beta posterior from which we can sample. That is, conjugacy implies the distribution of our beliefs after collecting data by interacting with the system will match the functional form of the prior, a desirable property since the posterior will be closed-form. The posterior is thus represented by concentration parameters of success α and failure β. Consider an option with $\alpha = 9$ and $\beta = 6$. Here, we have 15 observations, with 9 giving a reward. This gives a success rate of 0.6, but with low confidence due to few observations. Contrarily, if another option has $\alpha = 56000$ and $\beta = 44000$, the reward probability is 0.56 with high confidence, as we have many observations as measured by the variance of the beta distribution: $var(Beta(\alpha, \beta)) = \frac{\alpha\beta}{(\alpha+\beta)^2(\alpha+\beta+1)}$. The Beta distribution captures this uncertainty and can incorporate new information from bandits to update its parameters. Next, we sample an expected reward probability $\widetilde{Q}(a)$ from each option from their distribution $Beta(\alpha_i, \beta_i)$ where parameters are updated with the observed bandit rewards. The action with the greatest sampled value (which is an estimate of success probability) is selected: $a_t^{TS} = \arg max\ \widetilde{Q}(a)$. Subsequently, the Beta distribution is updated: $\alpha_i = \alpha_i + r_t 1[a_t^{TS} = a_i]$, $\beta_i = \beta_i + (1 - r_t)1[a_t^{TS} = a_i]$. For TS simulations, we upweight bandits that haven't been chosen at all to ensure all are visited at least once.

Literature Review

Applications for MAB problems include recommender systems, advertising, and clinical trials. We can approach these applications using a variety of methods such UCB, TS, and ϵ-greedy. Each application may have a different optimal approach: while an approach may work best in a recommender system, it may be less efficient in a clinical trial with lower success likelihood and fewer options. More generally, the success of a given bandit method is contingent upon the length of the sequence, the number of bandits/options, and the variation in reward probabilities. In the next section, we outline the empirical findings in existing work and how it relates to our objective.

For example, Santiago Ontanon (2021) tested UCB in real-time strategy games. Here, the arms represent the possible actions the user can select from. This approach effectively balances exploration and exploitation and quickly finds strategies to advance in these types of games (Ontanon). Similarly, the work of Wei Chen et al. (2013) gives some applications of the MAB problem, such as online advertising (click-through ratios on a different number of webpages; it's difficult to deploy it on all webpages due to a limited budget) and social influence maximization for viral marketing (finding seed nodes which would maximize the spread of influence). Additionally, they test the combinatorial UCB (CUCB) algorithm on these two applications. It gets an impressively low cumulative regret of roughly $log(n)$, where n is the number of rounds

or trials (Chen et al.). We leave discussion of CUCB and the combinatorial bandits for future work.

Diverting our attention from UCB, methods ϵ-greedy and TS have been tested by Izzatul Umami et al. (2021). They also tested UCB, but it was much less successful than the other 2 competitive methods. Here, these methods are applied to a marketing dataset to increase brand awareness; they explain how MAB algorithms, such as TS, are much more effective than the standard A/B testing in this and many other applications. Additionally, they find that ϵ-greedy can be more effective in the very short term, and always gets overtaken by Thompson sampling: TS is more open to experimentation initially, compared with ϵ-greedy, therefore accumulating a higher total regret at first, whereas it is more exploitative than ϵ-greedy in the later stages, thus accumulating little regret (Umami). Likewise, Neha Gupta et al. (2011) tested methods, including UCB and dynamic Thompson sampling (DTS), using a Bernoulli distribution. The DTS method extends Thompson sampling by being able to adapt to changes in the reward distributions, such as in dynamic environments. In their setup, DTS had the smallest total regret and outperformed other approaches they tested (Gupta et al.).

In these papers, the authors centered on specific applications of and approaches to the MAB problem. Next, we shift our focus to the work of Djallel Bouneffouf et al. (2020), who give some general applications of MAB and effective approaches for them. For instance, UCB works best in optimizing portfolio selection to maximize returns and in dynamic pricing to calculate the specific price at which revenue is maximized. By contrast, TS works best in recommender systems, which shows users something they already like (exploitation), as well as other content to explore different potential interests (Bouneffouf et al.).

To further investigate these empirical findings at a more fundamental level, we test five approaches - ϵ-greedy, upper confidence bound, and Thompson sampling - with the aim of figuring out in which settings these approaches work best. Instead of picking specific applications, we keep our examination abstract and vary the parameters of the MDP: sequence length, number of bandits, and reward probabilities.

Materials and Methods

For each method, we performed 10 simulations of varying sequence lengths (100, 1000 and 10,000), number of bandits (5, 10 and 25), and reward distributions (similar and disparate reward probabilities). These varying hyperparameters were used to simulate diverse real-world contexts. For clarity, similar reward probabilities are tightly packed near similar values, for example: $\{0.48, 0.54, 0.51, 0.56, 0.45\}$. Here, each bandit gives approximately the same average reward. Conversely, with disparate reward probabilities, there is a particular bandit that stands out; for example: $\{0.05, 0.18, 0.80, 0.11, 0.20\}$. In this setting, only one bandit frequently gives a reward, while the others seldom do. Our results are captured in multiple line plots which show the cumulative regret for each method in different settings after n trials as well as a 95% confidence interval for variation.

The random selection method selects a bandit through an RNG, which selects an integer between one and the number of bandits, inclusively. It ignores the bandit parameters. For full greedy, initially, the agent randomly explores any unvisited bandit, and records its reward. After all bandits are visited just once, the agent selects the one with the highest reward probability and keeps updating each bandits' expected reward probability based on the reward conferred. If ties occur, exploration continues only until a single bandit produces the highest cumulative reward.

The initial phase in ϵ-greedy is the same as that of full greedy; it visits all bandits once. Then, a random decimal between 0 and 1 is generated. If it's less than epsilon (which we chose as $\epsilon = 0.2$), then it randomly selects a bandit (exploration). Oppositely, if it's greater than epsilon, it exploits the bandit which has the current greatest reward probability.

The agent in UCB (we implemented the UCB1 approach) selects bandits intelligently from the beginning. For each option, it sums the expected reward probability (total successes divided by total visits) and the upper confidence bound (based on the equation in the methodology), and selects the bandit with the greatest sum. In this method, it also directly sets a time variable, initially set as 0, and incremented by 1 after each bandit selection so it can use this variable in the equations to calculate the UCB.

In TS, we include 2 variables, a and b, referring to successes and failures respectively. To select a bandit, it creates a Beta distribution based on variables a and b. It then samples a reward probability from each bandit based on their distributions, and selects the one that generates the greatest probability. Parameters a and b are then updated to produce the posterior distribution, and the process is repeated for the next selection.

Results and Discussion

Figure 2: Cumulative regret for each method over various sequence lengths in a setting comprising 10 options with similar reward probabilities.

Figure 3: Cumulative regret for each method over various sequence lengths in a setting comprising 10 options with disparate reward probabilities.

Figure 4: Cumulative regret for each method over various sequence lengths in a setting comprising 25 options with similar reward probabilities.

Figure 5: Cumulative regret for each method over various sequence lengths in a setting comprising 5 options with disparate reward probabilities.
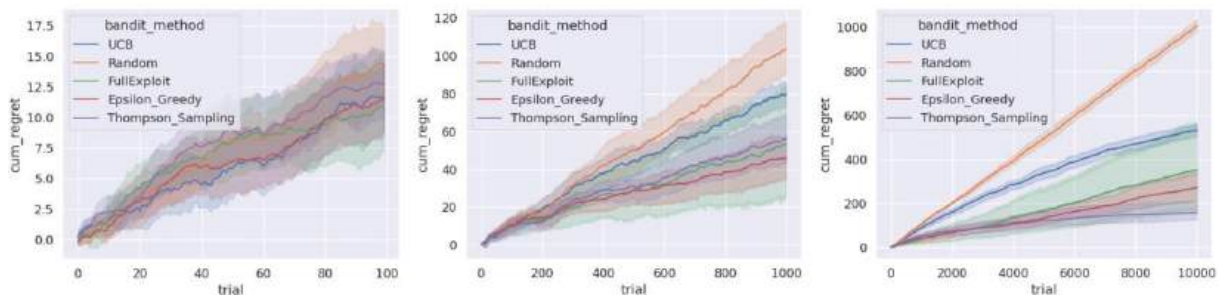
Figure 6: Cumulative regret for each method over various sequence lengths in a setting comprising 5 options with similar reward probabilities.
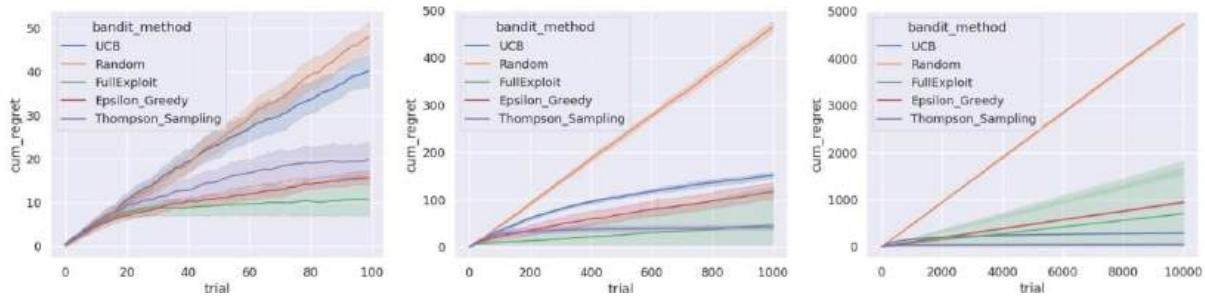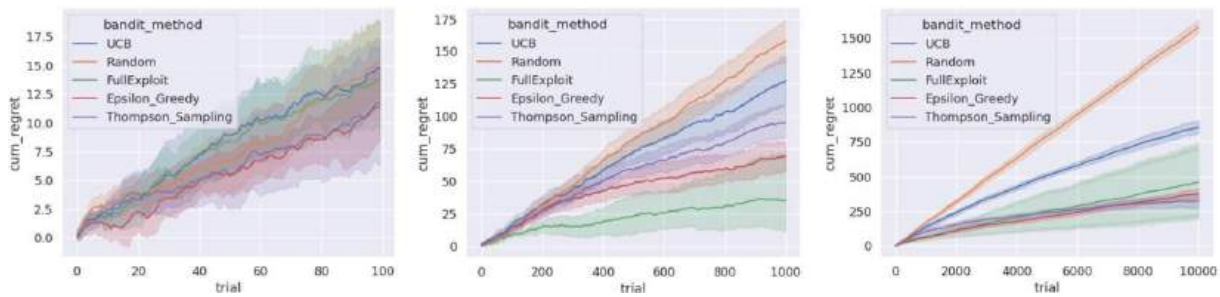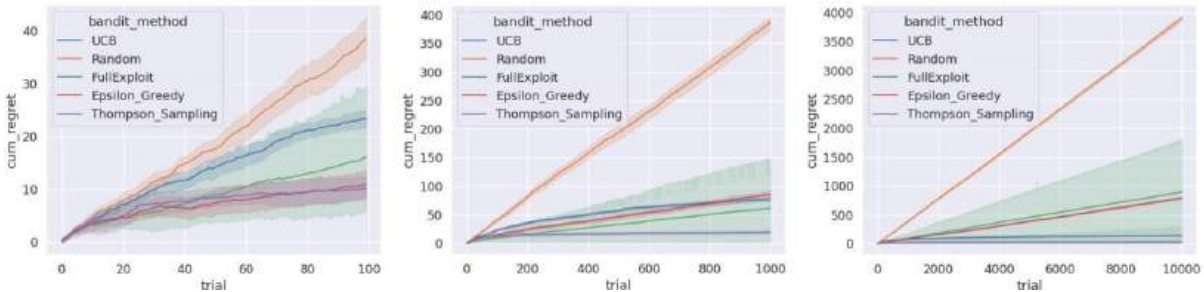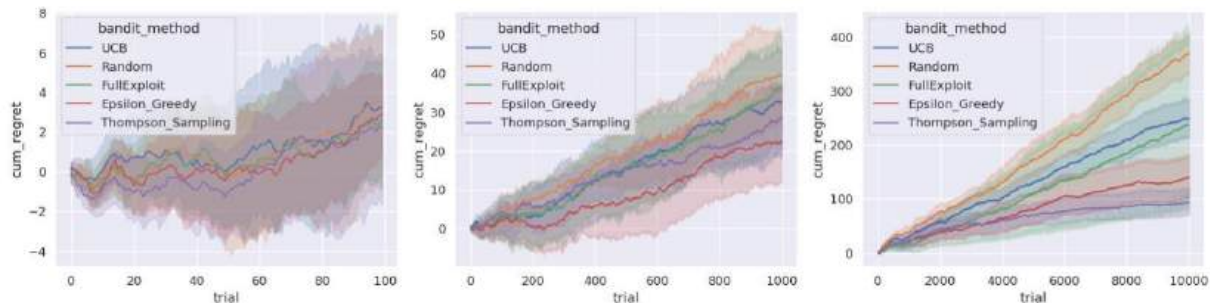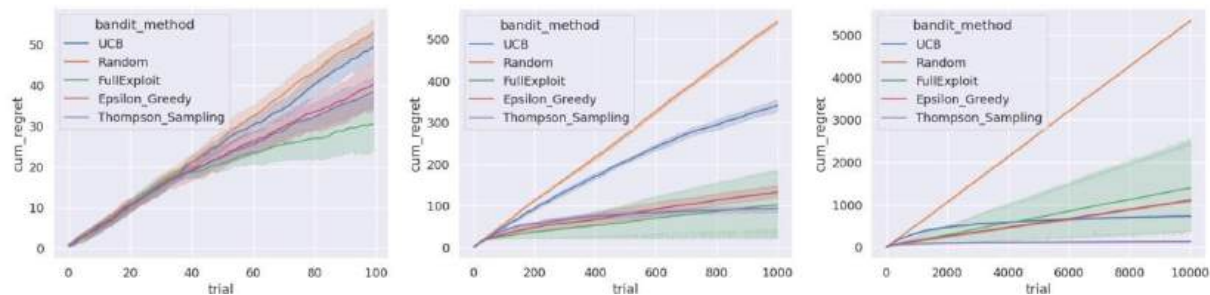

Figure 7: Cumulative regret for each method over various sequence lengths in a setting comprising 25 options with disparate reward probabilities.

After rigorous experimentation, it was clear that the random selection method showed the lowest performance; the plots showed a constant rate of increase of regret (they are roughly linear), demonstrating that it doesn't learn from its actions, as a random number generator selects the next bandit choice.

The next approach, full greedy, shows extreme variation between simulations, beating all methods in some, as observed in the best variant in Figure 2 - 1000 trials, while performing second to last in others, as seen in the worst variant in the same figure (Figure 2 - 1000 trials). Depending on the bandit it selects for its exploitation phase, it may generate incredibly low, or relatively high, regret: selecting the optimal bandit results in near-zero regret, while selecting a sub-optimal (or even some of the worst) bandit accumulates large regret, especially where reward distributions are disparate. Though appealing to see near-zero cumulative regret in some simulations, it is safer to avoid this method due to the high variance it possesses: it can generate a profoundly large cumulative regret in all but the most trivial cases.

Moving on to ϵ-greedy, the balance between exploration and exploitation is offset by its sensitivity to the epsilon hyper parameter, resulting in mediocre performance (generally third place). In long-term cases (10,000 trials), it outperforms the two naive approaches but loses to UCB and TS, as expected: these two methods are essentially ϵ-greedy where at each iteration epsilon is chosen intelligently and options are explored judiciously, rather than randomly. In the

short term (100 trials), our results show that the agent gains lower regret in settings with similar reward probabilities than in settings with disparate reward probabilities: regret of roughly 45 with similar reward probabilities (Figure 2 - 1000 trials) compared with 120 with disparate reward probabilities (Figure 3 - 1000 trials). However, we expected this method to work more efficiently with disparate reward probabilities, as the agent would easily identify the optimal bandit and exploit it with probability 0.8 ($\epsilon = 0.2$). Although, with disparate probabilities, the agent also gains substantial regret when exploring, offsetting the advantage of quickly identifying the optimal bandit. Conversely, with similar reward probabilities, the agent takes longer to recognize the optimal bandit, but also gains trivial regret when exploring. Hence, similar reward probabilities serve a greater advantage than disparate probabilities, especially in the long run: once the agent identifies the optimal bandit with high confidence, exploring becomes the primary source of regret. Lastly, unlike in UCB and TS, the regret does not plateau over time, rather it becomes linear as it continues to explore 20% of the time due to its fixed epsilon parameter.

Shifting our focus to the more mathematically sophisticated methods, upper confidence bound (UCB) maintains high-variance behavior, with high regret in many settings and exceptionally low in some. Since the agent always exploits the expected optimal bandit (the one with the greatest sum of expected reward probability and UCB), the upper limit decreases on that option, while increasing on the others, and the upper limits increase at a greater rate initially than in the later stages (due to the logarithm function utilized). This continually changes the expected optimal bandit, making the agent thoroughly explore most (or all) options, serving as a disadvantage, until the upper limits increase gradually. This is why poor performance is observed in short term settings (100-1000 trials). Settings where UCB performs poorly involve numerous bandits or similar reward probabilities. With many bandits, there are more options that the agent must explore thoroughly, further increasing regret. Looking at a short-term setting, with many bandits and similar reward probabilities (figure 4 - 100 to 1000 trials), we notice that UCB's performance is quite similar to the random selection method; UCB is relatively explorative in the short term. Additionally, when options have similar reward probabilities, only a small upper limit on sub-optimal options is needed for the agent to temporarily explore those options. Hence, in these settings, the expected optimal bandit perpetually changes, even often in the long run when there are many bandits. This makes the agent constantly swap between options to exploit, resulting in increased regret. Due to this, we expect UCB to work optimally in settings with fewer bandits with disparate reward probabilities, which is what Figure 5 - 10,000 trials depicts; here, UCB comes in second place relative to other methods, but performs optimally relative to its own performance in other long term settings. Like that of ϵ-greedy, the rate of increase of total regret decreases with time in UCB, but also plateaus in some settings. Though, we can never reach a true plateau, since we maintain the view that the agent still explores infrequently even when it likely knows the right bandit choice, which is a potential benefit as the optimal bandit is never known with definite certainty. However, we can consider it to plateau as the regret gained from momentarily switching to a suboptimal bandit can be considered negligible. Plateaus

appear earlier in settings with few options with disparate reward probabilities, as UCB has optimal performance in these settings (Figure 5). Conversely, they appear later (or don't appear until 10,000 trials) in settings with numerous bandits and similar reward probabilities (Figure 4) - when UCB performs poorly.

Our final method, Thompson Sampling (TS) performed exceptionally well in general. It performed worse in settings with similar reward probabilities than with disparate reward probabilities. This is because, with similar reward probabilities, posterior distributions over bandits are quite similar; hence, when sampling an expected reward probability, sub-optimal options may generate a greater probability than the optimal option and be selected. In fact, this problem persists even in the long term (Figure 6 - 10,000 trials), when we expect the agent to have identified the optimal bandit with high confidence: in settings where options have similar reward probabilities, cumulative regret does not plateau, though they are very close to achieving it; at 10,000 trials, with similar reward parameters, the beta distributions are still relatively variant; a lower variance would be needed (for similar reward probabilities) to consistently sample a higher reward probability from the optimal bandit than from other bandits, to perpetually exploit the optimal bandit. Conversely, with disparate reward probabilities, the beta distribution of the optimal bandit is noticeably further from those of other options. Hence, after even only some exploration, sub-optimal bandits would sample a lower probability than the optimal bandit in most cases, resulting in accumulating small regret after relatively little exploration. As observed in Figure 7, TS's cumulative regret plateaus in the mid-term (1000 trials), showing contrast with Figure 6 where the regret doesn't plateau even in the long-term (10,000 trials). The two types of settings where TS underperformed were short sequence-length (100 trials), and medium sequence-length (1000 trials) paired with similar reward probabilities. Looking at short-term settings (100 trials), we observe poorer performance as there is too little history of action outcomes for each bandit; the Beta distributions are quite entropic, and the sampled probabilities are almost random. For the latter setting, there was relatively poor performance as 1000 trials weren't enough to figure out the optimal bandit with high confidence (where bandits had similar reward probabilities). However, TS outperformed other approaches in all long-term settings (10,000 trials) and, with options having disparate reward probabilities, medium-term settings (1,000 trials) as well.

Conclusion

In our experiments, we tested 3 sophisticated methods and 2 baselines for tackling the explore-exploit objective: ϵ-greedy, Upper Confidence Bound (UCB), and Thompson Sampling (TS). Their performance varied as we modified the settings by changing sequence lengths, number of bandits or options, and the similarity of reward distributions. UCB and ϵ-greedy performed well in some specific settings, while TS performed well in general. UCB shows optimal performance in long sequence-length settings with few bandits with disparate reward probabilities. Similarly, TS performs optimally in any setting where options have disparate reward probabilities (and ideally with a long sequence length). Since TS outperforms UCB in

just about any setting we explored, we recommend using it over UCB; we leave future experiments to find settings where UCB outperforms TS.

Finally, ϵ-greedy shows optimal performance when options have similar reward probabilities and the sequence length is mid-term (1000-trials). Over a longer period of time, this method will continue to gain regret due to its epsilon hyperparameter. Though this method has great potential to work much effectively over the long-term: if a decay parameter, which reduces epsilon over time, was introduced, the agent would reduce how often it explores, which would essentially plateau the cumulative regret over time. We encourage future experiments to implement decay parameters and see whether this would outperform UCB or TS over the long term. Additionally, since we used a Bernoulli distribution for its simplicity, we encourage future research to use alternative distributions for reward probabilities beyond Bernoulli, and see how methods' performance changes with this modification.

Connecting our findings to the real world, let's focus on advertising and clinical trials. In advertising, we may have lots of different variants of the advert (many bandits), with similar reward probabilities, and we can consider it to be a long-term scenario (as there is lots of data: billions of internet users). Here, we expect TS would be most efficient, primarily due to the long sequence length. Conversely, in clinical trials, we would expect few bandits with really high reward probabilities (disparate reward distribution), with few data points (short-term case). Hence, ϵ-greedy could work effectively here. Additionally, due to its versatility, TS would be an effective alternative algorithm for clinical trials. In general, we conclude it is essential to deeply understand the sequence task in order to effectively address the explore-exploit trade-off.

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How Far Are We From The Illustration and Story In "Ready Player One"? Focusing on Haptic Technology By Young-Wook Suh Sohn

Abstract

"Ready Player One," a novel by Ernest Cline, transports readers to a dystopian future where virtual reality (VR) has become the primary escape for humanity. Central to this virtual utopia is the OASIS, a digital universe where users interact using sophisticated haptic technology. Haptic suits and gloves in this narrative provide users with the sensation of touch, temperature changes, and even pain, blurring the lines between the virtual and physical worlds. This vivid portrayal of haptic technology has sparked interest and inspired advancements in real-world haptic systems. Studying the advancements in haptic technology is crucial for several reasons. It allows us to evaluate the progress toward achieving immersive VR experiences similar to those depicted in "Ready Player One." Additionally, understanding the current state and potential future developments of haptic technology helps identify challenges and opportunities in various sectors, including entertainment, medicine, and rehabilitation. By comparing fiction with reality, we can measure the feasibility of achieving such advanced technologies and their potential impact on society. This paper aims to compare the fictional haptic technology in "Ready Player One" with current real-world advancements. This comparison will be made by examining technological innovations, capabilities, and limitations of contemporary haptic devices. Through this analysis, we aim to assess how far we are from achieving the immersive experiences depicted in the novel and explore the prospects of haptic technology.

1. Tactile Feedback: The Interface between Technology and Human Touch
1.1 Definition and Function of Mechanoreceptors

Mechanoreceptors are specialized sensory receptors embedded in the skin that respond to mechanical stimuli like pressure, vibration, and texture. These receptors play a vital role in our sense of touch, enabling us to interact with our environment by perceiving physical sensations. The primary types of mechanoreceptors include Merkel cells, Meissner's corpuscles, Ruffini endings, and Pacinian corpuscles, each responsible for detecting different aspects of touch.

- Merkel cells: Detect fine details and sustained pressure.
- Meissner's corpuscles: Respond to light touch and low-frequency vibrations.
- Ruffini endings: Sense skin stretch and sustained pressure.
- Pacinian corpuscles: Detect deep pressure and high-frequency vibrations.

The texture sensation is primarily mediated by Merkel cells and Meissner's corpuscles. Merkel cells respond to fine details and edges, allowing us to discern intricate textures. Meissner's corpuscles are sensitive to low-frequency vibrations, contributing to the perception of smooth or rough surfaces. Temperature sensation is detected by thermoreceptors, which are sensitive to changes in skin temperature. Nociceptors, which detect pain, play a role in alerting the body to potentially harmful stimuli. Vibration sensations are primarily mediated by Pacinian

corpuscles, which respond to high-frequency vibrations. These receptors enable a comprehensive range of tactile experiences, essential for creating realistic haptic feedback in VR and AR applications.

Thermoreceptors are specialized sensory receptors that detect temperature changes. They are divided into two main types: cold receptors and warm receptors. Cold receptors are sensitive to decreases in temperature, while warm receptors respond to increases in temperature. Nociceptors, on the other hand, are responsible for detecting painful stimuli, and alerting the body to potential harm. These receptors play a crucial role in creating realistic haptic feedback, as they contribute to the sensation of temperature changes and the perception of pain, enhancing the overall immersive experience in VR and AR.

1.2 Definition and Significance of Tactile Feedback

Tactile feedback, or haptic feedback, involves the use of touch sensations to convey information to the user. In haptic technology, this feedback is simulated through devices that mimic the feeling of physical interactions, such as textures, temperatures, and vibrations. Tactile feedback is significant because it enhances user immersion and interaction, making digital experiences more intuitive and realistic.

1.3 Applications of Tactile Feedback in Technology

In VR and AR, tactile feedback is essential for enhancing user immersion. By providing realistic touch sensations, haptic technology allows users to feel objects in the virtual world as if they were real, improving the overall experience. For instance, when a user reaches out to touch a virtual object, haptic gloves or suits can simulate the feeling of the object's texture, weight, and resistance, making the interaction more intuitive and engaging.

Haptic technology has significant applications in gaming and entertainment. By providing tactile feedback, haptic devices can simulate the feeling of holding objects, receiving impacts, or interacting with virtual environments, adding a new dimension to gameplay. For example, a player wearing a haptic suit can feel the impact of a punch in a fighting game or the recoil of a gun in a first-person shooter, enhancing the overall gaming experience.

In the medical field, haptic technology is used in rehabilitation devices to help patients regain motor skills by providing tactile feedback during exercises [6]. For example, haptic gloves can be used to simulate various textures and resistances, helping patients improve their hand strength and dexterity. Haptic technology is also used in surgical simulators to train medical professionals by simulating the tactile sensations of surgical procedures, allowing them to practice their skills in a safe and controlled environment.

2. Haptic Technology in "Ready Player One"

2.1 Description of Haptic Suits and Gloves in the Novel

In "Ready Player One," haptic suits and gloves are described as advanced devices that provide full-body tactile feedback. These suits are equipped with numerous sensors and actuators that deliver a wide range of sensations, from gentle touches to intense impacts, making the virtual experience remarkably lifelike. The gloves, similarly, allow users to feel the texture and weight of virtual objects, enhancing their sense of presence and immersion in the virtual world.

The haptic suits in the novel offer full-body feedback, allowing users to feel sensations across their entire body. This includes the sensation of touch, pressure, temperature changes, and even pain, providing a highly immersive experience that closely mimics real-life interactions. The suits are designed to deliver precise and realistic feedback, making the virtual world feel almost indistinguishable from the real one.

2.2 Immersive Experience through Tactile Sensations (VR + AR)

The novel emphasizes the importance of tactile sensations in creating an immersive VR experience. By integrating tactile feedback with visual and auditory stimuli, the haptic suits and gloves in "Ready Player One" create a seamless and engaging virtual world where users can interact with their surroundings as if they were real (Literal, 2023). This level of immersion is achieved through the precise and responsive feedback provided by the haptic devices, allowing users to feel every interaction in the virtual world.

The haptic technology in "Ready Player One" is capable of simulating a wide range of sensations, including touch, temperature changes, and pain. This allows users to experience the virtual world in a highly realistic manner, enhancing their sense of presence and engagement. The suits and gloves are equipped with advanced sensors and actuators that deliver precise and realistic feedback, making the virtual world feel almost indistinguishable from the real one.

One of the key features of the haptic technology in the novel is its ability to provide real-time interaction and feedback. This means that users receive immediate tactile responses to their actions in the virtual world, creating a dynamic and responsive experience. The haptic devices are designed to deliver precise and realistic feedback, allowing users to feel every interaction in the virtual world in real-time.

3. Current State of Haptic Technology

3.1 Overview of Recent Advancements

Haptic gloves have seen significant advancements in recent years. These gloves are equipped with sensors and actuators that provide tactile feedback to the user's hands, simulating the sensation of touch and interaction with virtual objects (Literal, 2023). Modern haptic gloves offer features such as force feedback, which simulates resistance when interacting with virtual objects, and vibrotactile feedback, which mimics the sensation of textures and vibrations.

Modern haptic gloves offer a range of features designed to enhance the user experience. Force feedback, for example, allows users to feel the resistance and weight of virtual objects, making interactions more realistic. Vibrotactile feedback mimics the sensation of textures and vibrations, adding another layer of realism to the virtual experience. Users have reported a more immersive and realistic experience when using these gloves, although there are still limitations in terms of precision and comfort.

Haptic gloves are used in various applications, including gaming, training simulations, and remote robotic control. In gaming, haptic gloves can enhance the overall experience by providing tactile feedback for in-game interactions. In training simulations, haptic gloves can be used to simulate real-world tasks, allowing users to practice their skills in a controlled environment (Hayward, 2018). In remote robotic control, haptic gloves can provide operators

with tactile feedback, improving precision and control. While users have reported a more immersive and realistic experience with haptic gloves, challenges remain in terms of cost, accessibility, and the range of sensations that can be accurately simulated.

Furthermore, haptic suits, which provide full-body feedback, have also seen advancements. These suits are equipped with a network of sensors and actuators that deliver tactile feedback to different parts of the body (Literal, 2023). Modern haptic suits offer features such as localized vibration, pressure simulation, and temperature control.

Modern haptic suits offer a range of features designed to enhance the user experience. Localized vibration allows users to feel specific sensations on different parts of their body, while pressure simulation can mimic the feeling of touch and impact. Temperature control adds another layer of realism by simulating temperature changes. Users have reported a more immersive experience with haptic suits, although there are still challenges related to wearability, comfort, and the range of sensations that can be accurately simulated.

Haptic suits are used in various applications, including gaming, training simulations, and therapeutic applications. In gaming, haptic suits can enhance the overall experience by providing full-body feedback for in-game interactions. In training simulations, haptic suits can be used to simulate real-world tasks, allowing users to practice their skills in a controlled environment. In therapeutic applications, haptic suits can be used to provide tactile feedback during rehabilitation exercises, helping patients improve their motor skills. While users have reported a more immersive and realistic experience with haptic suits, challenges remain in terms of precision, comfort, and cost.

3.2 Key Technologies and Their Functionalities

Tactile sensors are used to detect touch and pressure. They are essential for providing accurate and responsive feedback in haptic devices. These sensors convert physical stimuli into electrical signals that can be processed by the haptic system, allowing it to deliver realistic feedback to the user.

Actuators are used to deliver tactile feedback to the user. They can simulate a range of sensations, including vibrations, pressure, and temperature changes. Actuators work by converting electrical signals into physical movements or forces, creating the sensation of touch or interaction with virtual objects.

3.3 Limitations and Challenges

One of the main challenges in haptic technology is achieving precise and accurate feedback. Current devices often struggle to replicate the full range of human tactile sensations. Improving the precision and accuracy of haptic feedback is essential for creating more realistic and immersive experiences.

Another challenge is ensuring that haptic devices are comfortable and wearable for extended periods. Many current devices need to be more light and comfortable, limiting their usability. Improving the comfort and wearability of haptic devices is crucial for their widespread adoption.

Haptic technology is often expensive, making it inaccessible to many users. Reducing costs and improving accessibility is a key challenge for the industry. Developing more affordable haptic devices and improving distribution channels are essential for making this technology available to a wider audience.

4. Comparison of Fiction vs. Reality

4.1 Similarities between "Ready Player One" Haptics and Current Technology

The goal of "Ready Player One" and contemporary haptic technology is to create incredibly immersive virtual worlds. The approach that current haptic tools are designed enhances users' awareness of and engagement with their virtual environments by offering genuine tactile sensations. Similar to OASIS from the novel, this is indicative of a larger goal that aims to blur the distinction between reality and what is portrayed on screen. Wade Watts in "Ready Player One," for instance, uses sophisticated haptic gloves and outfits that allow him to touch objects inside OASIS as though they were real, making it far more realistic than anything on Earth (Cline, 2011).

The sense of touch is a crucial component of haptic technology in both real and fictional works. One of the greatest ways to enhance immersion and engagement in VR and AR is through the use of touch. The primary function of modern HHDs, which are frequently integrated into gloves and vests, is to simulate touch to enhance authenticity and interest in contact. This resembles the haptic system, which is described in "Ready Player One," in that it allows users to interact with objects by touching and manipulating them like they are real. Wade, for example, experiences the feel of velvet drapes or the grains of a wooden staff, illustrating the degree of touch experience that third-generation haptics aim to provide (Cline, 2011).

Furthermore, it is feasible to observe that emerging technologies in the field of haptics appear to be taking science fiction one step closer to reality. Among the companies using haptic garments to provide haptic input on various body areas are HaptX and Teslasuit. These advancements show that haptic experiences, like those in "Ready Player One," are still being researched and pursued. HaptX gloves, for instance, provide accurate tactile feedback of virtual objects through the use of microfluidics. Similar to this, the Teslasuit uses biometrics and motion-capturing technology to provide users with full-body haptic stimulation. They demonstrate some of the progress made in this area of study, but they also highlight the remaining challenges.

4.2 Differences and Gaps

Still, it falls short of the "Ready Player One" novel in terms of story development and immersion. The haptic suits and gloves in the book create an impeccable, exquisitely detailed virtual world that is still above the capabilities of current technology. These are the senses—touch, pressure, temperature, and even some sorts of pain—that are mentioned in passing in the novel but have not yet been integrated into modern technologies. Wade, for instance, may "feel" the cold of a virtual snowball or the heat of a virtual fire, something that modern haptic devices are unable to do. Wade feels this in the OASIS to a great extent (Cline,

2011). While current haptic devices can let the user only feel vibrations and basic pressure, they do not allow discernment of the variety of sensations referring to the fiction technology.

The current issue with haptic technology is that it is difficult to characterize its dynamic changes and real-time responsiveness. One of the most difficult tasks is to provide a prompt response that matches a user's activities in a virtual environment. Because "Ready Player One" uses immediate haptic technology, the experience is highly responsive. However, reaction latency and imprecise feedback are hallmarks of modern peripherals, which significantly reduce immersion. For instance, Wade was able to successfully engage with the virtual environment because of the explosion of his suit, which gave him the ability to feel the reaction to every motion he made (Cline, 2011). Currently, however, there is a clear difference between what technology is and what is described in fiction since the technology that is being used may react slowly to orders, potentially interrupting the user's interaction with the artifact.

The range and intensity of emotions that may now be experienced using haptic devices are likewise largely limited to those that are detailed in "Ready Player One." The haptic technology used in the novel includes a wide range of capabilities, including the capacity to sense temperature as well as other sensations related to textures and forces. In contrast, current haptic devices often only support the most fundamental skin sensations, such as pressing and vibrations. It's nevertheless a big challenge to obtain full body covering and an extended region of feeling. Haptic suits are described in the book as providing users with sensory data on all bodily functions and other elements. Wade can feel things like a little breeze on his skin or a punch during a fight, which is not possible with the haptic suits of today (Cline, 2011). In this respect, current technologies are limited to certain sectors and are unable to cover the entire body with the same degree of detail or in the way outlined in the novel.

The integration of haptic technologies with existing VR and AR systems is another issue. Given that haptic technology is a component of the virtual world, its application in the film Ready Player One is well-narrated. In this instance, real-world technology is not yet at the point where such integration is possible; there are frequent issues with synchronization, compatibility, and the general challenges of developing such a system that is flawless in its operation. Haptic technology now faces a few challenges, such as informing the user of their contact with the device through the usage of many, often disjointed components and systems. Wade's suit and visor, for example, are worn flawlessly as a single unit, producing cohesive sensory feedback that haptic technology has yet to effectively combine (Cline, 2011).

5. Future Prospects and Innovations

5.1 Potential Advancements in Haptic Technology

Future advancements in haptic technology may provide more detailed and realistic sensory feedback. This could include more accurate simulations of textures, temperatures, and vibrations. Developing more sophisticated sensors and actuators is essential for achieving this level of realism.

Improving the wearability and comfort of haptic devices is a key goal for the industry. This could involve developing lighter, more flexible, and more comfortable materials. Enhancing

the ergonomic design of haptic devices is crucial for their widespread adoption and long-term use.

Reducing the cost of haptic technology and making it more accessible to a wider audience is another key goal, as haptic gloves and suits range from 200 to 300 dollars (Knoxlab, 2024). This could involve developing more affordable devices and improving distribution channels. Ensuring that haptic technology is accessible to a broader range of users is essential for its widespread adoption.

5.2 Integration with Other Technologies

Integrating AI and machine learning into haptic technology could enable more adaptive and responsive feedback. This could involve using algorithms to tailor feedback to the user's actions and preferences. AI and machine learning can enhance the precision and accuracy of haptic feedback, creating more immersive and personalized experiences.

Integrating haptic technology with other sensory technologies, such as olfactory and auditory feedback, could create more immersive and multi-sensory experiences. This could involve combining touch, smell, and sound to create a more comprehensive virtual experience. Developing systems that integrate multiple sensory modalities is essential for achieving the level of immersion described in "Ready Player One."

5.3 Ethical and Societal Considerations

The widespread use of haptic technology could have significant impacts on human interaction and behavior. This could involve changes in how people communicate, interact, and experience the world around them. Understanding the social and psychological implications of haptic technology is essential for its responsible development and use.

The use of haptic technology also raises privacy and security concerns. Ensuring that user data is protected and that devices are secure is a key challenge for the industry. Addressing these concerns is crucial for building trust and ensuring the responsible development and use of haptic technology.

6.   Conclusion

The comparison between the haptic technology described in "Ready Player One" and current real-world advancements reveals significant progress, but also notable gaps. While there have been substantial advancements in haptic gloves and suits, achieving the same level of sophistication and immersion described in the novel remains challenging. Current devices offer a more immersive experience than ever before, but they still need to catch up to the novel's vision in terms of precision, comfort, and the range of sensations that can be simulated.

We are making strides towards the haptic technology depicted in "Ready Player One," but there is still a long way to go. Current devices offer a more immersive experience than ever before, but they still need to catch up to the novel's vision in terms of precision, comfort, and the range of sensations that can be simulated. Achieving the same level of sophistication and immersion described in the novel will require significant advancements in sensor technology, actuator design, and integration with other sensory modalities.

The future of haptic technology holds great promise, with potential advancements in sensory feedback, wearability, and integration with other technologies. However, addressing the challenges of precision, comfort, and cost is essential for realizing the full potential of haptic technology. As we move closer to the vision of "Ready Player One," it is important to consider the ethical and societal implications, ensuring that these technologies are developed and used responsibly. By doing so, we can harness the power of haptic technology to create more immersive and engaging experiences while addressing the potential risks and challenges associated with its use.

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A Placebo for Caffeine: Measuring Performance Enhanced by a Caffeine-Induced Placebo Effect on the Flesch-Kincaid Scales By September Jiang

Abstract

Caffeine, a chemical component of popular "wake-up" beverages, has been utilized for its psychoactive properties, but has been found to have detrimental health consequences such as accumulation of harmful substances, heart disease, and other side effects. A study was conducted to explore the placebo effect created by consumption of caffeine in high school students aged 15–18 using the Flesch-Kincaid scoring scales. Participants will compare their performance from before and after the treatment in which all subject groups will be given a placebo rather than the chemical compound caffeine to test the hypothesis that participants who believe they consumed caffeine will perform significantly better than the participants who do not believe they consumed caffeine.

Keywords: *caffeine, placebo, induced placebo effect, Flesch-Kincaid, reading ease, adolescents*

Introduction

The consumption of coffee and other "wake-up" beverages are becoming progressively more popular in modern society. They are taken daily by 80% of the population globally (Lin et al.) and are expanding to be the most commonly consumed psychostimulant worldwide (Anderson and Horne; Lin et al.). But what makes these cups of encouragement exceptional is a chemical compound known as caffeine (scientifically known as trimethylxanthine). Caffeine, the major component of these beverages, is a psychoactive drug that acts as a nervous system stimulant, speeding up processes between the brain and body (Fiani et al.). It is widely believed that caffeine provides a heightened sense of alertness, backed by the fact that caffeine molecules bond to the brain's adenosine receptors—the part of the brain that causes feelings of fatigue—and causes rapid releases of adrenaline (Miller). Due to the fact that caffeine's products are built upon its foundation of chemical properties and assumption by its consumer base, (Nastaj et al.), there is almost a guaranteed placebo effect (Miller)—a phenomenon defined as an inert substance given as medicine for its suggestive effect while appearing identical in appearance to the material being testing in experimental research (Salciunaite and Leonas).

The rise of caffeine consumption, especially in adolescents, can be attributed to caffeine's benefits, such as shortening reaction time (Lin et al.), improving cognitive performance, and amplifying mental awareness (Nastaj et al.; Salciunaite and Leonas). It has also been found to be a popular ergogenic aid in sports by demonstrating performance-enhancing effects (Filip-Stachnik et al.; "PLACEBO POWER"). But caffeine—its copious benefits—is still a drug (Anderson & Horne, 2008), and adolescents, in particular, are much more prone to addiction due to their developing brains. When combined with the knowledge that caffeine can augment attentional function and physiological performance (Lin et al.), adolescents tend to consume caffeinated beverages more frequently and in larger dosages. However, the acute advantages

provided by large doses of caffeine (Lin et al.) are overwhelmed by the detrimental health consequences.

Consumption of caffeinated beverages can accumulate harmful substances such as sugars, fats, and harmful food dyes (Bristol), and it may even be linked to many heart diseases. Common side effects experienced by people, regardless of age, include shakiness, tremors, insomnia, and headaches; not to mention, caffeine is a diuretic, a substance that causes frequent urination and eventual dehydration (Temple et al.). This drug has been shown to elevate blood pressure (Salciunaite and Leonas) in sharp, irregular spikes (Flaten et al.; Lin et al.), which can lead to sporadic occurrences of tachycardia—rapid heart rate typically over 100 bpm ("Tachycardia"). Moreover, tachycardia is commonly seen as a sign of potential heart failure, stroke, or sudden cardiac death—especially if left untreated. ("Tachycardia").

Literature Review

The placebo effect caused by consuming caffeinated beverages has been largely studied; usually, a group of participants are administered caffeine and another, the placebo group, is given something insignificant, such as decaffeinated coffee containing less than 6.6 grams per 100 mL of water (Salciunaite and Leonas). The results provided by the placebo itself, though, are intriguing. Rather than act as a control group used for comparison, the placebo group acts nearly as another experimental group. For instance, in the study conducted by Anderson & Horne (2008), the placebo caffeine group showed significant improvement in the performance of moderately sleepy people. Further, caffeine typically takes at least half an hour or more to become pharmacologically effective whereas, here, the placebo effect kicked into action much quicker (Anderson and Horne).

Customarily, studies are conducted to observe differences between effects caused by caffeine and other xanthines, a group of alkaloids that work as mild stimulants ("Xanthine Derivatives"), but, recently, there have also been more studies isolating just the placebo. Nastaj et al. noted that placebos can create an anesthetic effect when concerning pain, can show more authenticity in creative tasks, increase IQ test results and Stroop-effect task performance, and enhance memory. They deduced from their research that the placebo effect was not enough to reduce the misinformation effect when administered to subjects as caffeine (Nastaj et al.); however, there was a major factor not controlled in this experiment that may or may not affect credibility of the results.

When considering or attempting to guarantee the placebo effect, two mechanisms must be taken into account: an individual's expectancy and conditioning. Expectancy is defined as "an ability to predict certain events or results, in other words, expectancy describes individual's belief to receive certain outcomes" while conditioning is the "learning process in which neutral stimuli become associated with particular body reactions which eventually can be caused by presentation of that stimuli" (Salciunaite and Leonas). In this case, expectancy would be the belief of the participant that, after ingestion of caffeine, their ability to learn is increased and that their short-term memory as well as memory performance has been temporarily enhanced (Nastaj

et al.). The conditioning would be the daily consumption of coffee of each individual, which is about 200 to 400 mg of caffeine (Flaten et al.).

The conclusion reached by Nastaj et al. was most definitely inconclusive because only expectancy was factored into the experiment, leading them to state that the placebo was too subtle and therefore not sufficient in reducing the misinformation effect. This happened similarly in a study conducted by Flaten et al. in which strong expectations about the effects of coffee did *not* generate placebo responses after administration of decaffeinated beverages, leading them to claim that the expectancy theory of the placebo effect received only limited support from their research. It was Salciunaite and Leonas that found that both expectancy and conditioning would be required to invoke a placebo effect significant enough to produce observable results. When a placebo is led only by expectancies, which had been the circumstance for both Flaten et al. and Nastaj et al., the results tend to be insignificant (Salciunaite and Leonas). Only after the placebo is guaranteed to be at the scale at which results will provide sufficient data to support or reject a hypothesis can the data obtained from harnessing the placebo effect be used for a specific goal.

While many studies have shown that caffeine-induced placebos produced outcomes exaggerating the effects that normally would result from caffeine consumption, there are fewer studies centered around how the caffeine-induced placebos would behave when *all* participant groups are receiving a placebo treatment. Usually, the placebo is to function as a control and sometimes, a control group. Conversely, a study was conducted in which subjects were told they were to consume two solutions in a random order, one caffeine and another placebo, but were blind to the fact that they would be receiving the placebo in both situations ("PLACEBO POWER"). The researchers found that when participants believed that they'd ingested the caffeine solution, they performed significantly better when compared to the control group; they even suggested that there is a strong possibility that caffeine's effects are partly contributed to the placebo effect ("PLACEBO POWER").

The only gap in research is the significance of the placebo effect created by caffeine when isolated. If significant effects are found, they could provide many directions for the research to head in. One major gain would be utilizing caffeine's benefits while avoiding any undesirable side effects or health issues, especially those affecting developing brains in adolescents.

To measure this significance, performance due to "caffeine" would need to be quantified and compared. One such way that has not been considered, or at least is not common enough to be a widespread method, is quantification on the Flesch-Kincaid (FK) scoring scale(s) to analyze students.

There are two Flesch-Kincaid scores: the FK Reading Ease score and the FK Grade Level (*Readable*). The FK Reading Ease scores a text with a value between 1 and 100 with 100 describing a paper with the highest level of readability; meanwhile, the FK Grade Level assesses the approximate reading level of a text with a value between 0 and 18 with a score ranging 15 to 18 labeling the complexity of a paper as that of an academic paper (*Readable*). To clarify, the FK

Grade Level produces a numerical value denoting the approximate grade level of a piece of writing, such as 4 for fourth-grade level or 17 for graduate-school level.

Many studies have utilized the Stroop-effect task (Nastaj et al.; Salciunaite and Leonas) to gauge performance differences before and after caffeine consumption, but a much more relevant method of measurement would be the FK scoring scales, which are based on the total amount of words, sentences, and syllables in a piece of text (*Readable*). For instance, American school systems try to develop students' reading abilities throughout primary and secondary school, lasting roughly 12–13 years. This means that any change detected in the Flesch-Kincaid Grade Level score over a brief period of time would indicate either rapid adaptation to a new writing methodology or change in productivity. A similar concept occurs in shifts in the FK Reading Ease score, as this value merely determines the difficulty of a text (*Readable*). Any movements in this score should be correlated to rapid intake of new writing methodology or a change in productivity as well.

This finally leads to the development of the question: to what extent does a caffeine-induced placebo effect produce a significant performance enhancement as measured on the Flesch-Kincaid Reading Ease and Grade Level scales?

Because adolescents are at much higher developmental risk when consuming caffeine (and any other drugs), this research will be focused on high school students ranging 16 to 17 years old, with some exceptions. By standardizing the mental performance of every participant on a manipulatable, quantitative scale, such as the Flesch-Kincaid scale, something unique to every student becomes comparable. Not only that, but all students will be taking a placebo caffeine where the verbal affirmation takes the role of a treatment. This treatment covers the expectancy mechanism, which means that all participants must have consumed enough caffeinated beverages to meet the conditioning requirement—thus denoting that all active participants have been *preconditioned*.

Methodology

Study Design

Experiment Design

Hartshorne and Germine conducted a study to determine the ages at which mental abilities peaked and found that at around the ages of 18 to 19, information-processing speeds peaked but immediately began its decline. To utilize increasing information-processing speeds, the subject groups should consist of those under 18 years-old but above the age of 15, as "IQ tests lumped together all persons 16+ years-old into the homogenous category 'adult'" (Hartshorne and Germine). In addition, Hartshorne and Germine determined that "there is some broad age range, post-development but pre-senescence, at which individuals' cognitive ability is stable…reflected in studies of… 'typical adults' (usually 18–35 years old)," which means that this age range must be *avoided* in order to study ages still in a volatile, developmental stage.

Since I am limited to certain resources and type of participants as a high school student, the experiment and its analysis will be conducted accordingly around any obstacles.

To establish the most efficient experiment while maximizing the reduction of confounding variables, the measurement scale itself was thoroughly evaluated. Because the relationship between mental capacity and productivity is diverse, a different approach was needed to measure each student's individual mental performance: changes in each of the Flesch-Kincaid Reading Ease (FKRE) and Flesch-Kincaid Grade Level (FKGL) scales.

As every student has a different style of writing—and therefore a drastically differing diction, syllables per sentence, and sentence structure, each student should be compared to themselves rather than their peers for any performance development after the treatment. To not confound the pre-treatment and post-treatment data, participants are to produce a short answer response unrelated to academically-acquired knowledge—since everyone's subject matter knowledge varies—upon entering the room of the experiment. This way, no factors from the room can influence the initially produced prompt. The original prompt's FK scores will be used to gauge change in the participants' FK scores *after* the treatment, whether it be positive or negative. To do so, all participants are to produce another short answer response, although to a slightly different prompt than earlier—this time with verbal context to fulfill the *expectancy* agent of the placebo effect.

Moreover, administration of substances—especially because caffeine is a psychostimulant and thus a drug—is not ethically aligned for subject groups consisting of minors. Because the placebo effect isn't usually isolated in an experiment focused on caffeine, the distribution of a caffeine placebo was determined to be best.

The placebo effect and a placebo are considerably different; the placebo effect is a reaction to an active substance while the placebo is an *inactive* substance meant to emulate the reaction. This means that both subject groups will be receiving an inert substance designed to emulate caffeine's chemical properties. Because both groups are consuming the placebo, one group is to be told that they truly are consuming the liquid form of a caffeine supplement (caffeine-thinkers) while the other is to be told that they have received the placebo for the experiment (placebo-thinkers). The placebo-thinkers will also be informed of the extensive research highlighting caffeine's effects being due to the placebo effect in order to maintain the expectancy mechanism. Hence, the information given will be the treatment, or the independent variable.

Because the outcomes of caffeine and the placebo effect itself are so profound, it is believed that the caffeine-thinkers will perform significantly better than the placebo-thinkers. To determine change in score levels from the treatment, the post-treatment FK scores are to be compared with the pre-treatment FK scores (which will be referred to as the base models). Overall, this means that the caffeine-thinkers should score lower FKRE scores, indicating a more complex degree of composition, and higher FKGL scores, indicating a more developed grade level of writing, than their base models. The formally written hypotheses, known statistically as the alternative hypotheses, are $\mu_{pRE} > \mu_{cRE}$ and $\mu_{pGL} < \mu_{cGL}$ where the p-subscript denotes the

placebo-thinkers, the c-subscript denotes the caffeine-thinkers, the RE-subscript denotes the FKRE score, and the GL-subscript denotes the FKGL score. The change in the caffeine-thinkers' FKRE score (μ_{cRE}) is more negative—so, smaller—than the placebo-thinkers' (μ_{pRE}), rationalizing why the alternative hypothesis is written as is.

Pilot Study

A pilot study was conducted on a 17-year-old male participant. When asked, "[h]ow effective are these caffeinated beverages in boosting performance and/or productivity?", he answered that the effects of caffeine were "somewhat effective." This exact inquiry was later asked of every qualifying individual.

The participant was randomly assigned a treatment by a coin flip where heads designated caffeine-thinker assignment and tails designated placebo-thinker assignment. His treatment was tails. A caffeine placebo was then prepared (see *Procedure*) in an opaque and enclosed 8 fl oz cup *before* the participant entered the experiment room.

Upon entering the room, the participant was instructed to answer the short answer prompt "[w]rite about one of your favorite childhood memories, whether it's good or bad" in six minutes that commenced immediately after verbal delivery of the prompt. He was told that this prompt was merely a "warmup," but, in reality, this was to be used as his base model. After completion of the "warmup," the participant was then informed of the caffeine-induced placebo effect, what the placebo effect was, and that he would be taking an inert substance. The participant was given a minute to consume the placebo, another two minutes to listen to instructions, and finally six minutes to answer the prompt "[w]rite about one of your favorite high school memories, whether it's good or bad." After the participant exited the room, both of his base model and post-treatment FKRE and FKGL scores were calculated.

The FKRE and the FKGL scores of his base model were 68.4 and 10.3, respectively. But, after the treatment was applied—in which the participant stated that he "definitely felt *something*," the FKRE and FKGL scores of his resulting response were 59.1 and 10.3, respectively. This shows a change of -9.3 in the FKRE score, indicating that the participant's writing became slightly more complex. However, this shift alone is futile, especially since the FKGL remained constant, and the difference between the prompts themselves can act as a potential confounding variable.

Because both the procedure and results of the pilot study were feasible, the experiment itself progressed with a similar procedure. The only change made was the time limit for answering each short prompt—now extended to seven minutes—due to feedback from the pilot study participant.

Procedure

To comply with ethics, a Research Proposal Form was submitted to the Institutional Review Board and approved before any action was taken. All active participants filled out a Consent to Participate in Research form and received signatures from their legal guardians.

As for the process of acquiring qualified and willing participants, a questionnaire was used. This questionnaire was vital in meeting the conditioning mechanism for experimentally evoking the placebo effect and was conducted through the Microsoft Forms platform. Questionnaires are commonly used in that they can assess an individual's current knowledge on the study and automatically select or reject participants for the experiment due to the meeting of certain criteria. Some of the criteria for this study included 16 to 17 years of age with no more than ± 1 year of age; consistent consumption of caffeine from coffees, teas, or energy drinks; and maintenance of this consumption for at least one year. However, to create a slight diversion as to not bias the expectancy mechanic of the placebo effect, a red herring question was placed prompting individuals for their weight in pounds. This detail is later accentuated when presenting the treatment to each subject group by informing the subjects that their individual weights were considered in measuring out the "caffeine" portions.

After approximately 180 students completed the questionnaire in which 54 qualified, each student was then reevaluated in the case of irregularities within the questionnaire then contacted for participation. From the 54, a total of 24 students—12 to each treatment group—participated in the experiment.

Each of the 24 students were assigned a number, 1 through 24, and then randomly allocated to one of two treatment groups (see table B1) by a computer program written in the Java programming language (see fig. A1). This program was programmed from scratch, as computers are known to be pseudorandom. Pseudorandomness is a phenomenon where computer-generated values appear to be statistically random but, in reality, are not because they follow a completely deterministic and repeatable process (Computer Hope). By forcing a computer to follow a human thought process, statistical randomness was achieved through the Java program.

Since both treatment groups were to consume a placebo caffeine supplement and are different only in verbal context (the treatment), the substance being used for the placebo should be nonlethal, subtle in taste—so as to not trigger any suspicion, and non-confounding. A common element used in most studies that achieves all three characteristics is a sugar pill; a sugar pill is comprised of enough sugar as to not perplex any participants while still staying negligible in any results. But, because sugar pill manufacturers do not disclose the exact amount enclosed in a single capsule, 1 g of sugar, a harmless, insignificant amount, diluted in 4 fl oz of water will be administered to each participant.

To develop a convincing placebo substance, I considered the psychology behind the five senses. Not everyone has the same sense of taste to manipulate their brain into believing the placebo is the "actual" treatment, which means a different sense—such as sight—must step in to reinforce the plausibility of the placebo. I first placed one drop of yellow food coloring in the 4 fl oz of water to be given to each participant, but this resulted in an ultraconcentrated yellow color of the liquid (see fig. 1a). After repeatedly diluting the solution 4 fl oz at a time until the yellow color was evenly and subtly distributed (see fig. 1b), there was one drop of food coloring

dissociated in every 64 fl oz—or 0.125 drop per 4 fl oz given to participants. In the end, 128 fl oz of the placebo were created, but only 96 fl oz in total were used for the 24 cups.

Figure 1a (left) and 1b (right): Caffeine Placebo. (left) Photo of 1 drop (gtt) of food coloring in 4 fl oz of water. (right) Photo of 4 fl oz portion of 1 gtt of food coloring in 64 fl oz of water.

The experiment itself was conducted on Thursday, February 22nd, 2024, at 4:30 p.m. Originally, the time for the experiment was to be around 1:00 to 2:00 p.m., but changes were made to accommodate all participants and guarantee that an apposite number of participants partook in the experiment simultaneously in order to reduce confounding variables—and therefore reduce bias. Each group was separated promptly into two isolated, detached classrooms and instructed to answer a short answer warmup prompt ("Write about one of your favorite childhood memories, whether it's good or bad.") written on the classroom's whiteboard upon entering. Each participant was given exactly seven minutes to draft and submit a response via Microsoft Forms with clear instructions to write as vividly as possible. Participants were also informed that all responses would *not* be read and would be used for data collection purposes only; this disclaimer was given to reduce bias in the responses.

After all responses were recorded, four research assistants—two assigned to each group—handed out the same opaque, enclosed 8 fl oz cups as used in the pilot study to each participant where each cup was labeled with the respective participant's name and weight. Then, to reduce any bias resulting from appearance of experimenter, I delivered the verbal information to the caffeine-thinkers, describing to them the profound, internal effects of caffeine as well as how each cup contained supplemental caffeine in liquid form. I gave the same information to the placebo-thinkers, though slightly varied in that, this time, the placebo effect created from caffeine consumption contained profound, internal effects. Both groups were then given instructions by the research assistants—who read from a script—to drink all of the cups' contents before answering the new short answer prompt.
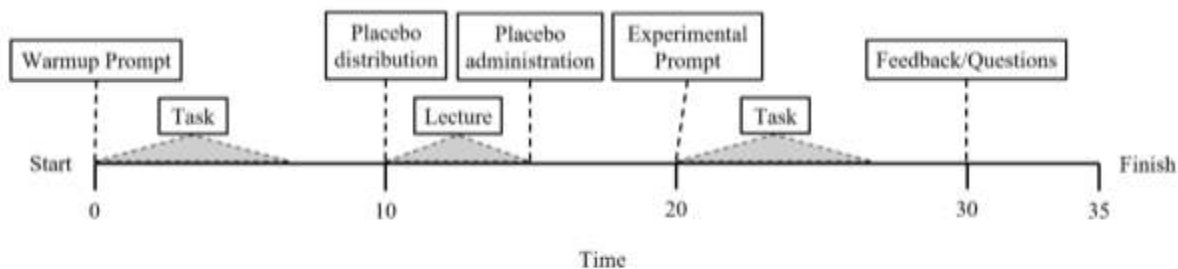
Figure 2: Experiment Session Timeline (in minutes).

This second prompt operated similarly to the first; each participant was given seven minutes to type their response to a different prompt ("Write about one of your favorite high school memories, whether it's good or bad.") The experiment concluded within 35–40 minutes from initiation at around 5:05 p.m., following an approximate timeline (see fig. 2).

After the termination of the experiment, each participant's base model and post-treatment responses were processed for their FKRE and FKGL scores. The change in the FKRE scores (ΔFKRE) and the FKGL scores (ΔFKGL) after the treatment were then manually calculated to detail any improvement or diminution in mental performance. Table B1 was referenced for each participant's assigned number used during randomization, their gauge on the effectiveness of caffeine—as it may affect the conditioning mechanism of inducing the placebo effect, and their age. Table B2 was then created to contain their FK scores, ΔFKRE, and ΔFKGL.

Data Analysis

Participants

The participants were comprised of high school students aged 15 to 18 years old (mean 16.3 ± 0.95, median 16) from which 7 were male (29.17%) and 17 were female (70.83%). All subjects reported consistent consumption of caffeine and that its effectiveness was very effective (4.17%), somewhat effective (58.33%), somewhat ineffective (29.17%), or very ineffective (8.33%).

Normality

The data from each treatment group was tested for normality—or normally distributed data, usually seen in bell curve distributions—since neither group contained at least 30 participants to meet the central limit theorem for normality. Data was processed through a Shapiro-Wilk test and tested for statistical significance at $p < .05$ (see table C1). Because all generated p-values were greater than .05, the data values were allowed to continue with a two-sample t-test.

Significance

To determine the statistical significance of the experimental results acquired, the null hypothesis—a hypothesis that is wholly opposite to the alternative hypothesis—for both FK

scores was tested through a significance test. A significance test produces a p-value denoting the probability of the given null hypothesis occurring, which means that, to reject such a null hypothesis, the p-value must be less than .05. If the null is rejectable, the alternative hypothesis is accepted; however, if the null is *not* rejectable, the alternative hypothesis cannot be accepted due to insufficient data from the sample data to conclude that the effect exists in the population. The said effect being tested in this scenario would be an experimentally-induced placebo effect causing a positive change to the FKGL score and a negative change to the FKRE score.

Because the ΔFKRE and ΔFKGL are being tested for statistical significance, a t-test for quantitative data should be used. Additionally, because each change in FK score is comprised of both the base model and post-treatment FK scores, a two-sample t-test must be utilized. A normality test determined the usability of the data before the two-sample t-test was conducted (*see Normality*). As for the two-sample t-test, data was processed using a TI-84 Plus CE handheld graphing calculator (see fig. C1–C2).

Results

For each significance test processed, the p-value generated was greater than .05, specifying that there was insufficient data to reject the null and therefore the alternative hypotheses could not be accepted. This didn't quite mean that the effect was entirely impossible, but rather that the experiment conducted through the procedure as described in *Procedure* was unable to produce enough data to corroborate an effect.

With this in mind, a boxplot was generated for each of the four data sets and compared (see fig. C3). Although the ΔFKRE and ΔFKGL were approximately evenly distributed, the placebo-thinker group's ΔFKGL displayed a right skew as well as an outlier on the far left. It's highly possible that the said outlier provided an effect on the generated p-value, but there is no concrete evidence to prove or disprove this.

Overall, results were conclusive in that the alternative hypotheses proposed under this procedure are unable to be accepted and that improvements can be made to the procedure or general process.

Discussion

If an experimentally-induced placebo effect imitating the effects of caffeine had been so simple to model, reducing bodily fatigue and hindrances to mental performance would be much healthier than caffeine consumption. Through numerous studies conducted by other researchers, it was noted that inducing the placebo effect itself involved two mechanisms: expectancy and conditioning. In addition, few studies included both mechanisms, leading to statistically insignificant results.

After carrying out an experiment that considered both mechanisms of a successful placebo effect, the data collected generated a p-value that was above .05, indicating that the hypotheses made could *not* be accepted.

Limitations

While the data collected may be insufficient in rejecting the null hypotheses, there had been innumerous limitations to the research.

Largely, as a high school student, I was limited in both tangible resources (e.g., available substances, experimental settings, and number of participants) and intangible resources (e.g., access to and approval for substance administration, time, expert knowledge and experience, and access to an expert advisor actively or formerly *in* the field of study).

One of the most important limitations within the actual procedure itself, however, was the range of non-subject-related questions that could be given to the participants in assessing their FKRE and FKGL scores. For instance, in asking the participants for a childhood memory versus a high school memory provides room for unfairness in the answering of the prompts and bias in the answers gathered. People who have a challenging time recalling past events are likely to score lower FKRE and FKGL scores on their base models due to smaller word count and shorter syllable count from the brief, basic descriptions. Meanwhile, because high school memories are much more recent than childhood memories, participants are likely to amass more content for the post-treatment prompt. This significantly impacts the ΔFKRE and ΔFKGL from the experiment, ultimately influencing the p-values.

The design of the experiment contained several flaws; due to availability of every participant, the original timing of the experiment had to be altered to fit everyone's schedules. This led to the conducting of the experiment at a late hour after an approximately nine-hour school day, which signifies that the level of fatigue of each participant may have affected their FKRE and FKGL scores. Not only that, but the availability of the students affected the subject group sizes. Instead of having an intended 62 participants with 31 per treatment group, the experiment had only 24 participants in total.

Potential Future Research

In future experiments, any statistically significant results can be situated in a larger context. A harmless caffeine alternative can be developed, and the side effects from caffeine, especially dehydration (Temple et al.) and caffeine poisoning (Cappelletti et al.), can be avoided. In fact, as of only 2018, there had been 92 cases of caffeine-related deaths (Cappelletti et al.). However, such advancements cannot be directly attributed to this study as there was insufficient data due to significant limitations.

To address the aforementioned limitations, the experiment can be conducted again with concern to how the limitations may be addressed.

There can be many adjustments made to solely the design of the experiment. A different approach can be taken, or a confounding variable can even be isolated; for example, instead of changing the provided verbal lectures, the types of questions administered can be changed instead. Another variable that should be isolated and tested is time of day, which directly affects exhaustion of the participants.

With the consumption of caffeine increasing risks for major diseases, research into harmless caffeine alternatives can guide medical research towards a new direction. Not only this, but such research can pave the way for healthier, more affordable natural energy in contemporary lifestyles.

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From Screen to Self: Exploring the Impact of Gender Stereotypes in 20th-Century Disney Princess Films on Girls' Identity and Self-Esteem By Lauren Schwager

Abstract:

With an analytical perspective on the media, the harmful truth regarding its effect on young girls' minds has been revealed. From promoting stereotypes to lowering a girl's confidence, different parts of the media have different impacts. One such industry is the film industry, and in this essay, the highly detrimental effects of 20th century Disney Princess movies are examined. These are seen in multiple ways, with behavioral changes in youth being the most noticeable change. Such findings have consisted of changes in morale, the value of beauty, and new goals of finding love as a form of success. Examinations like these are purposeful in the effectiveness that has been neglected throughout history. Now that society has reached a more modern era, issues like this are now discussed more often, bringing to light a more optimistic future. From referencing essays written by prestigious philosophers to learning from studies that assess behavior, the conclusion has been drawn that the stereotypes and beauty standards in 20th-century Disney Princess films negatively affect the psychological development of girls in their developmental years. Such stereotypes have poisoned the esteems of millions, a process of which is hoped to be halted. This essay aims to raise awareness on the impacts that these films have on childrens' minds.

Introduction:

From the day a girl is born, she is bombarded with an abundance of expectations that no man can relate to. Expectations to be beautiful, expectations to have kids, expectations to be loved, expectations, expectations, expectations. These supposed "expectations", are to, in the end, meet the goal of being validated by the male sex.

When thinking of young children, one can imagine how sensitive and absorbent they are to their surroundings. Like balls of clay, children's minds are sensitive and absorbent to everything that surrounds them. Growing up being surrounded by it, whether that's through TV shows, movies, books, or even interpreting it through parents, gender stereotypes shine through. The constant immersion of such ancient societal beliefs can cause detrimental harm, especially to young girls in their developmental years. Going back to those 'expectations' that are forced onto girls, the media's obtaining of them serves as an increasing threat to the upcoming generations of women. Just as the media has grown immensely, so have the tolls taken on the minds of young girls.

 Out of all the film industries that have perpetuated damaging stereotypes, the 20th-century Disney classic princess film industry proves to have one of the largest audiences. Although these movies have grown to be loved across the globe, their promotion of harmful stereotypes cannot be ignored. Specifically, they may contribute to unrealistic ideals that girls may feel the need to live up to. These ideals can include beauty standards, such as the idea that a woman must be thin, white, and have silky hair. The Intersectionality Theory, describes the

importance of how race and gender interact, and how history has shown that most activism has failed women of color. With the 20th-century Disney Classic Princess movies perpetuating these stereotypes, one can imagine how the impacts are emphasized for young girls of color.

Additionally, these films have also taught that in order to be considered successful, a woman must find love. Such sexist ideals demonstrate why women, growing up being told they need to live up to them, experience such struggles. To better understand the potential effects of these stereotypes on girls' self-esteem and body image, this research examines several examples of literature. There will be a secondary analysis of a study done on the behavior of children exposed to these movies. By doing this, we hope to further contribute to our world on these impacts, along with what we can do to ensure a healthier future where young girls can grow up without limitations. We hope to broaden perspectives on this issue, by raising awareness through education.

Methods:

To further examine the long-lasting effects of the 20th-century Disney princess movies, this study will utilize an extensive analytical approach, with literature being the sole focus. Essays that will be analyzed will examine diverse topics, from the true concept of gender to the look at how race and gender interact. A behavioral study that was partaken by another group of researchers will also be cited, to support the hypothesis that the stereotypes in 20th-century Disney princess movies do have an impact on the neurological and psychological development of young girls' brains. Although this essay does not specifically conduct a qualitative data study, it closely examines one that was executed by a prestigious author. In summary, this essay is one with information gathered from literature analysis, yet there is also qualitative evidence supplied. Intuitive theories and perspectives will be considered, with the hope of broadening each reader's mind on the true impacts girls across the world have faced. This paper will serve as a documented synthesis of existing pieces of literature.

Literature Analysis:
Section 1: Stereotypes in 20th-century Disney classic princess movies

From *Cinderella* to *Sleeping Beauty* to the *Little Mermaid* to numerous similar films, there is a common theme: a woman must find 'true love' in order to have a happy ending. In the film *Cinderella*, the main character lives in a poor, depressing household, and is forced to face her evil step-mother and step-sisters. It is not until she finds her "prince charming" does her crisis resolve itself, thus exemplifying the theme of having a man to love will be the solution. Similarly, Disney's *Sleeping Beauty* shares a different story but still manages to support this compelling argument. In this film, the young heroine, Aurora, innocently pricks her finger on a spinning wheel and then proceeds to fall into an infinite slumber. Aligning with the theme, Aurora cannot not be woken from this slumber unless she receives a "true love's kiss." This notion that salvation can only come through a man is deeply troubling, especially considering that her journey to a happy ending required a non-consensual romantic encounter. When her

"prince charming" comes to save her, her crisis eases. Ultimately, although both stories are different they both are embedded with patriarchal values pertaining to what defines a woman's success. Another example of a 20th-century Disney princess film that displays these stereotypes is *The Little Mermaid*. A film based off of a young mermaid named Ariel that wants to be human, she is yet again, prompted with the solution to fall in love. In order to stay a human, she is required to fulfill a spell to kiss him in three days. The only way to reach a solution or 'happy ending' was if she completed a love quest. To conclude, all of these films may have had different stories but they all still portrayed the same stereotypes, those of which have been subconsciously and consciously affecting girls since they were created. They have been teaching that it should be a goal to be loved, or that one needs to find love to be considered successful, and these morals being portrayed have been poisoning the minds of our youth, sickening them with ideals that affect their self-esteem throughout their whole life.

With these sexist ideas displayed in 20th-century Disney princess movies, one can imagine why and where these ideals stem from. To understand how societal norms and expectations shape gender identity, a series of essays will be examined. Judith Butler's, "Performative Acts and Gender Constitution: An Essay in Phenomenology and Feminist Theory" is a piece of literature that investigates why our entire world is based on the social construct of gender. In the introduction, the author begins by citing the Phenomenological Theory of 'Acts', setting the stage to connect this specific theory to the rest of the essay. This theory, espoused by Edmund Husserl, Maurice Merleau-Ponty, and George Herbert Mead, the author described as, "where social agents constitute social reality through language, gesture, and all manner of symbolic social sign." Butler connected this theory to the historical role of women, and how it has weaponized gender roles for women today. She spoke of how gender is separate from sex, with sex being a biological fact and gender being a cultural interpretation of that fact. Gender is simply a set of expected behaviors, and if one fails to "follow them", then that person will suffer punishments. In summary, the overall thesis found was, "[that] gender is in no way a stable identity or locus of agency from which various acts proceed; rather, it is an identity tenuously constituted in time- an identity instituted through a stylized repetition of acts." With this reading, it was found that there are infinite behaviors women are expected to attain, and if not, then they will suffer the repercussions. Butler spoke firmly about the clear difference between sex and gender, as that is commonly confused in our world today.

Additionally, Simone de Beauvoir's essay, "The Second Sex," is a piece of literature that explains in detail why the woman is considered "the other" and the "inessential". In the beginning, the author speculates on if a woman is even real. Beauvoir later explained that a 'woman' is simply a blend of characteristics and expectations, stemming from a history of immense patriarchy. She spoke of philosophers and Enlightenment thinkers who described women as disabled men, thus emphasizing that yes, we are both human, but the man will always come first. Another point the author made was how, in society, men are viewed as normal, as stable. That women are viewed as hormonal and unstable. The lack of female representation in

today's world is caused by our world's history, going along with other issues appearing in society currently.

      The connections and comparisons made to the past and to other systemic issues such as racism, antisemitism, and much more have helped the overall comprehension of the reality of the situation. Beauvoir made many points about the reality of our society today, helping explain the true explanation for why women are perceived as "the Other".

      Now, readers are asked to apply these perspectives to how history has shaped the film industry, specifically the stereotypes that appear in 20th-century Disney classic princess movies. To discover how young girls interpret these sexist stereotypes, Julia C. Golden and Jennifer Wallace Jacoby's study, "Playing Princess: Preschool Girls' Interpretations of Gender Stereotypes in Disney Princess Media" will be explored. In this piece of literature, a study was conducted to analyze the behavioral results and responses of children to Disney princess films. The study involved a diverse group consisting of 31 female preschool students, all between the ages of 3 and 5 years old. Throughout the entire study, multiple different methods were used to draw a conclusion. These methods consisted of parent-interviews, along with semi-structured interviews, and imaginary-play observations with the children. The parent interviews fulfilled the purpose of gaining adult insight, along with learning if parents themselves were affected by these stereotypes, thus potentially perpetuating them onto their children. The semi-structured interviews and pretend-play time with the preschool students brought expected results, with four similar themes appearing. The first one was a common value and focus on beauty. Results showed that these movies were psychologically affecting these girls, teaching them that to be beautiful, one must have clear skin, a small waist, and long silky hair. Another theme the authors noticed was the focus on clothing and accessories, thus proving the encouraged value of materialistic ideals. The third theme that was noticed was princess body movements, harmfully teaching girls that they will only be socially accepted if they walk, talk, and act gracefully, like a 'real princess'. The last quality that was noticed to be in value within these girls was the exclusion of boys. This study reveals a hard truth, regarding the likely common effects on many girls around the world. The authors chose effective ways of gaining this research, further adding to the knowledge we can use to empower women.

      Echoing Golden and Jacoby's study, authors Alice H. Eagly & Antonio Mladinic give a perspective that complements the research completed on the behavioral effects on girls. In an essay written by Alice H. Eagly & Antonio Mladinic, called "Are people prejudiced against women? Some answers from research on attitudes, gender stereotypes, and judgments of competence" (European Review of Social Psychology, 5(1), 1-35), these authors took the time to explore the history and evolution of stereotypes and biases against women. Taking into consideration the view of women in modern university students is generally more positive compared to the stereotypes of men. This research also looked at the grading of competency between men and women in comparison. The authors discussed the common discrimination, as women were being classified as nurturing and warm, thus being labeled as unqualified in a male dominated field, coercing them into taking low paying or domestic jobs.

Learning of this research truly uncovered the depth of societal sexism within our world. This information further emphasized the difficulties women are forced to go through to have a successful career in a male dominated field.

Section 2: How these stereotypes can affect the development of girls

To reach a conclusion, a consensus must be met regarding the true effects these films have on the development of young girls. To better understand whether these films confirm or refute the hypothesis, Collier-Meek's study (2011) on "Gender Role Portrayal and the Disney Princesses" examines the portrayal of gender roles in Disney princess media and its potential influence on children's gender development will be examined. In the article, "Gender Role Portrayal and the Disney Princesses", authors Dawn Elizabeth England, Lara Descartes, and Melissa A. Collier-Meek conducted an investigation with the purpose of studying the coded characteristics of stereotypical male and female behaviors throughout the Disney princess movies. For female characters, they took note of how many of the female characters' behaviors were gender coded, by looking for displays of emotion, submissiveness, weakness, and fear. For men, they took note of how often the male characters would demonstrate stereotypical male behavior, such as fearlessness, strength, assertiveness, and performances of a rescue. The results aligned with their hypothesis, with 65.32% of female characters displaying stereotypical female behavior and male characters having 50.05% of their behaviors being stereotypical male coded. These results further emphasize the extremity of the situations. Imagine all of the children that have access to these films, not only watching them but also being fully immersed in the merchandising forms also.

This evidence truly emphasizes the effects that these so-called "harmless" films have on the youth of our world. These popular films have produced billions of dollars for the film industry, while managing to infect the growing minds with sexism, insecurities, and prejudice. Adding onto the damage of these films, in a piece written by Kimberlé Crenshaw in the Stanford Law Review, called, "Mapping the Margins: Intersectionality, Identity Politics, and Violence Against Women of Color" (1991), the theory of intersectionality is explained. Connecting race and gender, the author reveals how feminism has failed women of color, as historically feminists only advocated for the rights and needs of white women. With intersectionality, race and gender can be studied interchangeably, thus avoiding ignorance.

Intersectionality is a way in which all should view the world. By looking at racial and gender issues contemporaneously, we can now uplift women of color, furthering the feminist ideal of *all* women being equal. In "The Gendered Society", by Michael Kimmel, is a piece centered on three focused claims: one, being that not only is gender the differentiator between men and women, but it is also the social construct that makes up the foundation of our world. Another argument Kimmel made is that men and women are more alike than different. The last argument he made is that gender inequality is what ignited the real differences between men and women. As these are rare yet groundbreaking perspectives, learning of such perspectives was very

interesting, and I now agree with how damaging gender has been to our world, creating an infinite divide.

In the article, "Media and the Development of Gender Role Stereotypes", written by L. Monique Ward and Petal Grower, valuable insights on the detrimental effects the media have on young girls are explained. One major factor that was noticed was that with consistent television watching, people have more gender stereotypical beliefs. Learning of this aligned with what I already believe about films and the media. While sexism has decreased in film over time, it is still very much present.

Section 3: Contribution to society

From learning of different theories written by prestigious authors to reading studies done to analyze behavior, an in-depth study of the effects of stereotypes in 20th-century Disney classic princess movies has been executed. What was found, is that our society is solely based on social constructs, those of which formed from few physical differences. It was also learned that young girls between the ages of 3 and 5 that when exposed to these films, experienced noticeable behavioral changes. In summary, there are negative effects to young girls across the world that watch these films.

The purpose of this paper is to bring attention to an urgent issue of our society today. In many aspects of the film industry, women are portrayed as sex objects. In 20th-century Disney classic princess movies, women are portrayed as helpless objects to be saved, and the only way to do that is through finding true love. The aim is that readers will take this information and feel the need to advocate these issues to others, and to further change the media for the better, creating one that is safe and respectful of women. The goal of this paper is to contribute to the known knowledge of this industry, by supplying and synthesizing it to raise awareness on the issue, so that in the future, it is common for young girls to be inspired by their representation in the movies and television shows they watch.

Conclusion:

Throughout their lives, individuals are faced with countless choices, both significant and minor, each carrying its own impact. As a society, we possess the power to positively influence one another through our decisions. Women of all ages, from their youth to their elder years, have been profoundly influenced by the classic Disney princess films of the 20th century. Consider the vast number of films that negatively portray women. The pervasive issue of sexism in the media has rapidly infiltrated society, affecting the perceptions and potential of countless individuals. This begs the crucial question: what can we do to address this? Reflecting on the power of choices, it becomes evident that while we cannot alter the past, we have the ability to shape the future. Through deliberate and conscientious choices—whether in film production or in the upbringing of daughters—we can profoundly influence the world for the better. It is essential that we collectively focus on being aware of the impact of our actions and on finding ways to prevent negative portrayals. By empowering women and young girls appropriately, we can uplift them, which in turn elevates society as a whole.The urgency of this matter cannot be overstated. We

must act now to ensure that the future is one where women are depicted positively and given the opportunity to reach their fullest potential. It is through this concerted effort that we can create a more equitable and thriving society for everyone.

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Beyond Likes and Shares: One Brand's Social Media Appearance By Anchit Manikandan

Abstract

This research paper explores the impact of social media appearance on brand performance, with a specific focus on Coca-Cola's "Share a Coke" campaign. The study digs into various aspects of the campaign's social media presence, including content strategy, user-generated content, engagement metrics, and brand perception to analyze its influence on key performance indicators such as brand awareness, customer loyalty, and sales. The "Share a Coke" campaign's success is attributed to its creative use of personalization, social media engagement, and emotional connections, resulting in increased sales and consumer interest. This paper also shows data on Twitter engagement, Facebook activity, and the campaign's impact on sales and consumer participation.

Introduction

In today's digital age, social media has emerged as a powerful tool for companies to engage with consumers and shape their image. The impact of a brand's social media appearance on its overall performance has become a subject of significant interest and research. This paper aims to explore how social media appearance influences brand performance, with a specific focus on Coca-Cola's renowned "Share a Coke" campaign.

The "Share a Coke" campaign, launched by Coca-Cola in 2011, stands as a prominent example of a successful, social media marketing initiative. This campaign involved replacing the iconic Coca-Cola logo on bottles and cans with popular names, encouraging consumers to share personalized Coke products on social media platforms using the hashtag #ShareACoke. The campaign stimulated a sense of personalization and social sharing and generated a significant increase in consumer interaction and brand visibility (Nguyen and Nguyen).

The primary objective of this research paper is to analyze the impact of the "Share a Coke" campaign's social media appearance on the overall performance of the Coca-Cola brand. By examining various aspects of the campaign's social media presence –including content strategy, user-generated content, engagement metrics, and brand perception– this study seeks to uncover the specific ways in which the campaign influenced key performance indicators such as brand awareness, customer loyalty, and sales.

Furthermore, qualitative analysis will be conducted through content analysis of social media posts, user-generated content, and consumer sentiment expressed through online platforms. By analyzing the themes, emotions, and overall sentiment conveyed in user-generated content related to the "Share a Coke" campaign, a deeper understanding of the campaign's influence on brand perception and consumer attitudes can be gained.

The paper consists of 2 main sections: a foundational overview of social media marketing, and a detailed analysis of the "Share a Coke" campaign, including a discussion of the implications of the findings. This paper introduces the foundations of social media marketing, its

impact on brand performance, the role of personalization, user-generated content, and social sharing in driving brand engagement.

Background

Social Media

According to an article from social media management company Sprout Social called "Social Media Marketing: What It Is and How to Build Your Strategy," social media platforms have revolutionized how brands interact with consumers, providing a dynamic and interactive space for engagement, communication, and promotion. Platforms such as Facebook, Instagram, Twitter, YouTube, and Snapchat have become essential channels for connecting with target audiences. Social media allows brands to share content, engage in conversations, build communities, and monitor consumer sentiment, which offers a unique opportunity for brands to humanize their image, foster brand loyalty, and create authentic connections with consumers.

Key Terms

The terms that are described below are social media terms that are critical to understanding the motivations of brands and the results of their campaigns.

1. Social Media Appearance: Refers to a brand's presence and activity on social media platforms, including the visual elements, content strategy, tone of voice, frequency of posts, and overall engagement with followers ("Social Media Marketing").

2. Brand Performance: Measures the effectiveness and success of a brand in achieving its objectives and goals. It encompasses various key performance indicators (KPIs) such as brand awareness, brand equity, customer loyalty, market share, and financial performance (Yasar).

3. User-Generated Content: Content created and shared by consumers or users of a brand's products or services. User-generated content often takes the form of posts, photos, videos, reviews, testimonials, or other forms of content created and shared on social media platforms ("Social Media Marketing").

4. Engagement Metrics: Measures that assess the level of consumer interaction and involvement with a brand's social media content. These metrics include likes, shares, comments, mentions, retweets, and other forms of user engagement ("Social Media Marketing").

5. Brand Awareness: The extent consumers recognize and recall a brand and its offerings. It reflects the brand's visibility, familiarity, and ability to be top-of-mind for consumers in relevant contexts (Yasar).

6. Customer Loyalty: The degree of attachment, preference, and repeat patronage exhibited by consumers towards a particular brand. Customer loyalty is often measured by metrics such as customer retention rates, purchase frequency, and advocacy ("Social Media Marketing").

7. Sales Performance: The measurement of a brand's revenue generation and sales growth over a given period. It reflects the brand's ability to convert consumer interest into actual sales and revenue (Yasar).

Results

       The effective utilization of social media platforms greatly contributed to the campaign's success. By creating the hashtag #shareacoke, Coca-Cola encouraged consumers to share their experiences and interact with the brand online. Social media channels catalyzed spreading the campaign's reach and building a community around the shared experience of exchanging personalized Coke bottles. Through user-generated content and viral sharing, the campaign generated substantial buzz and amplified its reach and impact.

       By personalizing the product, Coca-Cola created a sense of ownership and made consumers feel valued. This emotional connection was another factor that strengthened and fostered brand loyalty, as consumers associated positive feelings and memories with the brand ("Share a Coke Campaign").

       The campaign's success was further bolstered by its ability to create a shared experience, strengthening bonds among friends, families, and communities.

       The Share a Coke campaign's impact extends beyond its initial launch, as it inspired a wave of similar personalized marketing initiatives across various industries. By successfully combining personalization, social media engagement, emotional connections, and experiential marketing, Coca-Cola demonstrated the power of an integrated and innovative approach to social media marketing campaigns. The campaign's legacy continues to influence and shape the marketing strategies of brands worldwide, highlighting the importance of human connection and personal experiences in building strong brand-consumer relationships.

       Within less than a year of launching the Share a Coke campaign, Coca-Cola witnessed a sales increase of over 2.5% ("Share a Coke Campaign"). This growth is remarkable considering the scale of Coca-Cola's operations and the competitive beverage market. The campaign effectively resonated with consumers and translated into higher sales.

       A table shared by Yash Chauhan on *Medium* provides a summary of the results of the campaign. For example, in 2011, approximately 235,000 tweets were posted on Twitter, and roughly 1,000 fans engaged with the content. This campaign resulted in the sale of over 250 million bottles exclusively in Australia. Notably, the keywords "Machine" and "Vending" were frequently associated with Diet Coke, with respective engagement rates of 9.2% and 8.7%. On Facebook, more than 800,000 virtual bottles were shared, achieving a 14% share rate. By 2013, a total of 150 million bottles were sold in the United States, the United Kingdom, and Australia combined. As a unique touch to the campaign, Coca-Cola customized 730,000 glass Coke bottles, adding a personalized element to the promotion.

       In the same table, the author shows celebrity collaborations made a significant impact, amassing around 13.6 million impressions and 381,424 expressions. On platforms like Instagram and Twitter, influencers achieved impressive engagement rates of 8.7% and 13.88%, respectively. The campaign's paid support for organic posts, boasting a 2.16% click-through rate, generated a remarkable 105 million impressions. The campaign, under the hashtag #ShareaCoke, reached the number one trending spot with over 1.4 million mentions. In 2013, the campaign's

video garnered over 50 million impressions and more than 4 million views on YouTube. Coca-Cola's strategic use of paid social media marketing further boosted sales, leading to a 10% increase.

During the campaign in the UK, approximately 51% of Twitter users addressed Coca-Cola using names or hashtags. This level of engagement resulted in a 3% rise in Twitter activity related to the campaign (Dodrin). Additionally, on Facebook, the campaign generated a 5% increase in traffic (Dodrin). These statistics highlight the campaign's ability to generate conversations on social media platforms.

The Share a Coke campaign achieved remarkable success in the US, with an 11% increase in Coca-Cola's sales participation (Mendoza). This significant rise in sales indicates the campaign's effectiveness in driving consumer interest and purchase intent.

Over 1.25 million young adults participated in the Share a Coke campaign (Mendoza). The large number of participants demonstrates the campaign's appeal and ability to engage the target audience. Furthermore, 235,000 tweets featuring selfies were posted on Twitter, with approximately 111,000 campaign followers responding to these tweets (Ghosh). These figures indicate the active involvement and enthusiasm of consumers in sharing their personalized Coca-Cola experiences.

Conclusion

The #ShareACoke campaign by Coca-Cola serves as a case study in modern marketing and consumer engagement. Its ability to harness the power of personalization, emotional connections, and social media highlights the evolving landscape of brand-consumer interactions. While the campaign's immediate impact on brand loyalty and consumer behavior is evident, continued analysis will shed light on its long-term effects. As brands seek to forge stronger connections with consumers, the lessons from this campaign will undoubtedly remain relevant and influential in shaping future marketing endeavors.

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Navigating the Paradox: Atrial Fibrillation and Exercise By Daniel Finger

Abstract

Atrial fibrillation (AF) is a common atrial arrhythmia, currently affecting an estimated 1% of the global population. AF incidence may be increased through numerous modifiable and nonmodifiable risk factors, such as a sedentary lifestyle, smoking, age, genetics, heart disease, and others. AF can also increase the incidence of other conditions, most notably thrombosis and strokes. While moderate physical activity reduces the risk of developing AF, continual intense aerobic exercise, often performed by elite athletes, can paradoxically increase the risk of developing AF. This systematic review aims to comprehensively review and discuss how such activity affects the risk and incidence of atrial fibrillation via physiologic changes to the heart, such as left-atrial enlargement, remodeling of the sinoatrial node, electrophysiological remodeling of myocytes, electrolyte imbalances, myocardial fibrosis, and autonomic imbalances.

Introduction

Atrial fibrillation (AF) is the most prevalent cardiac arrhythmia, often leading to numerous negative sequelae in other organ systems. The incidence of AF is also increasing. Specifically, the incidence and prevalence of AF have increased by 31% and 33% from 1997 to 2017, respectively (Lippi et al.), with the condition currently affecting up to 1% of the general population (Vinciguerra et al.). Furthermore, the Framingham Heart Study (FHS) saw a 4-fold increase in age-adjusted AF prevalence over the last 50 years (Schnabel et al.). As average life expectancy continues to rise, the absolute AF burden may increase by more than 60% in 2050 (Lippi et al.). Given the concerning trends of escalating incidence rates and projected prevalence trends, AF may be aptly characterized as an impending global epidemic.

Normally, to pump blood throughout the body, the heart's four chambers are coordinated by electrical signals that originate from the sinoatrial (SA) node. Once the signal travels through the contracting atria, it reaches the atrioventricular (AV) node, which delays the signal by one-tenth of a second before traveling to the ventricles, which then also contract. This rhythm of electrical conduction and subsequent muscular contraction constitutes the regular, healthy heart rhythm, otherwise known as sinus rhythm. In contrast, in AF, the atria rapidly and irregularly contract in the setting of rapid ectopic firing (Löffler and Darby).

There are three major types of AF. Paroxysmal AF is characterized by the heart alternating between sinus rhythm and AF in random episodes that terminate spontaneously. Persistent AF is diagnosed when the AF rhythm is sustained, but sinus rhythm can still be restored. Lastly, permanent AF is when sinus rhythm cannot be restored (Waktare). AF initially starts as a transitory disturbance, but over time may develop into a longer and more persistent arrhythmia (Zoni-Berisso et al.).

AF also increases the risk of other dangerous conditions. A clear link has been observed between AF and strokes, with AF increasing the risk of ischemic stroke by 3 to 5 times (Escudero-Martínez et al.), being responsible for an estimated 15% of all strokes. As the atria fail

to contract in synchrony, portions of blood become stagnant, potentially leading to the formation of thrombi, which could then embolize to the brain. AF is also heavily linked to heart failure, with as much as 40% of advanced heart failure patients having AF (DePasquale and Fonarow). Furthermore, acute decompensation of chronic heart failure may be caused by a rapid irregular heartbeat and loss of atrial contraction. Conversely, heart failure may also cause AF, creating a feedback loop in which the two conditions may exacerbate one another.

AF has numerous non-modifiable and modifiable risk factors, including age, sex, and genetics. For example, the risk of developing AF increases with age, with advanced age being the most prominent risk factor for AF (Schnabel et al.). Males may be at a higher risk for developing AF, with studies finding a greater male prevalence for the condition across ethnicities and socioeconomic circumstances (Zoni-Berisso et al.; Zhang et al.), although comorbidity and disparities in average body size have been proposed as alternative explanations for this trend (Berge et al.). Genetic risk factors for AF have also been identified. An Icelandic population-based study found that the risk of AF increased by 77% for first-degree relatives of AF patients when compared to the general population (Arnar et al.). Racial and ethnic background has also been discovered to play a role in AF prevalence trends. The Candidate-Gene Association Resource Study (Marcus et al.) revealed that within the black population, the risk of developing AF demonstrated a significant independent correlation with increasing European ancestry. Adjusted analyses revealed that for every 10% increase in European ancestry, there was a corresponding 16-20% elevation in the risk of AF. Another study found that age-adjusted and sex-adjusted AF incidence rates per 1000 person-years were 3.9 in Asians and 6.1 in Hispanics, compared to 5.8 in black and 11.2 in white people (Rodriguez et al.).

Similarly, many modifiable risk factors exist for AF, including obesity, diabetes, both extremes of blood pressure, and a sedentary lifestyle. Obesity has been observed to increase the risk of developing AF through atrial remodeling. Moreover, an increased body mass index (BMI) has been directly linked to increased patient-reported AF symptom severity (Chalazan et al.). A decrease in oxygen saturation during sleep caused by obstructive sleep apnea has also been found to be an independent risk factor for AF (Gami et al.). Diabetes mellitus (DM) is another significant risk factor for AF, with a meta-analysis finding that DM patients had a 34% higher chance of developing the condition (Huxley, Filion, et al.). While knowledge regarding the pathophysiology of diabetes-related AF is limited, it is hypothesized to comprise a multifactorial etiology that includes structural, electrical, electromechanical, and autonomic remodeling. Hypertension is also a common risk factor of AF. Data from the Atherosclerotic Risk in Communities Study found that one out of five AF cases were linked to hypertension (Huxley, Lopez, et al.). Low blood pressure has further been observed to increase the risk of developing AF (Thomas et al.). Finally, physical inactivity is a strong risk factor for AF. An inverse relationship has been observed between cardiorespiratory fitness and incident AF (Qureshi et al.), and regular physical activity is generally recommended to reduce the risk of developing a multitude of cardiovascular conditions, including AF.

Although light to moderate physical activity is known to significantly reduce the risk of AF (Mozaffarian et al.), a paradoxical trend emerges when intense exercise is examined. An increased frequency of vigorous exercise was correlated with an increased incidence of AF in young men and joggers (Aizer et al.). In one study, 300 top-ranked experienced, high-level runners were studied, with AF being diagnosed in 5.3% of the runners, who had no other known risk factors, compared to 0.9% of the control group (Karjalainen et al.). Additionally, the incidence of AF significantly increases among aging athletes, suggesting a potential association between cumulative training hours and the prevalence of AF (Wilhelm). This information points toward a more complicated relationship between exercise and cardiovascular health.

There are several proposed physiological mechanisms that may explain this trend. These include exercise-induced enlarged atria, autonomic imbalances, disordered myocardial metabolism, and random ectopic firing and re-entry levels. This systematic review aims to comprehensively review and discuss how intense exercise affects the risk and incidence of atrial fibrillation via physiologic changes to the heart, such as those relating to the alteration of the cardiac conduction system and overall structure of myocytes.

Methods

A comprehensive literature search was conducted to identify research studies and articles related to the general topic of AF using online databases, such as PubMed, Semantic Scholar, and Google Scholar. Additional assistance was provided by AI search engines, such as Elicit. Common keywords used in searches included "Atrial Fibrillation," "Aerobic exercise," "P-wave," "Arrhythmia," and "Risk Factors." Additionally, current AF literature reviews were screened for relevant articles. All articles used in this systematic review were required to have been published between the years 1995-2024 in order to include relevant information that accounted for recent advancements. Out of 133 studies examined, 71 were excluded for reasons including date published, study design, and author-reported limitations. This process was used to investigate potential mechanisms linking aerobic exercise to atrial fibrillation.

Results and Discussion

Aerobic exercise in this review is defined as physical activity that uses large muscle groups in repetitive, continuous motion, resulting in increased oxygen usage and heart rate. Examples include running, cycling, swimming, and any activity defined as endurance training.

--Enlargement of the Left Atrium--

The atrial substrate, the electrical and structural state of the myocardium that predisposes the heart to AF, may be developed through diverse pathways of structural remodeling, such as those associated with left atrial enlargement. During adaptation to the increased cardiac output demanded by frequent aerobic exercise, the left atrium is believed to expand to hold greater

amounts of oxygenated blood. Research observing elite endurance-trained athletes found that the average diameter of the athletes' left atria was 4.6mm greater than that of the average control diameter (Iskandar et al.). Professional male football players were also observed to exhibit great variation in left atrial size, with the volumes of the largest atria being more than tripled compared to the smallest atria (Gjerdalen et al.). However, although the athletes were found to have an increased prevalence of tricuspid regurgitation, no impairment of left atrial function was observed between varying atria size. A notable discrepancy was observed between the two sexes: a study examining athletes from various common sports found that the difference in left atrial volume between male athletes and their controls was greater than the difference observed between female athletes and their controls (Mosén and Steding-Ehrenborg). Nevertheless, male and female athletes were both still found to have larger left atria compared to controls.

--Changes to the Sinoatrial Node--

The heart's sinus node may also undergo changes as a result of strenuous aerobic exercise. Exercise can cause sinus node dysfunction (SND) (Osborn and Icenogle), also known as sick sinus syndrome. SND is defined as disorders related to abnormal conduction and propagation of electrical impulses at the SA node (Hawks et al.). Links between SND and AF have been found. In a study examining 1000 SND patients, supraventricular tachycardia, including AF, was found in 53% of patients (Lamas et al.). Exercise training-induced electrical remodeling of the SA node has been found to cause other arrhythmias as well, such as bradycardia (Boyett et al.). SA node remodeling can occur on a molecular level through alterations in heart conduction channels. The pacemaking function of the SA node is largely controlled by a unique hyperpolarization-activated current known as the "funny" current (DiFrancesco). Hyperpolarization-activated cyclic nucleotide gated (HCN) channels are the molecular correlates of funny currents (Biel et al.) and may be altered through exercise. The resulting changes to this system may lead to the development of arrhythmias. A downregulation of ion channels, most notably that of the HCN4 channel and the corresponding funny current, was found in the hearts of exercise-trained rats and mice when compared to their sedentary counterparts (D'Souza, Bucchi, et al.).

Additionally, an upregulation of the microRNA miR-423-5p in the SA nodes of exercise-trained mice has been found to contribute to the downregulation of HCN4 and the funny current, linking exercise with bradycardia, another type of arrhythmia (D'Souza, Pearman, et al.). It is important to note that research on the miR-423-5p pathway has concentrated on its role in bradycardia, not AF. Consequently, findings from these studies should be interpreted with caution when considering their implications for AF. However, an association between sinus node dysfunction and loss-of-function mutations in the HCN4 channel has been reported in several studies (Schulze-Bahr et al.; Milanesi et al.; Ueda et al.), and an association between sinus node dysfunction and AF has also been found (Lamas et al.). Furthermore, mutations in the *HCN4* gene have been found to increase susceptibility for AF (Macri, S. Mahida, et al.). The coding

region of the *HCN4* gene was sequenced from patients with early-onset AF. The *HCN4* mutation frequency was two-fold greater for the AF patients compared to the control group (Macri, S. N. Mahida, et al.). While six of the seven novel *HCN4* variants did not functionally differ from the wild-type, one variant, p.Pro257Ser, failed to traffick to the cell membrane and co-localize with the wild-type HCN channels (Macri, S. N. Mahida, et al.).

--Electrophysiological changes to Myocytes--

Aerobic exercise may also alter the electrophysiology of cardiac myocytes, contributing to the development of the atrial substrate. In a study investigating the potential role of microRNAs in AF (Y. Lu et al.), left atrial samples from dogs were subjected to AF induction via 8-week right atrial tachypacing. This process raises the heart rate similarly to the effects of aerobic exercise. The samples were then analyzed alongside human atrial samples diagnosed with AF and rheumatic heart disease. Levels of the microRNA miR-328 were found to be elevated by an average of 3.9-fold in the canine samples and 3.5-fold in the human samples, respectively, when compared to their corresponding controls (Y. Lu et al.). Furthermore, forced expression of miR-328 in canines and mice reproduced AF phenotypes: enhanced AF vulnerability, diminished L-type Ca^{2+} current, and shortened atrial action potential duration. However, these conditions were largely dampened and reversed with the normalization of miR-238 levels. The study found *CACNA1C* and *CACNB1*, which are genes that encode cardiac L-type Ca^{+2} channel α1c- and β1 subunits, as the cognate target genes of miR-328. An inverse relationship was observed between miR-238 levels and L-type Ca^{+2} subunits in mammalian cardiac myocytes induced with AF.

While miR-328 may play a role in the development of exercise-induced AF, other microRNAs that are positively correlated with the severity of AF, such as miR-455-5p (Li et al.), have been proposed as potential biomarkers of AF. Additionally, miR-223, miR-664, miR-101, miR-320, and miR-499 have been observed to exhibit changes in concentration of over 50% in canine tachypacing-induced AF hearts (Y. Lu et al.).

--Electrolyte Imbalances--

Extreme aerobic exercise may cause electrolyte imbalances, which may contribute to the development of AF. Hypokalemia (potassium deficiency) has been found to increase the risk of developing AF (Tazmini et al.) and is associated with an increase in P-wave duration (Krijthe et al.), a sign that can often portend AF. A study on sweat and electrolyte loss found that Premier League soccer players lost an average of 6.0 ± 1.3 mmol of potassium per liter of sweat during a 90-minute training session (Maughan et al.). Similarly, a 2023 case report (Noor et al.) documented an Afghan teen's hypokalemic periodic paralysis, which started shortly after "intense exercise," the symptoms of which were resolved after a potassium chloride infusion.

This case study serves as an extreme example of intense aerobic exercise depleting electrolytes, in this case, potassium, leading to hypokalemia.

Hypokalemia is believed to create electrical inhomogeneity and alterations to conduction in the myocardium (Tribulová et al.). A potassium deficiency increases membrane excitability, diastolic depolarization, and the duration of the action potential and refractory period while simultaneously decreasing conduction velocity, the sum of which constitutes hypokalemia's arrhythmogenic potential (Akita et al.). In one study, guinea pig hearts were perfused with K^+ deficient solution (Tribulová et al.). After 15-30 minutes of perfusion, sustained ventricular and atrial fibrillations were found in each heart, independent of age and sex. Furthermore, after the standard solution was reintroduced, the fibrillations continued and were irreversible. The study found that hypokalemia had heterogeneously decreased intercellular connections by decreasing the immunopositivity of gap junction protein connexin-43. The sporadic patches of damaged myocyte connections created electrical inhomogeneity in the myocardium, leading to the initiation and sustainability of fibrillations.

Hypokalemia may also lead to a Ca^{2+} overload in myocytes. In one study, isolated rat myocytes were subjected to a reduction of extracellular $[K^+]$ to 2.7 mmol/L, leading to ventricular myocytes exhibiting Ca^{2+} overload. This increased the generation of spontaneous Ca^{2+} waves and delayed afterdepolarizations. However, this activity was only observed in a minority of atrial myocytes that contained t-tubules (Tazmini et al.). A K^+ deficit may cause a Ca^{2+} buildup through the intimate functional pairings between Na^+-K^+ ATPase and Na^+-Ca^{2+} exchanger proteins, as a decrease in Na^+ pump activity locally inhibits the extrusion of Ca^{2+} in myocytes (Tazmini et al.).

While an increased sodium influx is more commonly associated with AF (Wan et al.; Pääkkö et al.), hyponatremia, an abnormally low sodium concentration, may also increase the occurrence of AF (Y.-Y. Lu et al.). In the aforementioned study on electrolyte loss in Premier League soccer players (Maughan et al.), an average of 5.8 ± 1.4g of sodium was lost per player during the 90-minute training session. Many elite athletes experience electrolyte deficiencies. A study on Bosnian-Herzegovinian first-tier soccer and basketball players found that water and electrolyte intakes before, during, and after the recorded training were inadequate, regardless of age or sport (Pašalić et al.). In another study, the hearts and lungs of rabbits were superfused with a Na^+ deficit solution, which increased pulmonary vein diastolic tension, significantly increased the occurrence of early afterdepolarizations and delayed depolarizations, and increased the rate of burst firings with a rate up to 8 Hz (Y.-Y. Lu et al.).

--Fibrosis in the Heart--

The relationship between aerobic exercise and atrial fibrosis is complex and understudied. However, current research points to a relationship between intense, long-term aerobic exercise and fibrosis. A case study investigated the sudden death of an experienced marathon runner, revealing the presence of both replacement and interstitial fibrosis in the

myocardial walls of both ventricles (Whyte et al.). The case study proposes that lifelong, repetitive episodes of strenuous physical activity led to fibrotic replacement of the myocardium, ultimately resulting in a fatal arrhythmia. Further, the majority of recent studies of athletes following endurance exercise have reported an elevation in cardiac troponin levels (Shave et al.), a marker of myocyte damage. However, many studies argue against permanent myocardial damage caused by long-term, repetitive aerobic exercise (Siegel et al.; Scharhag et al.).

--Autonomic Imbalance--

The autonomic nervous system plays a crucial role in AF pathophysiology. The sympathetic and parasympathetic branches of the autonomic nervous system largely regulate the heart's activity. The vagus nerve is the primary nerve of the parasympathetic nervous system (Breit et al.), and its tone may be altered through endurance training.

During intense aerobic exercise, a shift from parasympathetic to sympathetic dominance is believed to occur, resulting in an increased heart rate, although parasympathetic activity does not completely cease (White and Raven). Continual intense aerobic exercise has also been shown to alter the autonomic balance, reducing sympathetic activity while increasing parasympathetic activity. Rats exhibited heightened parasympathetic tone after 16 weeks of treadmill training, and 64% of exercise-trained rats experienced >30s AF episodes, compared to only 15% of sedentary rats. However, AF inducibility returned to normal levels after detraining (Guasch et al.). An increased adrenergic (sympathetic) tone, followed by a significant shift towards vagal (parasympathetic) predominance, were observed prior to paroxysmal AF initiation in patients with pulmonary vein ectopy (Bettoni and Zimmermann). This supports the theory that AF may occur when the heart is recovering after exercise, at the point when parasympathetic activity is elevated (Kannankeril et al.).

The baroreflex, a mechanism of the autonomic nervous system, regulates moment-to-moment blood pressure (Benarroch) by reacting and adjusting to pressure changes through detection with baroreceptors. In a study in which 11 sedentary subjects progressively trained for a marathon over a year, moderate aerobic training over 3 months decreased blood pressure and heart rate while increasing cardiovascular variability and baroreflex sensitivity (Iwasaki et al.). Interestingly, more intense training was not found to increase these effects. However, this study is limited in scope because it only observed the subjects for a short time. Long-term athletes may potentially have increased effects that are only visible over longer periods. If such baroreflex sensitivity is increased in long-term athletes, a potential connection with AF may be established.

Conclusion

Atrial fibrillation (AF) is an arrhythmia in which the atria beat irregularly, increasing the risk of developing numerous conditions such as ischemic strokes. AF may be caused by a plethora of modifiable and nonmodifiable risk factors. The relationship between aerobic exercise

and the onset of AF is complex and far from being fully understood. While moderate activity is highly advised and has been largely found to reduce the risk of developing AF, it seems that many elite athletes who undergo more intense and longer training have a much higher risk of developing the condition. Various mechanisms for the development of AF in this population have been proposed, such as left atrial enlargement, SA-node changes, electrophysiological alterations to myocytes, electrolyte and autonomic imbalances, and fibrosis. It is highly likely that AF may have a multifactorial pathophysiology constituting many of the aforementioned mechanisms. This sheer variety of potential etiologies makes it difficult to completely understand the pathogenesis of AF in elite endurance athletes. Additional research is needed to better understand and characterize not only the aforementioned mechanisms of AF initiation, but also to analyze potential interactions between such mechanisms. With a better understanding of these physiologic changes and how they contribute to AF, adequate treatment can be better developed to slow the emerging epidemic of atrial fibrillation.

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Are There People Starving In A Rich Community? A Case Study of the Silent Challenges in the North Shore By Samuel Chen

Abstract:

The North Shore in Illinois is also known for being a wealthy community so many people assume that there are no poor people in the area. However, food insecurity remains a critical issue in the North Shore, where the pandemic caused rising living costs and economic disparities and led to increased reliance on assistance programs. This research examines the effectiveness of food insecurity assistance programs, such as food pantries, in this region, using ethnographic observations from a local food pantry and qualitative interviews with volunteers and clients in multiple pantries. The findings reveal that while these programs provide crucial support, gaps in accessibility and lack of cultural foods and information persist, particularly among vulnerable populations. This study underscores the need for targeted improvements in food assistance strategies to ensure more equitable outcomes in the North Shore community. This research also addresses the difficulties that many other clients in other areas face since similar issues also affect people beyond the North Shore as well.

Introduction

One particularly hot summer, a single mother and her children arrived at the food pantry just as the doors were opening. Her children peeked inside with hopeful eyes. The pantry was stocked with donated goods, thanks to the generosity of local residents and businesses. As the mother selected items—canned beans, rice, and a few fresh vegetables—she noticed the relief in her children's faces. For a moment, the weight of financial stress was lifted, replaced by the comfort of knowing that there would be enough food for the week.

In the North Shore, the area was known for its wealthy neighborhoods. But behind the façade lay a pressing issue: food insecurity was affecting more families than anyone had anticipated. Every day, many families would walk into food pantries looking for food that would sustain them for the next few weeks. With their modest income, they often had to choose between paying bills or buying groceries.

This scene was not unique to this particular family. Many families in the North Shore faced similar struggles, hidden behind the wealthy neighborhoods. Food insecurity was a silent challenge, affecting the daily lives of many, despite the region's affluence. The food pantry's efforts were a lifeline, but they also highlighted a larger issue: the need for sustainable solutions to address food insecurity in an area where the disparities between prosperity and poverty were stark and often overlooked.

This research focuses on four key food pantries: New Trier Township Food Pantry, Wilmette Food Pantry, Willow Creek Care Center, and Northfield Township Food Pantry. Each pantry serves distinct client demographics and operates under different structures and funding models, yet all share a common goal of alleviating hunger and providing essential services to their communities. For example, the New Trier Township Food Pantry and the Wilmette Food

Pantry are pretty small while the Willow Creek Care Center and the Northfield Township Food Pantry are massive. The differences in pantry size makes it harder for the smaller pantries to serve the same amount of people as the bigger ones. In the following sections, this study will dive into the state of food insecurity in the region, what pantries have been doing, and what they can do better to serve their clients.

Literature Review

Food insecurity is not a unique problem in the North Shore but a pressing issue nationwide. Many scholars have seen the issue and examined the effectiveness of government assistance programs and food pantries along with how food insecurity is a growing concern within the U.S. According to Alaimo, food insecurity is "the limited or uncertain availability of nutritionally adequate and safe foods, or limited, or uncertain ability to acquire acceptable foods in socially acceptable ways" (Alaimo 282). Food insecurity has risen over the past few years, especially in adults. Between the years 2021 and 2022, the percentage of people in the U.S with food insecurity rose from 10.2%,13.5 million people, to 12.8%, 17 million people (USDA). There are many factors that impact how much food insecurity increases, including race, place of residence, household composition and geographic location. For race, Blacks and Hispanics' food insecurity rates increased the most, at 2.6% and 4.6% respectively (USDA). Not only that, the place of residence is also important, with the highest increase outside metropolitan cities at 3.9% and inside the principal cities with an increase of 3.1% (USDA). The geographical area is also important when it comes to food insecurity increase, with the South having the highest increase at 3.1% and the Northeast at 2.8% (USDA). Children are also being affected by the increase of food insecurity and they are also struggling to put food onto the table. 12 million children don't have the comfort that there will be food on the table ("Hunger in the U.S"). More than 1 in 5 children are at risk of food insecurity, with 1 in 3 children for Latinos and African Americans ("Hunger in the U.S").

Food insecurity is also very important because it is linked to many health issues, such as diabetes, Chronic Kidney Disease, obesity and cardiac issues. 6.8 million U.S households suffer from very low food insecurity, which is defined as when the "normal eating patterns of one or more household members were disrupted and food intake was reduced at times during the year because they had insufficient money or other resources for food" (USDA). This is significantly higher than the 5.1 million people in 2021 (USDA). A survey that was conducted in two states interviewed benefactors from SNAP and charitable food pantries reported that 60% of households identified health conditions as the main challenge that comes with food insecurity (Jacknowitz et al.). One of the main reasons is because of the lack of nutrition that people get from cheap food (*Diabetes and Food Insecurity*). Cheap food is not that healthy for the body because it has high amounts of sugar, saturated fat and sodium (*Diabetes and Food Insecurity*). Not only that, they are also high in calories and carbs which can cause spikes in blood sugar levels (*Diabetes and Food Insecurity*). High blood sugar levels increase the risk of diabetes compilations like heart and kidney diseases, vision loss or lower-limb amputations (*Diabetes and*

Food Insecurity). Food insecurity can also cause people to skip meals, which can lead to lower blood sugar levels and that can cause diabetes complications (*Diabetes and Food Insecurity*). Health care costs can also be difficult for people who are already struggling with their budget (*Diabetes and Food Insecurity*). As a result, these people have to choose between health care or food. This can cause people to put off filing their prescriptions and checking their blood sugar level in order to save supplies (*Diabetes and Food Insecurity*). This can be very dangerous and lead to further health issues (*Diabetes and Food Insecurity*).

According to Feeding America, around 49 million people (1 in 6 Americans) received some sort of charitable food assistance in 2022 (*Charitable Food Assistance Participation*). Various assistance programs, such as food pantries, community kitchens, and government subsidies like SNAP are used by people in need. However, SNAP has been underperforming in many counties because the average modest meal in the U.S costs $3.14, but the SNAP benefits only cover $2.74 (Gupta and Waxman). Considering that 4 out of 10 SNAP users make zero net income, rising food costs and inadequate benefits make it hard for households to feed themselves (Gupta & Waxman). According to data from NielsenIQ on geographic variations in food prices, benefits were inadequate in one out of five 5 counties (Gupta & Waxman). SNAP benefits are particularly inadequate in urban areas with high food prices and in some rural areas that face above average food prices (Gupta & Waxman). Among adults with very low food insecurity, 51.3% drew on savings to pay for food and 1 in 10 used cash from loans to pay for groceries (Gonzalez & Martinchek). Continually using payday loans will undermine a family's financial stability and increase debt burdens to unsustainable levels (Gonzalez & Martinchek). SNAP is not sufficient enough for people with very low food insecurity, which is why they have to rely on savings and loans.

There have been many studies on food insecurity in the U.S and mostly focus on how widespread food insecurity is and how well the government assistance programs are at dealing with it. Some findings that all the sources commonly have is that government assistance programs are not doing enough (Chilton and Rose; Gonzalez and Martinchek; Gupta and Waxman; Jacknowitz et al.). The studies urged the government to increase the funding for government assistance programs as they are very important to those who cannot afford food comfortably (Chilton & Rose; Gonzalez & Martinchek; Gupta & Waxman; Jacknowitz et al.).While other studies are focusing on the increase in food insecurity ((Alaimo 282; *CDC Surveillance System: Trends in Prevalence of Food Insecurity in U.S. Adults*; USDA). There also have been sources that have mentioned that government assistance programs like SNAP aren't enough for families who have little to no income(Gonzalez & Martinchek). However, there are some limits to the studies, as some of them only have data from surveys that are merely part of a few states (*Policy and Benefits*). Some of the studies are also outdated as they were before the pandemic and a lot of policies changed because of it (Alaimo 282; Chilton & Rose; David; Myers & Painter; Zepeda). This could have influenced the study findings and made the study different. There are also other studies that try to cover nationwide data, which means their analysis may miss the grounded interactions and real world mechanisms (*CDC Surveillance*

System: Trends in Prevalence of Food Insecurity in U.S. Adults; *Charitable Food Assistance Program*; *"Hunger in the U.S"*; Urban). Many papers do not focus on wealthy communities because they assume that everyone in such communities does not confront issues related to food insecurity (*CDC Surveillance System: Trends in Prevalence of Food Insecurity in U.S. Adults*; *Charitable Food Assistance Program*; *"Hunger in the U.S"*; Urban).

This research will contribute to this topic because it focuses on the micro-level analysis of how communities deal with food insecurity and it demonstrates how food insecurity is still prevalent in wealthy communities. To reach these ends, data from a small community in a wealthy neighborhood is used. My paper also has a lot of data from the client side and pantry coordinators, which means it will have both sides of the narratives and behaviors. This makes my paper more reliable as I have information from the giver and the receiver in the food pantry operation. I got the information by utilizing ethnographic observations and interviews. These methods are in-depth and provide context for the study.

Methods

This study employs a mixed-method approach to evaluate the effectiveness of food insecurity assistance programs in the North Shore. The research combines two qualitative methods, interviews and ethnographic observations, to gain a comprehensive understanding of how these programs function and their impact on food insecurity in the region.
The administrators that I interviewed, mostly women, were very kind and patient. The interview invitations were sent out through email to the pantry administrators. In the email, I also attached an interview outline so that the interviewees were able to see what we were going to talk about in advance. These interviews were conducted with program administrators and sometimes clients to understand the operational structure, challenges, and perceived effectiveness of the programs. While I was volunteering at the Willow Creek Care Center, I connected with clients because I talked with them while I was putting their information into the system. After I put their information in, I asked them if they were willing to be interviewed for my paper. Each interview lasted between 30 to 60 minutes and was recorded with participants' consent. My participant observation took place at the Northfield Township Food Pantry. I participated in volunteer activities, such as food distribution and meal preparation, and observed what was going around in that space at the same time. The total observations amounted to 20 hours. This method provided insights into the everyday operations of the pantry and interactions between volunteers and clients that cannot be fully conveyed in the interviews.

I made sure that for each of these interviews, informed oral consent was obtained from all participants before their involvement in the study. The consent process included a clear explanation of the study's purpose, procedures, potential risks, and benefits. I also had the interviewees sign a consent form that outlined all the permissions and what I was going to do with the interview.

By integrating interviews and ethnographic data, the study provides a better understanding of these programs' strengths and areas for improvement.

Operational Structure and Pantry Services

The food pantries on the North Shore serve their clients by adapting their services to meet the needs of diverse populations and relying heavily on donations, though their operational structures vary. The New Trier Township Food Pantry is affiliated with New Trier Township and accountable to taxpayers through the township supervisor and board. It also serves clients who meet income guidelines and issues cards for their bi-weekly visits. During the pandemic, the pantry adapted its services to ensure safety by offering outside pickups before recently allowing clients to shop inside. Similarly, the Wilmette Food Pantry is managed by 8 to 10 dedicated volunteers, who handle all aspects of food distribution and organization. While the pantry caters to a broad and diverse group with minimal entry requirements, it also responds to increased demand with specific services like holiday food items. In contrast, the Willow Creek Care Center manages a high volume of clients with structured visit limitations and provides a comprehensive range of services beyond food, including clothing and clinics. They relied on a mix of government funding (60%), donations (20%), and church support (20%). The Northfield Township Food Pantry, a 501(c)(3) charity, does not check income levels but verifies residency. It sources food from the Greater Chicago Food Depository (GCFD), local supermarkets, and community donations. With about 50 regular volunteers and 150 additional ones who help occasionally, the pantry handles various tasks, including client interaction, stocking, cleaning, and picking up donations. Collaborating with other local pantries and schools for food drives and donations, the Northfield Township Food Pantry has strong partnerships with local companies and organizations that support the pantry through food drives and volunteering.

However, most of these pantries suffer from either the lack of government aid or the decreased government aid. The New Trier township food pantry operates on donations (85 to 90%) and a modest $25,000 budget in 2023. The pantry receives contributions from schools, churches, local businesses, and volunteer-organized food drives. Although the New Trier Township Food Pantry operates with the township, the pantry's heavy reliance on donations asks the question of whether or not New Trier Township is given enough funding. This relates to how the New Trier Township Pantry limits the amount of food that each client could choose. According to Brian Leverenz, a New Trier Township pantry staff:

People can't take more than 2 cereals, no more than 2 toiletries, 2 cans of food, 2 cookies, or 2 crackers. People can take 2 dairy items out of the fridge. We have milk, eggs, yogurt, and butter. People can take 2 meats out of the freezer, like chicken breasts, fish, pork chops, sausages.

This limit means that there will be some clients who will not be able to get all the food that they want and will have to make do with the food that they were able to get. Perhaps if the New Trier Township government had invested more funding into the pantry, it would be able to increase the amount of food that each client would be able to take out.

Similarly, Wilmette food pantry operates independently without government funding, relies solely on donations and is housed rent-free at Trinity Methodist Church. The pantry also

only operates on Tuesdays, which gives clients a very limited time period to get food. The pantry's heavy reliance on donations raises questions about whether the government provides sufficient support. The Wilmette Food Pantry is a very small pantry, which is why the pantry only has 8 to 10 volunteers since they do not need any more. According to Barbara Young, a Wilmette Food Pantry staff:

The pantry is allowed to only give the people what they have. If the pantry doesn't have a certain item, the people are just going to have to wait.

Since the Wilmette Food Pantry solely operates on donations, perhaps the pantry would be able to give out more food and operate on more hours if they had government support.

Although the Willow Creek Care Center gets more than half of their food from the government, they have recently faced cuts in government aid. This forces the Willow Creek Care Center to depend more on the community donations. According to Esther Desantiago, a Willow Creek Care Center staff:

The COVID pandemic opened up many more pantries but everyone still gets the same amount of food from the government. This caused the government to lower what everyone was getting, which dropped Willow Creek's funds by 20% two years before and another 20% last year.

Since the Willow Creek Care Center is the biggest food pantry in the North Shore, a lot of people get impacted by this decrease. The decrease in government aid could be the reason why the Willow Creek Care Center limits clients to use the pantry once a month. This raises even more concern about the funding that the government is putting into local food pantries since the pandemic has caused the amount of clients to increase.

Clients at the Willow Creek Care Center have also reported that they use SNAP and go to the Willow Creek Care Center. According to 2 male clients, they both reported that they also participate in SNAP and receive benefits from it. This shows how SNAP is not enough for their families since they also visit pantries to receive food.

Similarly, the Northfield Township Food Pantry is a pretty big food pantry as it serves 880 monthly families that live in the Northfield Township Area. However, according to Julie Schaefer, the coordinator for the Northfield Township Food Pantry:

"I don't have a hard number but I would say about 20% of everything we distribute is from the GCFD [the Greater Chicago Food Depository]. The rest of it is either things that we purchase or food items that are donated by community members."

This shows how little the government is providing food for the pantry, even though they serve more than 800 families per month. The pantry provides many limits to each category of food because they don't want them to run out for clients. During my ethnography, I have seen many clients having to put back food because they went over the limit by 1 or 2 items. However, if the government provides more help to the pantry, they will be able to provide more food for clients and remove some limits on food so clients will be able to get their desired amount.

Client Diversity and Community Outreach

The food pantries in the North Shore also serve a variety of clients and they also try to get their existence known in their community while also making the pantry seem welcoming toward clients. The New Trier Township food pantry collaborates with over 40 local nonprofits, schools, and police departments to enhance visibility and support, maintaining consistent volunteer recruitment through community engagement efforts. Wilmette responds to heightened demand driven by rising food prices and economic instability, adapting its services to meet specific needs such as offering holiday-related food items and accommodating various dietary restrictions. The Northfield Township Food Pantry encounters similar challenges, serving over 1,200 families with 800 visiting monthly and four new families joining weekly, yet 20% of the township's population remains unaware of its existence. Volunteers have become proficient and now operate independently after initially struggling with the pantry's workflow. Volunteers will also speak slower for clients who have trouble hearing in order to accommodate their hearing condition. They will also do this for people who don't know English that well. Sometimes clients like to bring in a second person to translate between the volunteer and the client to bring down the language barrier. The volunteers at the Northfield Township Food Pantry still often talk to each other about their life outside the pantry and coordinate with each other. Willow Creek addresses language barriers with Spanish-speaking staff and operates with a dedicated team of nine staff members and up to 800 volunteers weekly from diverse backgrounds. Not only that, but they also have signs all around the pantry that are in Russian, Spanish and English so that clients can read the signs in their native language and access the pantry. The center gains visibility through its website, church gatherings, and word-of-mouth referrals among customers. Another way that pantries like to get more clients to visit their pantry is to make the pantry more welcoming toward clients. Many clients are ashamed and embarrassed to be using the pantry so the Willow Creek Care Center makes itself more welcoming for clients by making the pantry seem more like a grocery store.

However, New Trier Township faces challenges in meeting increasing demand, particularly during economic downturns or periods of inflation. This is a reflection of the increasing food insecurity in our nation these days. A study found that 62% of adults whose grocery costs increased reported either reducing or not buying the food that they wanted(Martinchek et al). They also found that adults whose grocery costs increased were almost twice as likely to have food insecurity (29% compared to 16.5%), which shows the direct correlation between inflation and food insecurity (Martinchek et al). At the same time, many people are unaware of what support they can get from the community. For example, despite community outreach through flyers, business cards, and periodic media coverage, the Wilmette food pantry remains relatively unknown due to its small size. According to Brian Leverenz:

8 main reasons for people to visit the pantry: Disability and disease is the biggest. The most frequent disability is mental illness. Displacement/job loss is usually temporary. Divorce, death, desertion, drugs and alcohol, domestic violence. Some people fall in multiple categories…Many clients are kind of embarrassed or ashamed that they're using a food pantry.

There are many people who are being affected by these reasons, however, they do not visit the pantry because they either do not know about it or they are too ashamed to visit it. One way that pantries can improve their effectiveness in their community is to make the pantry more welcoming to people who are in these times of trouble.

The New Trier Township Food Pantry also has trouble getting a variety of foods onto the shelves since they mostly receive American food from donations and government aid. Similarly, the Willow Creek Care Center also has similar problems. According to Esther Desantiago:

The Care Center does have a goal of getting cultural foods for the families so that they get more comfortable food that they see at home, not just American food but also other types. They will get these mostly from donors because the government only gives out American foods. They do want the government to increase funding of the cultural foods because of migrants

The increase of migrants due to the Russia-Ukraine war and the cartel in Central and Southern America make this issue more pressing because they are not used to eating American food at home. According to the Migration Policy Institute, nearly 46.2 million immigrants lived in the US in 2022, which is the highest ever in US history(Batalova). Foreign population in the US also grew by 912,000 people between 2021 and 2022, which is 65% of the total population increase during that year (Batalova). According to a survey done on 33,000 immigrants by Kaiser Family Foundation, about 53% of them reported challenges accessing government assistance programs such as food insecurity programs due to the language barrier (KFF). Around 25% of the participants also reported that they feel overqualified for their job (KFF). This results in less income for their family since they are working a job that pays less. When observing the clients in the Willow Creek Care Center, I also found that there was a diverse population in the 22 clients that I observed: 36% English, 18% Russian or Ukrainian, 18% Venezuelan, 14% Spanish, 9% Mexican, and 4.5% Columbian. If they are able to get cultural food, it will make the pantry truly seem like a grocery store that they will find in their neighborhood, and it will be more effective than American food. This is why the government needs to add more variety to the foods that they give to food pantries because not everyone likes to eat American food.

Another issue that comes with the increase of immigrants is the language barrier between volunteers and clients. During my ethnography at the Northfield Township Food Pantry, I observed that some clients brought another person with them into the pantry. The person they brought was a translator who would interpret what the volunteer was saying and translate it for the client. This would help them understand the rules of the pantry and access it easier. However, not everyone has a relative that can speak both English and the client's native language very well. According to Esther Desantiago:

Language barriers are one of the challenges that the care center faces because they mostly serve migrants. The Care center doesn't have a single mandarin speaker and it's also hard for Ukrainian and Russian clients because the care center only has a few volunteers who can speak those languages. However, the care center has enough Spanish speakers because Desantiago was able to build a connection between the English and Spanish speakers.

Language barrier is a big issue in the North Shore as well because clients will not be able to get the full service of the pantry since they do not understand everything in the pantry. Pantries can increase the effectiveness of pantries for non-English speaking immigrants by getting volunteers who can speak multiple languages or start making guides that are in multiple languages. Non-english speaking clients can also bring in another person who can translate what the volunteer says to the client.

The age imbalance of volunteers is also remarkable. During my ethnography at the Northfield Township Food Pantry, there was a lack of volunteers from the younger generation. Most of the volunteers were middle aged or elderly men and women. According to Ron Kochman, a volunteer at the New Trier Township Food pantry:

I have been retired for 10 years and almost every pantry volunteer leaves after one year because of various reasons. I have also been living in the township since 1975: most friends and neighbors don't know the pantry exists.

The fact that Ron has been retired for 10 years brings up the question about volunteer availability. It makes a point that a volunteer needs to have enough spare time in order to volunteer at the pantry. This also proves the volunteer demographics in the ethnography since almost all of them were middle aged or elderly men and women.

Ron also makes the point that many friends do not even know that the pantry exists. This shows how the community is fully using the pantry since many of them are unaware of its existence. Even though the Northfield Township food Pantry serves over 1,200 families with 800 visiting monthly and four new families joining weekly, yet 20% of the township's population remains unaware of its existence. Similarly, Wilmette food pantry also has a problem with the lack of awareness of people in the community. According to Barbara Young:

The [Wilmette] pantry does have a website, and they try to have articles written about them and have a banner outside of the church, but there are still a lot of people who miss out because they are a small food pantry.

This raises the question of how many people are missing out on the food pantry because they do not know there is one in their community. This shows that pantries have a lot more potential in helping the community since there are many people in need of food who are unaware of the pantry in their community. These findings all show that there is a lot more that pantries can do to help their community by making themselves more known and by adapting for the people who cannot speak English that well.

Table 1. Comparison of Pantries

Pantries	Features	Challenges

New Trier Township Food Pantry	- Is affiliated with the New Trier Township Board - Operates on 85-90% donations and a modest budget of $25,000 - Clients must meet income guidelines and are issued a card for bi-weekly visits. - Clients come from affluent areas like Winnetka, with varying needs due to disabilities, job loss, or other crises.	- More government aid - Increasing amounts of clients among economic downturns - Diversity in the foods given by the government - Lack of awareness in the community of the local pantry
Wilmette Food Pantry	- Housed at Trinity Methodist Church, which provides space rent-free. - No formal identification is required; the pantry operates on an honor system and serves anyone in need.	- Not enough government aid - Lack of awareness in the community
Willow Creek Care Center	- Offers a comprehensive range of services including food, clothing, and clinics (dental and vision). - Clients are limited to one visit per month for grocery shopping, and the quantity they	- Not enough government aid - Increasing amounts of clients - Diversity in the foods given by the gov - Language barriers in the pantry

	can take is based on available inventory. ● Operates with a team of 9 staff members and utilizes up to 800 volunteers weekly across various shifts.	
Northfield Township Food Pantry	● The pantry serves approximately 1,200 families, with around 880 visiting monthly. ● Works closely with local grocery stores like Whole Foods, Trader Joe's, and Costco, receiving daily deliveries of food donations. ● Pantry is in high demand when the children are out of school.	● Unable to expand the pantry ● Clients are limited because of the increase ● Clients cannot access full pantry due to barrier ● Pantry needs volunteers to operate ● Still 20% of the township don't know the pantry exists.

Overall, the findings in this section prove that both the government and society have a lot of work to do in order to improve the effectiveness of the pantries. These findings are related to the existing literature because they both support the fact that the government is not doing enough to help the food assistance programs. For example, studies say that SNAP is not doing enough to support people with food insecurities since they have to take out loans and the money provided in SNAP is not enough for a modest meal due to inflation (Gonzalez & Martinchek; Gupta & Waxman; Jacknowitz et al.). Many studies support the findings except these findings are more specific towards the North Shore in Illinois. The North Shore in Illinois is unique compared to the other places studied because the North Shore is known for being a wealthy community and it mostly is. So these findings are targeted toward the heavy minority that have food insecurity in the North Shore. Other studies focus on areas that have more food insecurity than the North Shore or national statistics ("*CDC Surveillance System: Trends in Prevalence of Food Insecurity in U.S. Adults*"; Feeding America; *"Hunger in the U.S"*; Urban). The government and society can take action and make life easier for people in need by reducing the stigma against them and by providing more job opportunities for them. Many people in need have experienced shame and embarrassment because of their financial state which makes their life a lot harder. The

government can start connecting pantries with job opportunities so that people can maintain a stable income and financial state. Everyone has a role to play when it comes to helping the more unfortunate people in the community.

Conclusion:

Overall, pantries need more government support and they also need to adapt to the clients more, either through breaking the language barrier or giving them more diverse foods. Food pantries play an essential role in addressing food insecurity through tailored approaches. Understanding the dynamics of volunteer-client interactions, operational structures, and community outreach efforts is crucial for enhancing the effectiveness and sustainability of these vital community resources. The government should increase the funding for the food pantries so that they can expand their operations and increase the amount of food they give to each client. The government should also increase its funding for the government assistance programs that people nationwide use. Studies have found that government aid is not enough for SNAP recipients as they need to use their own money to buy modest meals (Gonzalez & Martinchek).

Future research should explore strategies for improving client satisfaction, volunteer engagement, and community awareness to further support these pantries' missions. They can also consider the question: "Are there any other ways that will better help people than giving food only?"

On the other hand, people can start considering what social structures are generating food insecurity and poverty consistently. For example, the state of job opportunities forces people to take low-paying jobs and the income is not enough to sustain them and their family, which then gives them food insecurity. Another social structure is the healthcare and social safety nets. These government programs are sometimes discriminatory toward certain ethnic minorities and that causes the clients to spend more of their budget on those programs. This leads to less of the budget being allocated for food, which leads to the family being food insecure. Political instability and unsafe environments also force clients to move areas into a new environment which can be hard for them to adapt to. During these hardships, clients often need support from the food pantry since they are unable to manage the budget that well. Food insecurity is not an issue that is isolated from other social issues and structures. Instead of a program that only takes food insecurity into consideration alone, a comprehensive program that provides solutions to poverty is much preferred.

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