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How Interactions with the West Shaped Chinese History By Kevin Y. Feng

Throughout China's long history, many foreigners have wanted to experience the culture and wealth of China through a variety of means. From the earliest known interactions at the founding of the Silk Road during the Han Dynasty, trade with outsiders has been integral to how China functions. When China became reluctant to free trade during the Qing Dynasty and Mao Zedong's era, society stagnated accordingly. The Qing Dynasty's refusal to develop and trade resulted in the traumatic Century of Humiliation for China, leading to Mao's revolution and the founding of the People's Republic of China in 1949. Despite being isolationist at times, there are instances of China's expansion and exploration of foreign lands. Zheng He's voyages across the Indian Ocean to Africa, India, and the Middle East were similar to many of the expeditions sent by the Han Dynasty to create trade routes along the Silk Road. In modern times, Xi Jinping's Belt and Road Initiative, founded in 2013, is China's current globalization and economic expansion plan. In recent years, the West has grown increasingly concerned by Xi's policies despite the heavy reliance on each other. China's long and complicated history can inform how it treats foreigners interested in doing business and its international policies today.[1]

Overview

While trade is necessary for a country the size of China, the scale of this trade fluctuates greatly and often inversely to how prosperous China is at a certain point in time. For example, trade with foreigners was not greatly expanded during the Tang and Song dynasties, which are widely considered to be the peak of Chinese civilization when the West was in the middle ages.[2] There was little that China could gain from any potential interactions with the West at that time. Ethnocentric ideas at the time prevented further exploration and expansion of Chinese influence beyond China's historical borders. This lasted into the Ming Dynasty with the decision to stop further voyages after Zheng He. While European powers expanded a few centuries later, when they were more technologically advanced, China stopped its technological growth and isolated itself from the outside world.

The expansion during the Han Dynasty was one major exception to this isolationist tendency. Much like modern Chinese trade, the economic policies of the Han Dynasty were expansionist and sought out new markets for their high-demand, exclusive goods. The Han Dynasty's desire for exploration led to the formation of the Silk Road, which connected the East to the West and provided trade routes as well as protection for merchants for centuries.[3]

The Tang and Song dynasties are widely known as some of the most prosperous times in Chinese history when significant cultural, technological, and political advancements were made. The widespread use of paper money, the invention of the compass, and increased porcelain production propelled Chinese civilization to become the most prosperous in the world. The capital of the Tang Dynasty was Chang'an (today's Xi'an), which boasted a population of two million people. Xi'an was by far the largest city in the world at the time and the entire Tang dynasty was the most populous civilization in the world, having over 60 million people.[4] In the

Song Dynasty, the population dramatically increased and Confucianism became the principle on which the government was based. The Tang and Song dynasties' interactions and trade along the Silk Road were more towards the Middle East and India rather than Europe which was in the middle ages. Then, later during the Yuan dynasty when the Kublai Khan ruled China, European explorers like Marco Polo made journeys to China in search of new resources. In the Ming dynasty, Europe sent Jesuit missions to China, such as Matteo Ricci and Michele Ruggieri. These missionaries spread Christianity throughout China and increased European connections with the far East.[2-4]

Interactions between China and the West from the 1800s to the 1970s have been unfriendly at best and deadly at worst. Since the British Empire landed in China in the 19th century, the immediate reaction of the Qing Dynasty was to get rid of foreigners and maintain their culture and dynasty. Despite the efforts of the Qing dynasty, which had the highest GDP in the world around 1800[5], China was divided into spheres of influence designed for economic extraction by Europe and the United States, which both still today have an uneasy relationship with China. These historical wounds inflicted on China by the West have not healed like those in India, Africa, and the Americas. Unlike China, many former colonial nations in those places have adopted a resemblance to Western democracy. Instead of using violence and revolution to achieve independence, many of them have been granted independence because of the deterioration of their suzerain. On the other hand, China was never completely controlled by a Western power, and despite being a victim of various acts of unfairness and atrocities, China has been able to maintain self-governance under its own unique system.

Since the inception of the dynastic cycle in China with Emperor Qin Shi Huang, China has treated all kinds of foreigners more as nuisances than guests. Despite Emperor Qin's effort to keep out the 'barbarians' from the north, his Great Wall was ineffective in its primary purpose. The Wall was mainly symbolic in warning foreigners to keep out and that the Chinese did not want to interact with them. Today, China is 92% Han Chinese due to millennia of seclusion. Compared to most other countries, China is relatively homogenous in its population for its land area. This homogeneity is crucial to the way the Chinese government operates.[6]

Emperor Qin Shi Huang's unification of China from the Warring States period led to the unification of peoples and cultures. Before Qin, China had certain similarities to Europe's political and cultural composition. Many parallels are seen between these vastly different places. For example, both had similar land areas and were composed of many independent states with their own language/dialect and culture. However, China differed in that these Warring States were unified under one central government and have forcefully stayed that way for most of the time since the Qin Dynasty. Emperor Qin's political and cultural unification of China over 2,000 years ago prevented different regions in China from being split and forming separate cultures. Today, being Chinese is widely seen as being one culture and national identity. [7]

The Silk Road

The Western world's first significant interaction with China was during the East and West Han Dynasty (202 BC- 9 AD and 25-220 AD, respectively) when China traded goods along the Silk Road. This trade route transported exclusive Chinese goods such as paper, gunpowder, silk, and porcelain to the Middle East, where they would go through various middlemen until finally reaching the Roman Empire in Europe.[3] The first relationships between China and the peoples of Central and Western Asia were developed in the Han Dynasty when Emperor Wu of Han sent the envoy Zhang Qian to establish official diplomatic relationships with Central Asia. Zhang Qian's journey was some of China's first interactions with anyone from a different part of the world. His original journey toward the West explored and documented various groups of people, including today's India, Pakistan, Afghanistan, the Mongolian Steppe, and more. After his journey, the commercial relationships between West and East were set up, and numerous more envoys followed in the next few centuries. One envoy was documented to meet the Roman Emperor Augustus sometime between 27 BC and 14 AD.[8] Another journey around 120 AD brought Buddhism to China for the first time, which is still one of the largest religions in China with broad influence in the country.[9, 11]

Ancient Sino-Western relationships mainly were those of trade routes and were transactional until later in history when a ethnocentric view of foreigners developed in the Chinese people when Mongols ruled China during the Yuan dynasty. The Chinese people treated the Mongolians as foreigners and changed some of the policies of isolation that existed for so long. This change welcomed explorers and missionaries from Europe. Notably, Marco Polo gained the favor of Kublai Khan and helped administer certain regions in China. Relationships between China and the rest of the world improved and were fruitful when China was widely considered for centuries to be more advanced than their trading counterparts. Technological advances throughout the later period propelled China to become the population and economic powerhouse of the world.

Zheng He's Voyages

Zheng He was born in the rural region of Kunming in 1371 to a Chinese Muslim family. Zheng He claimed that his family was descended from early Mongol conquerors and a King from Bukhara (now Uzbekistan). By the beginning of the Ming dynasty, when Zheng He was alive, shipbuilding and navigational technology in China was at a peak. As a eunuch, Zheng He gained power and influence in the Yongle court; the newly crowned emperor selected Zheng He to explore the world.[10]

China's lead over Europe in terms of technology at the time was well-known throughout both parts of the world for centuries. While most European nations were stuck in the millennia-long cycle of being unable to develop both culturally and technologically, China was in some of their most prosperous dynasties, where many significant developments took place. Since the Song Dynasty, there was the first use of a bureaucratic government that was much more straightforward and effective than previously.[32] The widespread use of the Civil Service Exam introduced a meritocracy that selected government officials who were scholars instead of

those based on inheritance. The shift towards intellectual government officials led China to expand its knowledge in all areas of human endeavor, including maritime technology.

Zheng He set sail with a fleet of 65 ships and over 20,000 men, where he explored much of Southeast Asia, India, the Arabian peninsula, and Eastern Africa. Despite his exposure to all these different, new cultures, when he returned, the Chinese bureaucracy deemed the rest of the world too simple and uncultured compared to China, thus stopping all further expeditions. Unlike European sailors whose journeys to new places led to the establishment of vast trading empires, China decided that they had everything in the world and that further interactions with foreigners would be pointless. After a few hundred years of increased isolation in China, the European powers surpassed China in its technology and trading networks. Because China was so non-expansionist, it eventually succumbed to others willing to expand. After hundreds of years of self-isolation and little technological development, China fell prey to expansionist powers that would see tremendous opportunities in China's land, population, and resources.

China's Century of Humiliation

Imperialist ideologies spread throughout Britain in the 19th century, led many entrepreneurial individuals to expand corporations that would spread British influence. The East India Company, founded in 1600, played increasingly more prominent roles in how the British conducted expansion and imperialism. Over the hundreds of years that the East India Company was in operation, it became a vessel of the British government. By having this company as a middle-man, Britain was able to protect its reputation by claiming how it was merely the actions of one company rather than the motives of the entire nation. The company had its own small military, which proclaimed to exist to defend its economic interests only. While this company was mostly known for its activities in India in the late seventeenth and early eighteenth centuries, much of its focus was in China, where it purchased large amounts of goods such as porcelain, tea, and silk.[12]

As the desire for tea in England soared when the nobility popularized it in the early 1700s, the British East India Company sought to meet this demand. While the Qing dynasty had no interest in any trade or interactions with foreigners, the East India Company secured the port region of Canton for its business by 1713. Despite the efforts to expand to more ports throughout the next few decades, the British were not able to gain access to the rest of China. [13]

As the Qing government believed that any interactions with foreigners were of little value, they demanded silver exclusively as payment. Increasing demand and imports of tea drained Britain's supply of silver, leading to the illegal importation of opium from British-controlled India to China. The profits from the illegal trade of opium to China enabled British merchants to continue to pay for their tea. The increasing opium trade with Britain marked the first time China would import more goods than it exported. This disruption in what had been a stable economy for centuries led to the first Opium War in 1842.[14]

The Treaty of Nanjing that ended the first Opium War was the first of a series of unequal treaties that ruined the Qing economy and prevented development for the next century. After the

first Opium War, trading ports were opened forcefully, and certain rights and privileges were granted to Western powers. Through widespread mismanagement and corruption within the Qing Dynasty, China was carved into spheres of influence by Western powers at the turn of the 20th century. The deteriorating economic and social conditions induced many people in China to distrust and hate foreigners and the incompetent Qing government.

   The infamous Century of Humiliation in China left the nation in social and economic ruin. Over the next century, Western powers would extract China as much as possible through any means necessary, just like what they did in all their other conquered lands. While China was so large that no country could directly control it, these 'economic relations' between China and the West meant suffering and loss for millions of Chinese.

   The First Sino-Japanese War from 1894-1895 witnessed Japan's emergence as a regional power and the Qing Dynasty's eventual collapse in 1912.[15] In the decades following this war, the rise and fall of the Republic of China, World War II, and the Chinese Civil War brought even greater chaos, death, and suffering to China. The cycle of war and chaos between periods of relative stability in various dynasties is seen throughout Chinese history. Governance of China by the Chinese Communist Party (CCP) shares many similarities to the Chinese dynasties. It seems as though this cycle of war and stability will persist no matter who is in charge. This time, the rise of the CCP was simply like any other dynasty, only with a different means to rule China.

China During and After Mao

   The events in the 19th and 20th centuries created the necessary conditions for Mao Zedong to win the people over and take power in China. When there is desperation to survive, powerful leaders like Mao can arise by promising the people what they need. Because of China's terrible past experiences with foreign involvement, Mao implemented policies that shifted Chinese culture and outlook towards an isolationist country of peasant farmers. This desire to return to what life was like before British imperialism led to massive failures as the economic reality defied Mao's wishful ideals. Despite millions of Chinese people dying under Mao's reign, his expertise in propaganda allowed him to stay in complete control. Although Mao's isolationist policies were questionable in their economic success, it is understandable from an internal point of view why Mao chose to make these decisions. From Mao's understanding of the last century, any interactions with the West had led to the destruction of society and terrible things happening. For many Chinese people who experienced this chaos at the time, being isolated but protected would sound pretty good.[22]

   Mao's rise to power was through a long and convoluted civil war that had impoverished the nation even further than it already was. When the CCP was founded in 1921, inspirations from the Russian Revolution fueled indignant intellectuals who wanted to introduce a Marxism-Leninism system to China. The movement started slowly, with most of the Chinese population not knowing what Communism was or who Mao Zedong was. After seeing the success of his Russian counterparts in their respective revolution and civil war, Mao gathered his support and troops mainly in the form of guerilla fighters. At the same time, his opponent,

Chaing Kai-shek (President of the Republic of China), had a more traditional military. Because of the threat to his governance, Chaing tried killing as many communists as he could. Even after most were dead, Mao led the 6,000 mile Long March towards rural northern China, where he was more supported. The Japanese invasion of China throughout the 1930s gravely weakened the Nationalists and resulted in a brief pause in the civil war. Mao gathered greater support by promising the redistribution of land to the peasants, which made him increasingly popular in rural China. This increased support, combined with military aid from the Soviet Union in the 1940s, allowed Mao and the People's Liberation Army to gain power and leverage. In 1945, both the Soviet Union and the United States urged the Communists and the Nationalists to hold peace talks, both stating that there should be some coalition government. In one such peace talk organized by President Harry Truman in 1945, Mao and Chiang signed a ceasefire.[16] Unfortunately, both sides soon violated their previous agreement and resumed the civil war. After a series of battles between the Soviet-aided communists and the American-supported nationalists, Mao eventually took control of China and established the People's Republic of China (PRC) in 1949. While the PRC was a new and relatively unestablished country throughout the middle of the 20th century, Mao gained worldwide recognition for some of his actions.

The PRC's involvement in the Korean War in the late 1950s just about a year after its founding encouraged the Union of Soviet Socialist Republics (USSR) to provide China with increasingly large amounts of military aid. The result of China's involvement in the Korean War was an armistice between the North and the South Koreas. This significantly improved China's reputation and sent a message to the world that China now had a formidable military.[17, 18] The development of China's atomic bomb (1964), hydrogen bomb (1967)[19], and satellite (1970) paved the way for the PRC to gain the permanent seat of the United Nations Security Council held by the Republic of China until 1971.[20] Along with the Korean War, China's involvement in the Vietnam War reinforced many anti-West sentiments instilled by the government. The Sino-Soviet Border Conflict in 1969 realigned China's foreign policy away from the USSR. This collapsed friendship catalyzed Richard Nixon's historic visit to China in 1972, which reduced tensions between the two nations and set the path for the normalization of relationships. The Sino-Vietnamese border war started in February and ended in March of 1979 when Chinese troops invaded northern Vietnam in brutal battles that lasted for just over three weeks. This was only months after the United States established diplomatic relationships with the PRC on January 1, 1979 and only weeks after Deng Xiaoping's visit to Washington D.C. and the CIA headquarters in Virginia. Deng's visit was highly unusual as few foreign leaders had ever been granted access to the CIA headquarters, let alone the most secretive seventh floor where highly classified information was held. Deng and former CIA director Stansfield Turner had a meeting where they discussed plans for American spy equipment to be set up in Western China to spy on the Soviet Union.[21, 23] In return the United States helped China by providing military technology that would allow them to spy on the Soviet Union.[34]

Deng Xiaoping's newly introduced policies of having a free market brought many Western companies to China to make more money. These free-market policies set the foundation

for all modern trade between China and every country (specifically the United States). As China was a developing nation throughout the 1990s and 2000s, many American and European businesses made significant profits in doing business with China by making the products cheaply for worldwide consumption. China's economy also grew exponentially as a consequence. Today's conflicts between the US and China are primarily because of China's rise to power and its potential expansion.[24]

China's Belt and Road Initiative

The Belt and Road Initiative (BRI), the signature foreign policy initiative by President Xi Jinping in 2013, is China's global outreach program to provide developing nations with infrastructure and funding in exchange for a friendly and profitable relationship with China and a loan the host country must repay. While China knows that many of these countries will have problems in repaying these loans, it can be in the interest of both nations involved. Because of imperialism and extractive economic policies implemented by European powers throughout much of the 19th and early 20th centuries, many nations in Southeast Asia, the Middle East, Africa, and Latin America have and are currently experiencing cycles of poverty that can benefit from external loans. While developing nations receive infrastructure, the main thing that China gains in return is its influence in these regions, where the United States very often does not see profitable economic opportunities.

China's BRI will invest an estimated $1 Trillion in foreign countries by 2025, which may rise to $8 Trillion by 2049. This shift towards a more globalized and more economically expansionist China has the United States worried about the strength of China's influence in these developing countries.[28]

The role of the Silk Road during the Han dynasty is similar to that of China's BRI today. The Silk Road allowed the Han dynasty to transmit its ideas, culture, and products across Asia and indirectly reach places like the Roman Empire. Today, the BRI has much of the same use to the Chinese government as the Silk Road did to the Han Dynasty; both spread Chinese influence over vast areas and expand political and economic ties with other nations. The Silk Road expanded China's outreach to powerful empires at the time, like the Roman Empire and the Parthian Empire.[11] Much like the BRI, which sometimes has to accept that some countries may not be able to repay loans, maintaining the security of the Silk Road had its costs; the Han Dynasty dispatched a series of military campaigns to drive out the Xiongnu (a nomadic group of peoples who were unfriendly with the Han Dynasty). Both the Silk Road and the BRI are developed in a time of relative prosperity for China. Many see the Han Dynasty as a golden age, and today, China has the second-largest economy in the world and is one of the fastest-growing economies in the world. In these times of prosperity for both societies, there are similarities in how they are run and how each obtains tremendous power. Both the PRC and the Han dynasty use a form of the Civil Service exam. For modern-day China, this solely determines college admissions, while the Han dynasty used it to select highly educated government officials. This style of governance and bureaucracy has been constant throughout Chinese history that either

works very well for the country as a whole or turns the country to ruin and chaos because of weak rulers. This repetitive cycle throughout history is unique to China; no other civilization has had cycles of rise and fall throughout their history.

China's unique dynastic cycle, which largely continues today, is a significant reason for many of the problems that China faces and its strenuous relationship with the United States. When the British East India Company first encountered the Qing Dynasty, they aimed to do business and make as much money as possible. Britain in the 1800's had goals similar to what the PRC has today. Despite the differences between imperial Britain and the PRC, both are superpowers of their time and seek wealth from abroad.

China's BRI exemplifies modern-day imperial expansion with goals similar to their European counterparts 150 years ago. The difference here is that China exercises a lower level of imperialism, which is limited thus far to economic influence over the recipients of the BRI. In the past, other countries have exercised higher levels of this paradigm. For example, India became a full colony of the British Empire, and spheres of influence were set up in China by many European countries and the US. Similarly, the United States established a protectorate in Cuba in the early 20th century. Throughout history, every successful civilization has expanded beyond its borders in search of resources. However, China is unique in that only recently has it expanded beyond its historical borders to have some sort of low-level imperialism via the BRI.[27]

While other countries like the United Kingdom, France, and the United States hold some of their original imperial territories, China rents just one foreign military facility: the Chinese military base in Djibouti.[27] Every world power expands, once they can. This has been continuous throughout human history because people always want more. China's BRI and the global economic expansion that comes with it are just another example of humanity's constant desire for more. The conflict between an existing superpower and an emerging superpower is expected as their competition inevitably grows. However, China's 'cool' and sustained conflict with the United States since President Trump changed US foreign policy towards China is unique to Chinese history in that China never experienced any foreign relationship like this before.[30]

With the exception of the Han Dynasty, most Chinese interactions with the Western world were either fruitless when China was powerful or traumatic when China was powerless. Although the Chinese attitude towards foreigners has somewhat changed in the 20th and 21st centuries, the current tensions between the United States and China have historical roots. The inability to expand and develop new technology for hundreds of years preceded China's downfall and its century of humiliation. In more modern times, China's economic expansion with President Xi Jinping's new Belt and Road Initiative has led to global influence on a scale unseen before. Over 140 countries have signed on to China's BRI since its creation in 2013[31], including wealthy European countries like Italy, which signals its intention to withdraw under the prodding by the US.[26] Over the upcoming years, China's BRI will continue to expand, and its influence will grow even further than before, which could bring about increased conflict with the United States.[29]

Conclusion

China's attitude towards foreigners over the course of its history has been mixed and constantly changing. Although the dynastic cycle and form of government are essentially constant, China's relationships with foreigners can fluctuate from positive and profitable for both parties to traumatic for China. Notable earlier experiences in expansion was during the Han Dynasty with the creation of the Silk Road and the journey of Zheng He. The Silk Road was a vital trade route that provided both ends of it with goods and culture from the other. Despite being nearly 2,000 years before the creation of the BRI, the two have striking similarities in their purpose and nature. Zheng He's journey was a product of centuries of cultural development; China's navigational technology and ship-building abilities greatly outclassed those of European explorers decades before Christopher Columbus set sail. Despite the success of his voyages, the Ming court decided to stop exploration and labeled Zheng He's voyages a waste of money. After this, little contact or trade was made with Westerners until the British arrived in China in the 1700s. China's century of humiliation was a result of Western spheres of influence, the Opium Wars, distrust in the Qing Dynasty, and also the inability to modernize. Then, Mao Zedong's rise was made possible by the political reality of China, which invited communism to flourish among the Chinese populace at the breakpoint of society. Mao's isolationist policies throughout the 1950s and 1960s after he took power put the Chinese people behind in their education and technology. Official diplomatic relationships between the United States and the PRC were established in 1979, shortly after Mao died in 1976. These new relationships were made possible by more modern Chinese leaders, like Deng Xiaoping, who implemented pro-trade economic policies and encouraged foreign investment. For any nation to function properly, its relationships and trade with others must be balanced. With this balance, there must also be development, as a failure to expand trade and modernize will result in corruption and collapse of government. The constant cycle of rise and fall in Chinese civilization is the most important historical aspect in order to foresee events that will affect China; the study of history is the only way that the future can be grasped. The cyclical rise and fall throughout Chinese history comes down to one thing: the one-man rule.[33] It is inconceivable that China will ever defy its history by abandoning this form of governance.

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Mirna as Keystone in Therapeutic Association in Various Diseases By Richard Jerald

Abstract

miRNAs are pivotal regulators of gene expression and have a profound impact on various cellular pathways and physiological processes. Whether upregulated or downregulated, miRNAs can influence the progression of diseases, tissue regeneration, and the overall functioning of cells and tissues. Their role in regulating gene expression makes them essential components of cellular and molecular biology. miRNAs play a critical role in the progression and potential treatment of metabolic diseases by regulating various aspects of metabolism, insulin sensitivity, and inflammation. Understanding the specific roles of miRNAs in these diseases and developing targeted miRNA-based interventions offers potential avenues for more effective treatments and improved management of metabolic disorders.

Keywords: miRNA; metabolic disorders; neurological disorders; cancer;

Introduction

Small, non-coding RNA molecules known as microRNAs (miRNAs) are essential for post-transcriptional gene control. They participate in a number of cellular functions, including as proliferation, differentiation, development, and responsiveness to external stimuli. By attaching to the 3' untranslated regions (UTRs) of target messenger RNAs (mRNAs) and causing translational inhibition or mRNA degradation, miRNAs have the ability to affect the expression of genes. Numerous cellular pathways and physiological functions are significantly impacted by the up- and down-regulation of miRNAs. Small, non-coding RNA molecules known as microRNAs (miRNAs) are essential for post-transcriptional gene control. They participate in a number of cellular functions, including as proliferation, differentiation, development, and responsiveness to external stimuli. By attaching to the 3' untranslated regions (UTRs) of target messenger RNAs (mRNAs) and causing translational inhibition or mRNA degradation, miRNAs have the ability to affect the expression of genes. Numerous cellular pathways and physiological functions are significantly impacted by the up- and down-regulation of miRNAs [1].
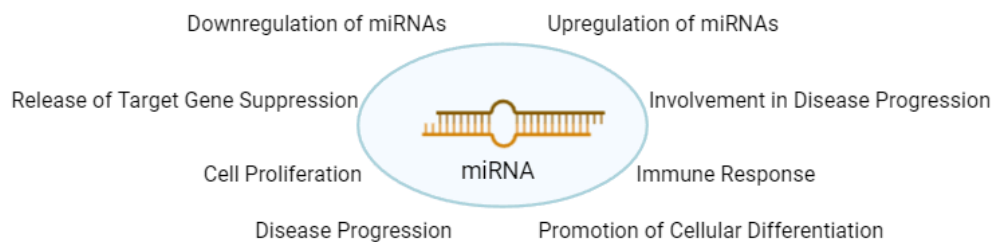
Figure-1. Function of miRNA
Functions of miRNA

- Upregulation of miRNAs:
  When miRNAs are upregulated, meaning their expression is increased, they can have several effects on cellular pathways and processes. Upregulated miRNAs can lead to increased suppression of their target genes. This can impact the expression of proteins involved in various pathways, potentially leading to changes in cellular behavior. For example, upregulated miRNAs may inhibit the expression of tumor suppressor genes, contributing to cancer progression [2].
- Promotion of Cellular Differentiation:
  Upregulated miRNAs can drive the differentiation of stem cells into specialized cell types. For example, miR-124 is known to promote neural differentiation by targeting genes that maintain stem cell properties.
- Involvement in Disease Progression:
  Dysregulation of miRNA expression, particularly upregulation, is associated with the progression of various diseases. Upregulated miRNAs may contribute to the pathogenesis of conditions such as cardiovascular disease, neurodegenerative diseases, and different types of cancer [3], [4].
- Immune Response:
  Upregulated miRNAs can regulate immune responses by targeting genes involved in immune signaling pathways. This can have implications for both innate and adaptive immune responses.
- Downregulation of miRNAs:
  Conversely, when miRNAs are downregulated, meaning their expression is reduced, they can also have significant impacts on cellular pathways and processes:
- Release of Target Gene Suppression:
  Downregulated miRNAs release the suppression of their target genes, allowing for increased expression of these genes. This can lead to the activation of specific pathways or the production of certain proteins.
- Cell Proliferation:
  Some downregulated miRNAs inhibit cell proliferation. Reduced levels of these miRNAs can lead to increased cell division and may be associated with conditions like cancer.
- Disease Progression:
  The downregulation of specific miRNAs has been implicated in the progression of diseases, such as metabolic disorders, neurodegenerative diseases, and viral infections. For example, downregulation of miR-122 is associated with hepatitis C virus (HCV) infection.
- Tissue Regeneration:
  Downregulated miRNAs may promote tissue regeneration and repair by allowing the expression of genes involved in these processes.

miRNA Involvement in Pathways:

MiRNAs are involved in numerous cellular pathways, depending on their target genes. Some common pathways include:
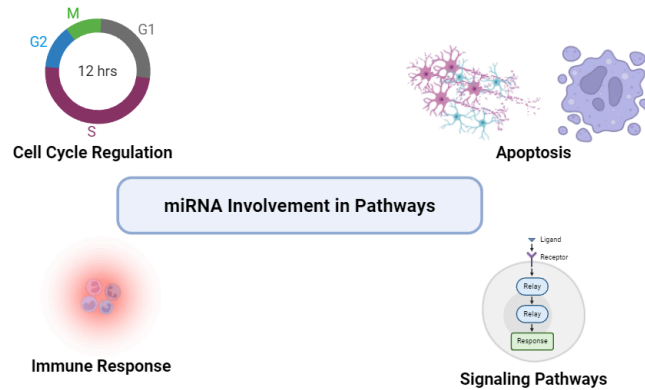
Figure 2 Pathways involved by miRNA
- Cell Cycle Regulation:
  MiRNAs can influence the cell cycle by targeting genes involved in cell division and proliferation, such as cyclins and cyclin-dependent kinases (CDKs).
- Apoptosis:
  MiRNAs regulate apoptosis (cell death) by targeting pro-apoptotic or anti-apoptotic genes. For example, miR-21 targets pro-apoptotic genes and promotes cell survival.
- Signaling Pathways:
  MiRNAs can modulate various signaling pathways, including the PI3K/AKT/mTOR pathway, Wnt/β-catenin pathway, and Notch signaling pathway, by targeting key components in these pathways.
- Immune Response:
  MiRNAs play a role in regulating immune responses by targeting genes involved in immune signaling, cytokine production, and antigen presentation.

Disease model

The overview of miRNAs that can be used in diagnosis and progression of different disease models:

1.Cancer and different types

Certain miRNAs can serve as biomarkers for cancer diagnosis. Altered miRNA expression profiles in cancer cells or circulating miRNAs in the blood can provide valuable information for early detection and classification of cancer types. MiRNAs can affect cancer progression by targeting genes involved in cell proliferation, apoptosis, and metastasis. They can act as either oncogenes (promoting cancer) or tumor suppressors (inhibiting cancer), depending on their specific targets. The mechanisms by which miRNAs impact cancer progression and their potential as therapeutic targets are complex and multifaceted. miRNAs are involved in the

regulation of cancer biology through two main mechanisms, modulation of crucial signaling pathways associated with OSCC or direct interaction with target proteins[5].

Here is a detailed explanation of the role of miRNAs in cancer progression and treatment, including the relevant pathways:

- Oncogenic miRNAs in Cancer Progression:

  Upregulation of oncogenic miRNAs: In cancer, some miRNAs are upregulated, leading to the suppression of tumor suppressor genes or the de-repression of oncogenes. This promotes cell proliferation, invasion, and metastasis. One example is miR-21, which is often overexpressed in many cancer types and targets tumor suppressors like PTEN.

  Downregulation of tumor suppressor miRNAs: Conversely, tumor suppressor miRNAs are often downregulated in cancer. These miRNAs usually target oncogenes and genes involved in cell cycle regulation. The let-7 family of miRNAs, for instance, acts as tumor suppressors and is frequently downregulated in cancer.

  Involvement in EMT (Epithelial-Mesenchymal Transition): EMT is a process in which cancer cells lose their epithelial characteristics and gain mesenchymal traits, allowing them to invade and metastasize. miRNAs like miR-200 family regulate EMT by targeting transcription factors like ZEB1 and ZEB2.

- Tumor Suppressor miRNAs in Cancer Progression:

  Loss of tumor suppressor miRNA function: When tumor suppressor miRNAs are downregulated or functionally impaired, they can no longer inhibit oncogene expression, leading to uncontrolled cell growth and progression. For example, miR-15 and miR-16 are tumor suppressor miRNAs that target BCL2, an anti-apoptotic protein.

  Cell cycle regulation: Many tumor suppressor miRNAs, such as miR-34a, regulate cell cycle progression by targeting genes like cyclin D1 and CDK4, thereby inhibiting cell proliferation.

- miRNA-Based Cancer Treatment:

  MiRNA mimics: Synthetic miRNA mimics can be introduced into cancer cells to restore the function of tumor suppressor miRNAs or enhance the expression of miRNAs that target oncogenes. This approach can help inhibit cancer cell growth and metastasis.

- Antisense miRNAs (antimiRs): AntimiRs are single-stranded RNA molecules designed to inhibit specific oncogenic miRNAs. They can prevent the miRNA from binding to its target mRNA, thus preventing the inhibition of tumor suppressor genes.

- Nanoparticle-based delivery: MiRNA-based therapies often employ nanoparticles as delivery vehicles to enhance the stability and specificity of miRNA therapeutics. This approach helps target cancer cells more effectively while minimizing off-target effects.

- Combination therapy: MiRNA-based treatments can be combined with conventional chemotherapy or targeted therapy to enhance treatment efficacy. For example, miR-34a mimics have been tested in combination with chemotherapy in clinical trials [6], [7].

- miRNA-Related Pathways:

PI3K/AKT/mTOR pathway: miRNAs like miR-21 and miR-221/222 can target genes in this pathway, promoting cell survival and resistance to apoptosis.

Wnt/β-catenin pathway: miRNAs such as miR-34 and miR-200 family members can regulate this pathway, impacting cell proliferation and metastasis.

TP53 pathway: miRNAs like miR-34a are direct targets of the TP53 tumor suppressor protein, and they play a role in TP53-mediated cell cycle arrest and apoptosis.
miRNAs play a complex and dynamic role in cancer progression, influencing key cellular processes that contribute to the disease's development and spread. Understanding these miRNA-driven mechanisms is essential for developing miRNA-based therapeutics and improving cancer treatment strategies. The potential to manipulate miRNA expression and activity holds promise for more targeted and effective cancer treatments.
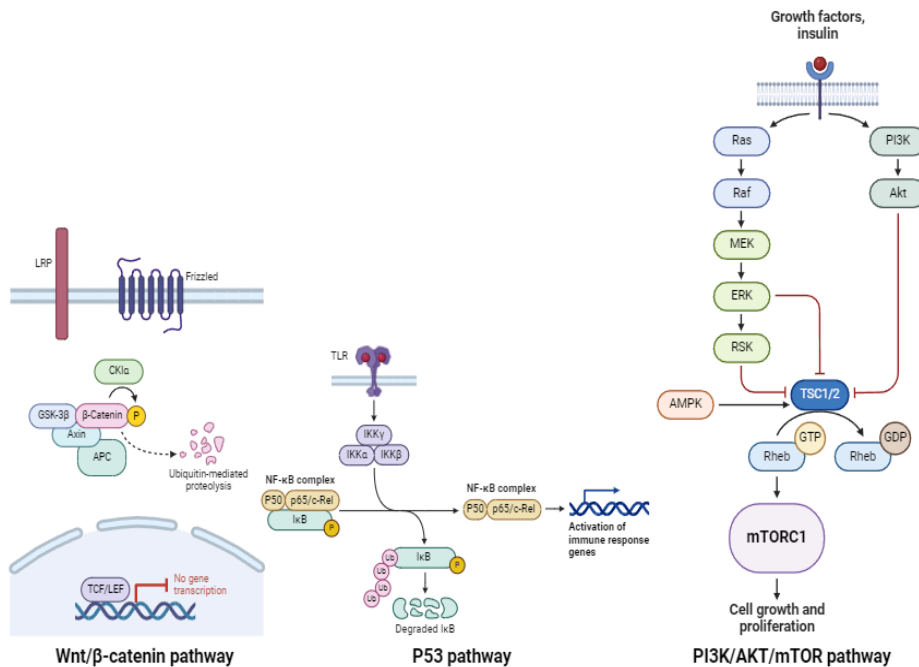
Figure 3: miRNA pathways involved in Cancer progression

miRNA-Based Therapeutic Approaches:

miRNA Replacement: In cases where specific miRNAs are downregulated and associated with neurodegenerative diseases, miRNA replacement therapy may be used to restore their levels.

miRNA Inhibition: For diseases where specific miRNAs are upregulated and contribute to pathogenesis, miRNA inhibition using antimiRs can be employed to reduce their expression.

Delivery Strategies: Developing effective delivery systems, such as viral vectors or nanoparticles, is crucial for delivering miRNA-based therapeutics to the central nervous system.

2. Cardiovascular Diseases: Dysregulated miRNAs are associated with various cardiovascular diseases, such as myocardial infarction, heart failure [8] [9], and atherosclerosis. Monitoring specific miRNAs in blood samples can aid in the early diagnosis and risk assessment of these conditions. MiRNAs can influence disease progression by modulating processes like cardiac hypertrophy, fibrosis, and angiogenesis. Understanding the role of miRNAs in these processes can provide insights into potential therapeutic interventions [10].

3. Neurodegenerative Diseases:
Altered miRNA expression patterns are found in neurodegenerative diseases like Alzheimer's, Parkinson's, and Huntington's disease. MiRNAs in cerebrospinal fluid or brain tissue can be used as diagnostic biomarkers. MiRNAs can influence neurodegenerative disease progression by regulating genes associated with neuroinflammation, protein aggregation, and synaptic dysfunction. Research in this area aims to identify therapeutic targets to slow disease progression. miRNAs also play a significant role in the progression and potential treatment of neurodegenerative diseases, including Alzheimer's disease, Parkinson's disease, Huntington's disease, and amyotrophic lateral sclerosis (ALS). These diseases are characterized by the progressive degeneration of neurons in the central nervous system. MiRNAs are involved in regulating various molecular pathways associated with these diseases [11]. Here's a detailed explanation of the role of miRNAs in neurodegenerative diseases, along with relevant pathways:

    a. Alzheimer's Disease:
        miRNAs and Amyloid Precursor Protein (APP): MiRNAs like miR-29 and miR-101 target APP, which is involved in the generation of amyloid-beta (Aβ) plaques, a hallmark of Alzheimer's disease. Dysregulation of these miRNAs can lead to increased Aβ production. Tau Protein Regulation: MiR-132 and miR-125b target the tau protein, which forms neurofibrillary tangles in Alzheimer's disease. Dysregulation of these miRNAs can result in tau hyperphosphorylation. Inflammatory Pathways: MiRNAs such as miR-146a are involved in neuroinflammation, a key feature of Alzheimer's disease, by regulating immune responses and cytokine production.

    b. Parkinson's Disease: Dopaminergic Neuron Degeneration - MiRNAs like miR-133b play a role in maintaining the health of dopaminergic neurons, which are severely affected in Parkinson's disease. Dysregulation of this miRNA can contribute to neuron degeneration. α-Synuclein Regulation - MiR-7 and miR-153 target α-synuclein, whose aggregation is linked to Parkinson's disease. Dysregulated miRNAs can lead to increased α-synuclein

levels. Oxidative Stress Response - Some miRNAs are involved in regulating oxidative stress pathways, which contribute to neuronal damage in Parkinson's disease.

    c.   Huntington's Disease: Mutant HTT Gene Regulation: MiRNAs like miR-9 and miR-124 target the mutant huntingtin (HTT) gene in Huntington's disease, which leads to the production of abnormal HTT protein. These miRNAs may provide a potential therapeutic strategy to reduce mutant HTT levels. Neuroinflammation: MiRNAs are implicated in the regulation of inflammatory responses that contribute to disease progression in Huntington's.

    d.   Amyotrophic Lateral Sclerosis (ALS):

    e.   TDP-43 and FUS Protein Regulation: MiRNAs like miR-132 and miR-206 can target genes encoding proteins such as TDP-43 and FUS, which form pathological aggregates in ALS. Dysregulated miRNAs may contribute to these proteinopathies.

    f.   Glutamate Excitotoxicity: MiRNAs are involved in the regulation of glutamate signaling pathways, which play a role in the selective motor neuron degeneration seen in ALS.

4. Infectious Diseases:

MiRNAs have been investigated as potential diagnostic markers for infectious diseases. For example, miRNA profiles can help differentiate viral from bacterial infections and monitor disease progression. The progression of miRNAs plays a role in the host response to infections and can affect the severity and outcome of the disease. Understanding these miRNA-mediated mechanisms can aid in developing treatments and vaccines.

miRNAs are also involved in the progression and potential treatment of infectious diseases. These small RNA molecules play a role in regulating the host immune response and the replication of various pathogens. Here's a detailed explanation of the role of miRNAs in infectious diseases, including relevant pathways:

    a.   Role of miRNAs in Infectious Disease Progression:

Immune Response Regulation: miRNAs are involved in regulating the host immune response to pathogens. They can either promote or inhibit the immune response, depending on the context. For example, miR-155 and miR-146a play crucial roles in modulating immune signaling pathways.

Viral Replication Control: In viral infections, miRNAs can target viral transcripts, thereby inhibiting viral replication. For example, miR-122 is involved in the regulation of hepatitis C virus (HCV) replication by binding to the viral genome.

Bacterial Infection Susceptibility: miRNAs can influence susceptibility to bacterial infections by targeting host genes involved in immune defense mechanisms. Dysregulation of miRNAs can either enhance or weaken the host's ability to combat bacterial invaders.

b.   Role of miRNAs in Treatment of Infectious Diseases:
Host-Directed Therapy: miRNAs can be manipulated for host-directed therapy against infectious diseases. Modulating the expression of specific miRNAs can enhance the host's ability to fight infections. For example, miR-155 can be targeted to enhance the host's antiviral immune response.

c.   Antiviral Therapies: miRNAs can be targeted for the development of antiviral therapies. In some cases, the use of antimiRs that inhibit host miRNAs involved in facilitating viral replication can be explored.

d.   Specific Pathways and Examples:
HIV Infection: miR-29a and miR-29b are known to target the 3' untranslated region of the HIV genome and inhibit viral replication. On the other hand, some miRNAs like miR-132 can promote HIV infection by targeting host restriction factors.

e.   Hepatitis B Virus (HBV): miR-122, an abundant liver-specific miRNA, plays a critical role in HBV replication. Targeting miR-122 using antimiRs has been investigated as a potential therapeutic strategy against chronic HBV infection.

f.   Tuberculosis (TB): miR-33 is associated with lipid metabolism, and it can be modulated to enhance the host's ability to combat Mycobacterium tuberculosis infection. By targeting miR-33, researchers have explored strategies to improve TB treatment.

g.   Malaria: miR-451 regulates erythropoiesis and has been studied in the context of Plasmodium falciparum infection. Modulating miR-451 may help reduce the severity of malaria.

h.   Respiratory Viral Infections: miR-146a is known to regulate the innate immune response to respiratory viruses like influenza. By targeting this miRNA, it may be possible to modulate the host's response to viral infections.

5. Metabolic Diseases:
miRNAs have been linked to metabolic disorders like diabetes and obesity. Specific miRNAs can serve as biomarkers for disease diagnosis and monitoring. miRNAs can regulate insulin

sensitivity, lipid metabolism, and inflammation in metabolic diseases. Understanding these mechanisms can help develop targeted therapies [12], [13].

miRNAs are involved in the progression and treatment of metabolic diseases, which encompass conditions like obesity, type 2 diabetes, and metabolic syndrome. These diseases are characterized by dysregulation of metabolism and glucose homeostasis. MiRNAs play a critical role in regulating gene expression related to metabolism and can contribute to both the progression and potential treatment of these diseases. Here's a detailed explanation of the role of miRNAs in metabolic diseases, including relevant pathways:

a. Role of miRNAs in Metabolic Disease Progression:
Insulin Sensitivity and Glucose Homeostasis: MiRNAs like miR-33a and miR-103/107 have been implicated in regulating insulin sensitivity by targeting genes involved in insulin signaling pathways, such as IRS-2. Dysregulation of these miRNAs can lead to insulin resistance, a hallmark of metabolic diseases.

b. Lipid Metabolism: MiRNAs like miR-122, found predominantly in the liver, can regulate lipid metabolism. Dysregulation of miR-122 has been associated with increased hepatic lipid accumulation and the development of non-alcoholic fatty liver disease (NAFLD).

c. Adipocyte Differentiation and Function: MiRNAs play a role in regulating adipocyte differentiation and function. For example, miR-143 and miR-375 can influence adipogenesis and lipolysis, contributing to obesity and related metabolic disorders.

d. Inflammatory Pathways: Chronic low-grade inflammation is associated with metabolic diseases. MiRNAs like miR-146a and miR-155 can regulate inflammatory pathways by targeting pro-inflammatory factors like TNF-α and NF-κB.

e. Specific Pathways and Examples:

miR-33: miR-33 regulates cholesterol homeostasis by targeting genes involved in cholesterol efflux, such as ABCA1. Inhibiting miR-33 has been explored as a potential therapy for atherosclerosis and other metabolic disorders.

miR-375: miR-375 plays a role in regulating insulin secretion from pancreatic beta cells. Modulating its expression may help improve glucose homeostasis in type 2 diabetes.

miR-27a/b: miR-27a and miR-27b target PPARγ, a transcription factor that plays a central role in adipocyte differentiation and lipid metabolism. Modulating these miRNAs can influence fat cell formation and lipid storage.

miR-21: miR-21 is involved in promoting fibrosis in non-alcoholic steatohepatitis (NASH), a severe form of NAFLD. Inhibiting miR-21 may reduce liver fibrosis in NASH.

6. Autoimmune Diseases:

Dysregulated miRNAs are associated with autoimmune diseases like rheumatoid arthritis, multiple sclerosis, and lupus. MiRNA profiling can be used to diagnose and classify these diseases. MiRNAs can influence the immune response, inflammatory processes, and tissue damage in autoimmune diseases. Modulating miRNA activity may provide therapeutic options to manage disease progression.

MicroRNAs are involved in the progression and treatment of metabolic diseases, which encompass conditions like obesity, type 2 diabetes, and metabolic syndrome. These diseases are characterized by dysregulation of metabolism and glucose homeostasis. MiRNAs play a critical role in regulating gene expression related to metabolism and can contribute to both the progression and potential treatment of these diseases. Here's a detailed explanation of the role of miRNAs in metabolic diseases, including relevant pathways:

Insulin Sensitivity and Glucose Homeostasis: MiRNAs like miR-33a and miR-103/107 have been implicated in regulating insulin sensitivity by targeting genes involved in insulin signaling pathways, such as IRS-2. Dysregulation of these miRNAs can lead to insulin resistance, a hallmark of metabolic diseases.

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Inflammatory Pathways: Chronic low-grade inflammation is associated with metabolic diseases. MiRNAs like miR-146a and miR-155 can regulate inflammatory pathways by targeting pro-inflammatory factors like TNF-α and NF-κB.

Epigenetics and Cancer:

Epigenetics refers to changes in gene expression and regulation that do not involve alterations in the DNA sequence itself but are instead driven by modifications to DNA and associated proteins. MiRNAs, on the other hand, are small RNA molecules that post-transcriptionally regulate gene expression. These modifications, including DNA methylation and histone acetylation, are critical factors in cancer development and progression.

Aberrant epigenetic changes can silence tumor suppressor genes and activate oncogenes, contributing to uncontrolled cell growth. For instance, DNA hypermethylation in the promoter region of tumor suppressor genes, such as p16 and BRCA1, is a common epigenetic alteration in various cancers [14]. MiR-21, for example, functions as an oncogene in many cancer types by targeting tumor suppressor genes [15], [16]. In contrast, miR-34a, a well-known tumor suppressor miRNA, is frequently downregulated in cancer and plays a crucial role in inhibiting cell proliferation and promoting apoptosis. Epigenetic modifications can also regulate the expression of miRNAs in cancer. DNA methylation and histone modifications can silence or activate miRNA genes, impacting their downstream gene targets [17].

Epigenetics and Neurodegenerative Diseases:
In neurodegenerative diseases like Alzheimer's, Parkinson's, and Huntington's disease, epigenetic modifications can influence disease progression. Changes in DNA methylation, histone acetylation, and miRNA expression are observed in these conditions. For instance, altered DNA methylation patterns of genes related to neuroinflammation and neuronal plasticity have been linked to Alzheimer's disease. miR-132, miR-133, and miR-34a have been implicated in Alzheimer's disease, where they target genes involved in amyloid beta processing, tau protein hyperphosphorylation, and neuronal apoptosis. In Parkinson's disease, miR-7 and miR-153 target alpha-synuclein, which forms pathological aggregates in affected neurons. In Huntington's disease, miR-9 and miR-124 target the mutant huntingtin (HTT) gene, which is associated with disease pathogenesis.

Epigenetics and Metabolic Diseases:
Epigenetic changes, including DNA methylation and histone modifications, contribute to metabolic diseases such as obesity, type 2 diabetes, and metabolic syndrome. Epigenetic modifications can alter gene expression in adipose tissue and the liver, affecting insulin sensitivity, lipid metabolism, and inflammation [18], [19], [20]. miR-122, predominantly found in the liver, is a key regulator of lipid metabolism. Dysregulation of miR-122 is associated with non-alcoholic fatty liver disease (NAFLD) and dyslipidemia. MiR-375 influences insulin secretion in pancreatic beta cells, making it relevant to diabetes. MiR-33 has a role in regulating cholesterol homeostasis and is implicated in atherosclerosiss [21].

Epigenetics and Infectious Diseases:
Epigenetic modifications can modulate host-pathogen interactions in infectious diseases. For example, DNA methylation and histone modifications can regulate the expression of immune response genes and viral genes during viral infections. These epigenetic changes can impact the course of viral infections, such as HIV and hepatitis B/C. They can target viral transcripts, inhibit viral replication, and modulate host immune responses. MiR-29, for instance, targets the HIV genome and inhibits viral replication. MiRNAs like miR-146a and miR-155 regulate immune signaling pathways and cytokine production during viral and bacterial infections.

The exosomal miRNAs have shown to act as novel biomarkers in predicting the clinics diagnosis and prognosis of hepatocellular carcinoma. For example, reduced expression of serum exosomal miR-320a, serum exosomal miR-34a, and serum exosomal miR-638. 136 have clinical diagnostic values to distinguish between subjects with HCC and normal controls. Besides, the low expression level of serum exosomal miR-320a is closely related to vein invasion, advanced TNM stage, shorter OS, and lymph node metastasis. The exsosomal miRNAs indicate to be an exciting avenue of research in biomarker discovery in HCC [22].

MCC is an aggressive neuroendocrine cutaneous neoplasm with a poor prognosis due to its high recurrence and metastasis risk. It is challenging to make a clinical and histological diagnosis, but early disease detection is crucial for effective treatment. A lot of attention is currently being paid to understanding the molecular profile of MCC, especially changes in miRNA expression to lays the way for miRNA's potential diagnostic, prognostic and therapeutic value. The need for improved prognosis is highlighted by the fact that some early-stage patients experience disease progression and mortality. By researching cutting-edge miRNA-based therapeutic methods, which have been made possible by the continual advancement of functional approaches that enable the detection of molecular interactions, the current bleak prognosis of these patients can be improved [23], [24].

Pathologic elements of Merkel cell carcinoma (MCC) and Oral Squamous Cell Carcinoma [5] need to be characterized and analyzed due to the heightened aggressiveness with which it progresses despite its relatively low prevalence. Numerous research has shown empirical data supporting the notion that miRNAs exert a pathogenic influence in MCC. The expression of miRNAs, which potentially impact multiple pathogenic pathways in MCC, exhibits significant variability. Differential activation of genetic pathways in MCC, such as Wnt/β-catenin signaling, PI3K/AKT/mTOR axis, P53 signaling, KRAS mutation, notch signaling, TLRs, Wnt/Fzd signaling, EGFR signaling, and VEGFs, may account for some of the reported differences. Because of their unique collaboration in these signaling pathways, miRNAs can provide early warning signs of MCC, serving as potential indicators of its onset or recurrence. Moreover, identifying miRNAs represents a promising advancement in the therapeutic[23] [24].

This review essentially elucidates the features of the miRNA transcriptional profile that are relevant to Chronic lymphocytic leukemia (CLL). Patients with CLL had a substantial correlation between the expression of some miRNAs and a poorer prognosis. To improve the early diagnosis and prognosis of CLL and to enable appropriate medical intervention for CLL patients, more studies are needed on these valuable non-invasive indicators to clarify the microenvironment signaling or epigenetic changes related to CLL pathogenesis. To further our understanding of the molecular mechanisms and signaling pathways responsible for the pathogenesis of CLL, studies of the sophisticated relevance between miRNAs and the

progression of CLL have shed light on the Wnt/-catenin signaling, PTEN/ AKT/mTOR axis, KRAS, JAKs/STATs, P53, TGF-β, and EGFR signaling pathways. Therefore, the present review shows that while CLL is still a major type of leukemia in elderly persons and there is a wide range of possible outcomes from the disease, there is the reason for optimism in the development of better early diagnosis and treatment of CLL through the application of non-invasive diagnostic approaches based on the analysis of miRNA expression profiles. Since survival and prognosis of CLL rely on the stage of the tumor at the time of diagnosis, further study in this area will provide a proof-of-principle method for the use of miRNAs as a diagnostic tool for early CLL identification before the commencement of metastasis. The study of miRNAs in leukemic cells has revealed not just a previously unknown layer of gene control, but also fresh therapeutic options for patients with CLL. Consequently, the comprehensive characterization of the miRNA landscape in patients with various clinical evolutions could aid in the comprehension of CLL [25]

Challenges and Future Directions:
Developing miRNA-based therapeutics for metabolic diseases faces challenges related to delivery and specificity. Ensuring that miRNA interventions do not have off-target effects and are safe for long-term use is crucial.

Understanding the precise roles of miRNAs in infectious diseases, as well as developing miRNA-based therapies, presents several challenges. The development of targeted delivery methods and ensuring the safety and specificity of miRNA-based interventions are important considerations.

Harnessing the potential of miRNAs for host-directed therapy and antiviral strategies holds promise for the development of targeted treatments against infectious diseases. Understanding the precise roles of miRNAs in neurodegenerative diseases and developing safe and effective miRNA-based therapies remain challenging. Further research is needed to identify disease-specific miRNA signatures, elucidate the complex miRNA-mRNA regulatory networks, and optimize delivery methods for clinical applications.

Table – 1 representing the regulation of miR in different diseases

	Author	Disease	Up Regulation	Down Regulation
1.	(Hosseini et al., 2023)	Oral Squamous Cell Carcinoma (OSCC)	miR-29a, miR-145, miR-144–3p, miR‑188–5p, miR-770, miR-375, miR-519d-3p, miR-30a, miR-379, miR-21, miR-31–3p, miR-224	miR-29a, miR-145, miR-144–3p, miR‑188–5p, miR-770, miR-375, miR-519d-3p, miR-30a, miR-379, miR-21, miR-31–3p, miR-224
2.	(Doghish et al., 2023b)	Osteosarcoma (OS)	miR-499a, miR-221, miR-19a-3p , miR-27a-3p, miR-197–3p, miR-214, miR-221	miR-34a, , miR-596, miR-29b, miR-342–5p, miR-590, miR-26a, miR-140, miR-329–3p, miR-216b, miR-410–3p, miR-141–3p, miR-509–3p, miR-519d-3p, miR-767–5p, miR-328–3p, miR-513a-5p,
3.	(Volpini et al., 2023)	Cancer Treatment	MRX34, EnGeneIC & ADRI: Meso, miR 1,	Cobomarsen/MRG-106
4.	(Zhang et al., 2023)	Inflammatory Pain	miR-146a-5p,, miR-216a-5p,, miR-155-5p,, miR-451,, miR-449a, miR-101-3p, miR-146, miR-141-3p, miR-23a, miR-149, miR-138, miR-182-5p, miR-183, miR-223, miR-211, miR-34a, miR-124-3p, miR-141-3p, miR-485-5p, miR-107, miR-22, miR-124a, miR-29bpri-, miR-365-3p, miR-1224, miR-125a-3p	Not Specified
5.	(Fathi et al., 2023)	Gastric cancer (GC)	miR-25, miR-106b, miR-93, miR-196a-5p, miR-155, miR-130, miR-155-5p, miR-181a, miR-632, miR-27b, miR-101, miR-128, miR-616-3p	miR-26a, miR-4316, miR-125a, miR-193b, miR-92a
6.	(Khan and Siraj, 2023) (Trideva Sastri et al., 2022)	Coronary artery disease, Atherosclerosis	miRNA-126, miRNA-146a, miRNA-22, miRNA-21, miRNA-29b, miRNA-146a/b, miRNA-19b, miRNA-3614	miRNA-146a/b, miRNA-19b, miRNA-3614
7.	(Ismail et al., 2022),	Breast cancer	miR-155, miR-941, miR-30b-5p, miR-4800, miR-632, miR-372, miR-106a, miR-96, miR-32,	miR-4319, miR-600, miR-26a-5p, miR-130-3p

	(Ma et al., 2023)		miR-206, miR-1207-5p, miR-639, miR-519a-3p, miR-191-5p, miR-204, miR-148, miR-101, miR-192, miR-615-5p, miR-32, miR-383-5p, miR-101, miR-192, miR-615-5p, miR-32, miR-383-5p, miR-101, miR-124a, miR-26b, miR-200c/141 cluster, miR-21, miR-683, miR-10b, miR-93, miR-200b, miR-340, miR-148a, miR-374a, miR-122, miR-222, miR-215-5p, miR-let7d, miR-29b, miR-140-5p, miR-126, miR-126-3p, miR-526b, miR-655, miR-199b-5p	
8.	(Wang et al., 2023)	Pulmonary hypertension	miR-1, miR-17, miR-20a, miR-23a, miR-24, miR-25/138, miR-27a, miR-30a, miR-130, miR-132, miR-143-5p, miR-200a, miR-200c, miR-214, miR-214-3p, miR-221, miR-222, miR-629, miR-let-7b, miR-15a-5p, miR-135a-5p, miR-244-5p, miR-26a-5p, miR-29b, miR-30c, miR-34a, miR-98, miR-124, miR-125a-5p, miR-137, miR-140-5p, miR-141, miR-153, miR-182-3p, miR-193, miR-203, miR-206, miR-543, miR-1	miR-17/20, miR-20a, miR-23a, miR-24, miR-25/138, miR-27a, miR-30a, miR-130, miR-132, miR-143-5p, miR-200a, miR-200c, miR-214, miR-214-3p, miR-221, miR-222, miR-629, miR-let-7b, miR-15a-5p, miR-135a-5p, miR-244-5p, miR-26a-5p, miR-29b, miR-30c, miR-34a, miR-98, miR-124, miR-125a-5p, miR-137, miR-140-5p, miR-141, miR-153, miR-182-3p, miR-193, miR-203, miR-206, miR-543
9.	(Hussen et al., 2023), (Miao et al., 2024)	Lung cancer (LC)	miR-3614-5p, miR-128-3p, miR-9, miR-9-5p, miR-23a, miR-487b, miR-134, miR-655, miR-1246, miR-181b-5p	miR-132, miR-422a, miR-206, miR-107hsa-, miR-486-5p, miR-142-3p, miR-203, miR-145, miR-133a, miR-124, miR-196b, miR-940, miR-497, miR-29c, miR-22, miR-195, miR-375
10	(Guo et al., 2023), (Pelletier et al., 2023)	obesity, type 2 diabetes (T2D)	miR-3614-5p, miR-128-3p, miR-9, miR-9-5p, miR-23a, miR-487b, miR-134, miR-655, miR-1246, miR-181b-5p, miR-27a, miR-132	miR-422a, miR-206, miR-107

11	(Yehia et al., 2023)	Multiple myeloma (MM)	miR-144 , miR-638 , miR-181a-5p , miR-744–5p , miR‑608 , miR-135b , miR-30–5p , miR‑125b , miR-20a , miR-214–3p , miR-410, miR-21 , miR-221/222 , miR-135b, miR 642a , miR-215–5p , miR-451 , miR-206, miR-636, miR-18a, miR-29b, miR-125b, miR-223–3p, miR-30 s, miR-203a-3p, miR-21 , miR-125b , miR-155 , miR-29b-3p , miR-9 , miR-331–3p , miR-451 , miR-15a and −16, miR-146b, miR-146b-3p, miR-324, miR-1271, miR-1271–5p	miR-144, miR-638, miR-203a-3p, miR-342–3p, miR‑608, miR-103a-3p, miR-30 s, miR-128–3p, miR-19a-3p, miR‑25–3p, miR-29a
12	(Gupta et al., 2023), (Zhang et al., 2024)	Tumor	miR-181, miR-633	miR-181, miR-633
13	(Hakimi et al., 2023)	Recurrent miscarriage (RM)	miRNA-21, miRNA-22, miRNA-93, miRNA-106a, miRNA-125b, miRNA-146a, miRNA-148a, miRNA-182, miRNA-183, miRNA-210, miRNA-let-7a	miRNA-16, miRNA-29a, miRNA-92a, miRNA-100, miRNA-125a, miRNA-126, miRNA-133a, miRNA-135a, miRNA-140, miRNA-149, miRNA-199a, miRNA-214
14	(Khan et al., 2023)	Prostate cancer (PC)	miR-21, miR-32, miR-34a, miR-125b, miR-135a-1, miR-146a, miR-155, miR-200a/b/429, miR-221/222, miR-224, miR-372, miR-382, miR-452, miR-505-3p, miR-532-3p, miR-650, miR-1207-3p, miR-4534	miR-17-5p, miR-19a-3p, miR-505-3p, miR-18a, miR-23-3p, miR-27a, miR-30a, miR-30c, miR-141, miR-375, miR-145-3p, miR-145-5p, miR-204-5p, miR-135a-1 , miR-532-3p , miR-10b, miR-382 , miR-452 , miR-505-3p, miR-4534
15	(Chen et al., 2023)	Tumor Cells & Immune Cells	miR-21, miR-21-5p, miR-1246, miR-29a-3p, miR-19b-3p, miR-222, miR-222-3p	miR-130b-3p, miR-425-5p, miR-25-3p, miR-106b-5p, miR-301a-3p, miR-101, miR-27a-3p, miR-183-5p, miR-148b-3p, miR-155, miR-125b-5p, miR-3591-3p, miR-181b, miR-148b-3p,

				miR-21 (, miR-21-5p), miR-155 (, miR-155-5p, miR-155-3p), miR-223 (, miR-223-3p), miR-487a, miR-31a-5p, miR-221-3p, miR-501-3p, miR-95, miR-942, miR-92a-2-5p, miR-503-3p, miR-588, miR-365, miR-125a/b, miR-192-5p, miR-7, miR-16-5p
16	(Zou et al., 2023), (Yu et al., 2023), (Dong et al., 2023), (Hashemi et al., 2023a)	Pancreatic cancer (PC)	miR-125b-5p, miR-23b-3p, miR-155, miR-19a	miR-339-5p, miRNA-124–3p, miRNA-944, miRNA-335, miRNA-145, miRNA-598, miRNA-10a-5p, miRNA-766–3p
17	(Mohammed, 2023)	Colorectal cancer (CC)	miR-10b, miR-532–5p, miR-500a, miR-21, miR-202–5p, miR-31, miR-574–5p, miR-188–5p, miR-106a, miR-200, family, miR-224, miR-645, miR-19a-3p, miR-128–3p, miR-20a, miR-23b/27b/24, miR-17, miR-196b-5p, miR-96, miR-576–5p	miR-215–5p, miR-143/145, miR-26b, miR-485–5p, miR-6869–5p, miR-155, miR-490–3p, miR-383, miR-708, miR-205, miR-326, miR-206, miR-193a, miR-194, miR-126, miR-27b, miR-7, miR-18a-3p, miR-101, miR-466
18	(Tryphena et al., 2023)	Parkinson's disease	miR-21 , miR-373 , miR-27b, miR-124, miR-126, miR-128, miR-26a, miR-221, miR-18	miR-7 , miR-153, miR-214, miR-34b/c, miR-146 Mitochondrial dysfunction - miR-218, miR-103a-3p, miR-181, miR-4639–5p, miR-494, miR-145–3p Dopaminergic neuronal apoptosis pathway- miR-205, miR-599, miR-27a/b, miR-30e, miR-421, miR-485–3p. miR-132–3p, miR-126 Oxidative stress pathway-, miR-144–3p, miR-34a, miR-135b, miR-27a, miR-144, miR-7, miR-141–3p Neuroinflammation pathway) - miR-190, miR-223, miR-188,

				miR-133b (IGF-1, PD Diagnosis- miR-30c-5p, miR-373, miR-29a, miR-29c, miR-144–3p, miR-132–3p, miR-146–5p, miR-132, miR-141, miR-146b-5p, miR-193a-3p, miR-214, miR-19b, miR-195, miR-24, miR-155–5p, miR-146a-5p, miR-153, miR-409–3p, miR-10a-5p, miR-1, miR-19b-3p
19	(Sharma et al., 2023), (Uppala et al., 2023), (Abulsoud et al., 2023)	acute myocardial infarction	miRNA-1-3p, miRNA-1, miRNA-122-5p, miRNA-126-3p, miRNA-126, miRNA-126-5p, miRNA-146a, miRNA-146a-5p, miRNA-191, miRNA-191-5p, miRNA-21-5p, miRNA-21, miRNA-208a, miRNA-208a-3p, miRNA-208b, miRNA-223-3p, miRNA-328, miRNA-499a-5p, miRNA-499, miRNA-499-5p, miRNA-499a	miRNA-126-3p, miRNA-191, miRNA-191-5p, miRNA-21-5p, miRNA-126
20	(Prajzlerová et al., 2023), (Alshahrani et al., 2023)	Rheumatic diseases	miR-10a, miR-548a-3p, miR-23-3p, miR-223-3p, miR-5196, miR-146a, miR-155, miR-141, miR-192, miR-200a, miR-200c, miR-429, miR-146a, miR-16, miR-20a, miR-22, miR-23a, miR-27a, miR-92a, miR-103, miR-150, miR-223, miR-181a , miR-15b, miR-19b, miR-25, miR-93 , miR-142-3p, miR-181a, miR-17, miR-20a, miR-92a, miR-106a, miR-203, miR-107-3p, miR-125b-5p, miR-145-5p, miR-153-3p, miR-199a-5p, miR-323b-3p, miR-369-5p, miR-410-3p, miR-485-5p, miR-543, miR-584-5p, miR-589-3p, miR-1260b, miR-3942-5p, miR-6087, miR-7977, miR-106a-5p, miR-183-5p,	miR-132, miR-223, miR-448, miR-551b, miR-124, miR-16, miR-21, miR-223, miR-451, miR26a, miR-125a-5p, miR-24, miR-23b, miR-125b, miR-16-5p, miR-125b, miR-126-3p, miR-146a-5p, miR-23-3p, miR-223-3p, miR-5196 ERA, miR-16, miR-223 , , miR-99b-5p, miR-143-3p, miR-145-5p , , miR-27a-3p , miR-125b OA,let-7e, miR-454, miR-885-5p ,miR-146a-5p , miR-92a, miR-320b , , miR-19b-3p, miR-122-5p, miR-486-5p , miR-93, miR-126, miR-146a, miR-184, miR-186, miR-195, miR-345, miR-885-5p , miR-126-5p, miR-320a, miR-146a-5p

#	Reference	Disease		
			miR-375-3p, miR-550a-5p, miR-550b-2-5p, miR-4511, miR-4732-3p, miR-6741-3p , miR-141-5p, miR-200b-5p, miR-200c-5p , miR-21, miR-5196 ,miR-483-5p, miR-146a ,miR-155 ,miR-214 , miR-151-3p, miR-150-5p, miR-451a , miR-22-3p, miR-125a-5p, miR-146a-5p, miR-32, miR-34a, miR-10b, miR-16, miR-30a, miR-150, miR-154, miR-29a-3p, miR-146a-5p, miR-222-3p, miR-625-3p, miR-5196, miR-145, miR-498, miR-4310, miR-1234, miR-3679-5p, miR-4299, miR-877, miR-3907, miR-223, miR-4442, miR-21, miR-7	Synovial fluid miR-210 SLE , miR-16, miR-21, miR-126, miR-223, miR-451 ,miR-448, miR-551b, miR-124 ,miR-146a, miR-155, miR-146a ,miR-192, miR-200a
21	(Abd-Elma wla et al., 2023)	Malignant pleural mesothelioma	miR-182-5p, miR-23b-3p, miR-31let-7b, miR-30b, miR-483-3p, miR-584, miR-885-3p, miR-197-3p, miR-19a, miR-19b, miR-21, miR-25, miR-126, miR-197, miR-32-3p, miR-1281, miR-222, miR-126, miR-2053	miR-29c-5p, miR-31-5p, miR-145-5p, miR-205, miR-16-5p, miR-193a-3p, miR-141, miR-200a, miR-200b, miR-200c, miR-9, miR-7-1, miR-203, miR-101-3p, miR-494, miR-181a-5p, miR-145-5p, miR-212-3p, miR-223-3p, miR-1294, miR-1-3pPIM-1, miR-215-5p, miR-34a-5p, miR-34b-5p, miR-34c-5p, miR-15a-5p, miR-15b-5p, miR-16-5p, miR-126-3p
22	(Gareev et al., 2023)	Brain tumors	miR-28-5p, miR-218, miR-22, miR-199b-5p, miR-34a, miR-124, miR-10b	Not Specified
23	(Hajizadeh et al., 2023)	Hepatocellular carcinoma	miR-21-5p, miR-1246, miR-3174, miR-92a, miR-93-5p, MicroRNA-196a/-196b, miR-144, miR-494, miR-582-3p	miR-206, miRNA-137, miR-4651, miR-342, miR-124-3p, miR-33b, miR-383, miR-489, miR-325-3p, miR-876–3p, let-7c, miR-16, miR-26, miR-377, miR-339,

			miR-330-3p, miR-16 and , miR-375 (as a combination), miR-221-3p, miR-155, miR-106b, miR-142-5p, miR–145–5p, miRNA-542-3p, miR-92a, miR–340, miR-644a, miR-183-5p
24	(Vali et al., 2023)	neuropathic pains	miR-21, miR-155, miR-203, miR-214, miR-221, miR-222, miR-224, miR-378, miR-423-5p, miR-574-3p,	miR-34a, miR-451a, miR-29a, miR-29b, miR-29c, miR-125b, miR-126, miR-141, miR-143, miR-145,
25	(Cui et al., 2023)	human disease	miR-34, miR-96, miR-126, miR-22, miR-21, miR-155, miR-17-92, miR-96-182-183, miR-23-27let-7, miR-221-222, miR-15-16, miR-125, miR-17-92, miRNAs, miR-17-92, miR-221	miR-34, miR-96, miR-126, miR-22, miR-21, miR-155, miR-17-92, miR-96-182-183, miR-23-27let-7, miR-221-222, miR-15-16, miR-92, miR-221, miR-17-92 cluster (pro-, miRNA), miR-17-92, miR-92, miR-92, miR-92, miR-92, miR-92, miR-92, miR-92
26	(Natalicchio et al., 2023)	type 2 diabetes andcancer development	miR-7, miR-9, miR-15a, miR-17-92 cluster, miR-24, miR-25, miR-26, miR-29 family, miR-34a, miR-92b, miR-96, miR-124a, miR-125b-5p, miR-130a/b, miR-132, miR-146, miR-148, miR-152, miR-153, miR-181b, miR-182, miR-187, miR-200 family, miR-204, miR-212, miR-216a, miR-223, miR-299-5p, miR-320a, miR-335, miR-375, miR-383, miR-455, miR-770-5p	miR-7, miR-9, miR-15a, miR-17-92 cluster, miR-24, miR-27a, miR-29, miR-34, miR-106b, miR-125b, miR-126, miR-132, miR-135, miR-144, miR-181, miR-205, miR-375, miR-449a, miR-802
27	(Dhuppar and Murugaiyan, 2022), (Hashemi et al., 2023b), (Sousa-Filho et al., 2023)	inflammatory bowel disease	miR-301a, miR-206a, miR-31, miR-138-5p, miR-142-5p, miR-378-3p	miR-378-3p, miR-143, miR-196, miR-130a-3p, miR-144-3p, miR-15a-5p, miR-16-5p, miR-24-3p, miR-10a-5p, miR-141-3plet-7g-5p, miR-375

28	(Doghish et al., 2023a)	Chronic lymphocytic leukemia (CLL)	miR-155, miR-21, miR-17/92, miR-425, miR-92-1, miR-221, miR-34a-5p, miR-21-5p, miR-331, miR-150-5p, miR-96, miR-708, miR-320c/d, miR-7-5p, miR-19b, miR-212	miR-15a/16-1, miR-181b, miR-29, miR-29c, miR-34a, miR-15, miR-16, miR-25-3p, miR-145, miR-19a-3p, miR-144, miR-30d, miR-133b, miR-451a, miR-23a, miR-191-5p, miR-146a-5p, miR-155-5p, miR-34a-5p, miR-29a, miR-15a, miR-96, miR-182, miR-15/16, miR-150-5p, miR-126-3p, miR-181a-5p, miR-23a-5p, miR-191-5p, miR-146a-5p, miR-155-5p, miR-34a-5p, miR-17~92, miR-21, miR-29a, miR-146a, miR-15a, miR-96, miR-182, miR-155, miR-15/16, miR-708, miR-320c/d, miR-7-5p, miR-34a, miR-182-5p, miR-19b, miR-212
29	(Ismail et al., 2022)	Diabetic Neuropathy, Microvascular complications	miR-27a, miR-27a-3p, miR-92b-3p, miR-365	miR-126, miR-485, miR-342-3p, miR-325-3p, miR-543, miR-27b-3p, miR-1228-3p, miR-125a, miR-122-5p, miR-590-3p
30	(El-Husseiny et al., 2023)	Bone diseases Osteoporosis Bone cancer	miR-9–5p, miR-21, miR-29, miR-31, miR-100, miR-103–3p, miR-135a-5p, miR-146a, miR-148a, miR-155, miR-182–5p, miR-200a-3p, miR-214–5p, miR-221, miR-365, miR-410	miR-30b-5p, miR-122–5p, miR-223
31	(El-Mahdy et al., 2023b)	Tumor	miR-196b, miR-204–5p, miR-4295, miR-762	miR‑125a, miR-134, miR-125a-5p, miR-133a, miR-99a-3p, miR-99a-5p, Hsa-let-7e-5p, miR-141
32	(Abd-Allah et al., 2023)	Melanoma	miR-4535, miR-1268a, miR-199a-1-5p, miR-592, miR-135a, miR-146a, miR-342, miR-21, miR-18a-5p, miR-145, miR-633, miR-652, miR-92a, miR-139-5p, miR-365, miR-150, miR-18a-5p, miR-548b,	miR-136, miR-485-5p, miR-708

			miR-140-3p, miR-27b, miR-22, miR-603, miR-1246, miR-25, miR-9, miR-136, miR-485-5p, miR-329, miR-10b, miR-769, miR-454, miR-106b-5p, miR-19b-3p, miR-182, miR-144, miR-340, miR-524-5p, miR-4262, miR-146b-5p, miR-7, miR-142-3p, miR-485-5p, miR-708, miR-200b-3p, miR-675-3p, miR-18b, miR-638, miR-124a, miR-145	
33	(Szopa et al., 2023)	Renal cell carcinoma	miR-301a, miR-32, miR-223, miR-146b, miR-365-2, miR-365-1, miR-335, miR-18a, miR-365-1, miR-183, miR-625, miR-9-2, miR-130b, miR-9-1, miR-21-5p, miR-223-3p, miR-365a-3p	miR-200a, miR-130a, miR-30c-2, miR-149, miR-584, miR-139, miR-10b, miR-24-1, miR-27b, miR-204, miR-769, miR-23b, miR-181a-2, miR-497
34	(Doghish et al., 2023f)	Retinoblastoma (RB)	miR-506, miR-494–3p, miR-141–3p, miR-125b, miR-503, miR-340	miR-133a-3p, miR-140–5p, miR-181a-5p, miR-532
35	(AL-Noshokaty et al., 2023)	Merkel cell carcinoma	miR-30a-3p/5p, miR-34a, miR-96, miR-142–3p, miR-146a, miR-150, miR-182/183, miR-190b, miR-200c-141, miR-340, miR-375, miR-483–5p, miR-502–3p, miR-630, miR-769–5p, miR-873, miR-1539, miR-20a-5p, miR-203, miR-3170	miR-30a-3p/5p, miR-34a, miR-142–3p, miR-146a, miR-150, miR-182/183, miR-190b, miR-200c-141, miR-340, miR-375, miR-483–5p, miR-502–3p, miR-630, miR-769–5p, miR-873, miR-181d, miR-374c, miR-3170, miR-125b, miR-203
36	(Elkady et al., 2023)	Multiple myeloma	miR-181a, miR-25–3p, miR-20a	miR-342, miR-363, miR-338–3p, miR-19a-3p, miR-429
37	(Raza et al., 2023)	Abiotic stress	miR396, miR393, miR393, miR156, miR156, miR319, miR390, miR164, miR414c, miR167Os, miR535, miR393, miR393, miR156, miR156, miR159Os, miR535, miR160, miR164mdm-, miR156mdm-, miR166mdm-, miR172mdm, miR319mdm-, miR399,	miR396, miR393, miR393, miR156, miR156, miR319, miR390, miR164, miR414c, miR167Os, miR535, miR393, miR393, miR156, miR156, miR159Os, miR535, miR160, miR164mdm-, miR156mdm-, miR166mdm-, miR172mdm-, miR319mdm-, miR399,

			miR172a, miR160f-5pCsa-, miR394aCsa-, miR396a-3pCsa-, miR167a-5p, miR159, miR156, miR397a, miR166u, miR171p, miR824	miR172a, miR160f-5pCsa-, miR394aCsa-, miR396a-3pCsa-, miR167a-5p, miR159, miR156, miR397a, miR166u, miR171p, miR824
38	(Anilkumar et al., 2023), (Doghish et al., 2023e)	Triple-Negative Breast Cancer	miR-27, miR-126-5p, miR-135b-5p, miR-136-5p, miR-182-5p, miR-190a, miR-15a, miR-15b, miR-16, miR-21, miR-98, miR-181a, miR-340, miR-29a, miR-100, miR-125b, miR-138-5p, miR-146a, miR-221, miR-222, miR-4324, miR-4800-3p, miR-6836-3p, miR-454, miR-21, miR-210, miR-221let-7a	miR-126-5p, miR-135b-5p, miR-136-5p, miR-182-5p, miR-190a, miR-145, miR-195, miR-205, miR-342, miR-141, miR-141-3p, miR-182-5p, miR-200a, miR-200c, miR-203, miR-339-5p, miR-363-5p, miR-375, miR-664b-5p, miR-4655-3p, miR-4784, miR-6787-5p
39	(El-Dakroury et al., 2023)	Adrenocortical carcinoma	miR-9, miR-21, miR-149–3p, miR-139–5p, miR-483–5p, miR-483–3p, miR-503, miR-431, miR‑675	miR-195, miR-375, miR-99a, miR-100, miR-200b, miR-205, miR-214, miR-335, miR-497, miR-7
40	(Elsakka et al., 2023)	Cardiovascular diseases	miR-499, miR-423–5p, miR-22, miR-92b, miR-320a, miR-122, miR-520d-5p, miR-210, miR-671–5p, miR-1233, miR-508–5p, miR-126, miR-24, miR-214	miR-18a-5p, miR-26b-5p, miR-27a-3p, miR-30b, miR-142–3p, miR-30e-5p, miR-106a-5p, miR-342–3p, miR-30c, miR-146a, miR-107, miR-139, miR-142–5p, miR-183–3p, miR-193b-3p, miR-190a, miR-193b-5p, miR-494, miR-558, miR-652–3p
41	(Shahin et al., 2023)	Gall bladder cancer	miR-155, miR-20a, miR-182, miR-642a-3p, miR-4430	miR-1, miR-145, miR-135a, miR-26a, miR-34a, miR-335, miR-130a, miR-218–5p, miR-451a, miR-143–3p
42	(El-Husseiny et al., 2023)	Salivary gland cancer	miR-21, miR-130a, miR-155, miR-93, miR-205, miR-23b-3p, miR-22	miR-144-3p, miR-140-5p, miR-101-3p, miR-98, miR-582-5p, miR-187, miR-125a-5p, miR-29a
43	(Doghish et al., 2023d)	Testicular germ cell tumors (TGCTs)	miR-184, miR-133b-3p, miR-125b, miR-372, miR-373, miR-302a, miR-302b, miR-302c, miR-223	miR-383, miR-199a, miR-146, miR-221, miR-222, miR142–3p, miR-449, miR-26aLet-7a, miR-514a, miR-513b

44	(El-Mahdy et al., 2023a), (Doghish et al., 2023b)	head and neck cancer:	miR-17-5p, miR-411-5p,	miR-125a-5p, miR-206, miR-876-5p, miR-141, miR-17-5p, , miR-874-3p, miR-140-5p, miR-29c-3p
45	(Abulsoud et al., 2023)	Glioblastoma	miR-3154	miR-4731, miR-770, miR-16–5p, miR-16, miR-381, miR-384, miR-362, miR-497–5p
46	(Zhao et al., 2023)	PD-L1 expression	Not Specified	miR-142-5p, miR-214, miR-377-3plet-7, miR-320a, miR-140, miR-873, miR-497-5p, miR-424(322), miR-34a-5p, miR-138, miR-34a, miR-378a-3p, miR-4759, miRNA-140-3p, miRNA-200a, miRNA-141, miRNA-200b, miRNA-200c, miRNA-429, miR-195-5p, miR-148a-3p, miR-140-3p, miR-675-5p
47	(Elkhawaga et al., 2023b)	Pheochromocytoma	miR-1225–3p, miR-429, miR-200b, miR-375, miR-34b, miR-101, miR-194–5p, miR-133a-3p, miR-324–5p, miR-125b, miR-326, let-7a, miR-133a-3p, miR-101, , miR-21, miR-324–5p, miR-125b, miR-326, miR-210, miR-221/222, miR-244, miR-376b, miR-431, miR-541, miR-136, miR-210, miR-324–5p, miR-125b, miR-326, miR-101, miR-183, miR-183, miR-483–5p, miR-483–5p, miR-139–3p, miR-765, miR-885–5p, miR-1225–3p, miR-137, miR-375, miR-338–3p, miR-96, miR-182, miR-382, miR-133b, miR-488, miR-34a, miR-182–5p, miR-202–5p, miR-551b-3p, miR-183–5p, miR-21–3p, miR-96–5p, miR-940, miR-381	miR-21–3p, miR-99a, miR-100, miR-1225–3p, miR-429, miR-200b, miR-375, miR-101a, miR-383, miR-194–5p, miR-122, miR-331–3plet-7a, miR-133a-3p, miR-101, miR-21, miR-497, miR-195, miR-194–5p, miR-122, miR-103, miR-331–3plet-7a, miR-133a-3p, miR-101, miR-21, miR-324–5p, miR-125b, miR-326, miR-139–3p, miR-210, miR-221, miR-221, miR-376b, miR-431, miR-541, miR-136, miR-410, miR-101, miR-183, miR-183, miR-483–5p, miR-483–5p, miR-139–3p, miR-765, miR-885–5p, miR-1225–3p, miR-137, miR-193b, miR-508, miR-148b-3p, miR-338–3p, miR-15a, miR-16, miR-96,

				miR-182, miR-382, miR-133b, miR-488, miR-34a, miR-182–5p, miR-202–5p, miR-551b-3p, miR-183–5p, miR-21–3p, miR-96–5p, miR-940, miR-184, miR-381
48	(Mitra et al., 2023), (Chakkarav arthi et al., 2023), (Kuang et al., 2023)	Soil Transmitted, Helminthiosis control	miR-12071, miR-2b, miR-7a, miR-3479b, bantam-3p, let-7-5p, miR-10-5p, miR-71-5p, miR-4989-3p	miR-10-5p, let-7-5p
49	(Norouzi et al., 2023)	Intestine Cancer	miR-21, miR-17-5p, miR-20a, miR-92a, miR-31, miR-96, miR-183, miR-182, miR-135b, miR-224	miR-34a, miR-143, miR-145, miR-133a, miR-133b, miR-126, miR-133b, miR-143, miR-145, miR-199a,

Conclusion

miRNAs have become important regulators in the pathophysiology of many illnesses, including malignancies and neurodevelopmental disorders such as autism spectrum disorder. It has been shown that they control gene expression and have a role in the onset, course, and response to treatment of diseases. Since targeting these tiny non-coding RNAs has the potential to lead to the development of innovative treatment options, understanding the function of miRNAs in disease pathophysiology has opened up new possibilities for therapeutic treatments. Furthermore, miRNAs have shown potential as biomarkers for early illness diagnosis and prognosis, offering crucial clinical data for patient care. miRNAs have become a crucial component in the area of therapeutic association in a variety of disorders. The capacity of miRNAs to regulate gene expression and impact pathological processes makes them a desirable subject for therapeutic approaches. Additionally, miRNAs' function in the host immune response has been highlighted by their association with the reaction to commensal and bacterial infections. In summary, miRNAs have shown their significance as regulators in the genesis of several illnesses, serving as both therapeutic targets and diagnostic biomarkers. Thus, taking use of miRNAs' therapeutic potential creates new avenues for individualised and targeted treatment of a range of illnesses. miRNAs have become important actors in the pathophysiology of many illnesses, including cancer and neurodevelopmental disorders like autism spectrum disorder. miRNAs have a significant impact on the diagnosis and progression of various disease models. Identifying disease-specific miRNA signatures and understanding their role in disease pathogenesis can lead to improved diagnostic methods and the development of targeted therapies for a wide range of diseases. Research in this field continues to uncover new miRNA-based strategies for disease management and treatment. In conclusion, epigenetics and miRNAs are key players in different disease models. Epigenetic modifications can lead to changes in gene expression that contribute to disease progression. MiRNAs, by regulating gene expression post-transcriptionally, can either promote or inhibit the

pathogenesis of various diseases. Understanding the intricate interplay between epigenetics and miRNAs in disease pathogenesis opens the door to innovative diagnostic and therapeutic approaches in the field of medicine.

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The Role of Machine Learning in Academic Research in Cognitive Psychology By Hanyuan (Danny) Li

Abstract

This research paper studies the role of machine learning (ML) in evolving the field of cognitive psychology from a traditional focus on explaining human behavior to predicting it. The paper begins with an exploration of the historical context, where cognitive psychology predominantly aimed to understand behavior through experimental studies, often resulting in theories with limited predictive capacity. It then transitions to an introduction of machine learning, describing it as a method that equips computers to learn from data, thus enhancing pattern recognition and decision-making capabilities.

The core of the paper examines three empirical studies that illustrate the application of machine learning in cognitive psychology, each targeting different behavioral aspects and employing various machine learning algorithms to predict outcomes. The studies by Bachurina et al. (2022), Bonfante et al. (2023), and Van Slooten et al. (2018) are discussed in-depth, showcasing their methodologies and findings in predicting cognitive task performance, aggressive behavior among youth, and decision-making processes through physiological measures like pupil size, respectively.

In synthesizing these studies, the paper reflects on the broader implications of integrating machine learning in cognitive psychology research. It addresses the challenges and considerations in model selection, the potential for overfitting, and the balance between model complexity and interpretability. The discussion extends to the selection criteria for different machine learning models based on data nature, behavioral phenomena, and predictive accuracy, fostering a critical evaluation of the generalizability of research findings.
Conclusively, the paper highlights the transformative impact of machine learning in cognitive psychology, significantly enhancing the field's predictive capabilities and opening new avenues for understanding and intervening in human behavior. It calls for ongoing research to further refine and expand the applicability of ML, aiming for more universally applicable and reliable predictive tools in psychological research.

Introduction

Prior to machine learning, the purpose of psychology was to understand and explain human behavior. With the emergence of machine learning and its constant technological advancements, psychology has quickly shifted its goals to predicting behavior instead of explaining it. Machine learning can be conceptualized as training an artificial intelligence (AI) to recognize patterns and make decisions based on data. The algorithm predicts dependent variables using independent variables. Instead of programming the computer with specific rules to follow, one provides it with data and lets it learn from that data. Over time, the computer finds patterns and learns how to make predictions or decisions on its own, in a way similar to how humans learn from experiences. For example, by looking at many photos of cats and dogs, a computer

can learn to tell the difference between them and can begin to classify them. Machine learning can be used to enhance the prediction capability in cognitive psychology by analyzing large datasets to identify patterns and trends in human behavior which can lead to more accurate models of cognitive processes. In this research paper, I start by looking at how researchers in cognitive psychology used to study human behavior before they applied machine learning. After that, I introduce what machine learning is in simple terms, explaining that it is a method using computers to analyze and learn from data, helping us understand patterns that are too complex for humans to see easily.

Next, I will take a closer look at three specific studies published in academic journals where machine learning was used so that researchers can better predict how people would behave or think in different situations. For each study, I discuss what the researchers were trying to find out, how they used machine learning to improve their research, and what they discovered.

In the first article by Bachurina et al. (2022), the research team undertook a study in which they gathered information from a series of experiments involving adult participants. These participants were engaged in various tasks designed to assess their cognitive and behavioral responses. The core objective of this study was to harness the power of machine learning to analyze the collected data. The researchers aimed to create models that could predict how individuals would behave or respond to tasks that were not part of the original experimental setup.

In the second article, Bonfante et al. (2023) focused on a different aspect of human behavior. They carried out experiments involving both delinquent and non-delinquent youths to explore the underlying factors that might predict aggressive behavior in young individuals. By carefully analyzing the behaviors and characteristics of these groups, the researchers aimed to identify specific features or patterns that could serve as indicators of a propensity toward aggressive conduct. This study not only provided insights into the behavioral tendencies of youths but also highlighted the potential of machine learning in identifying risk factors for delinquency, which could be crucial for preventive measures and interventions.

The third article, authored by Van Slooten et al. (2018), took a unique approach by focusing on physiological data, specifically the changes in pupil size, as adult participants engaged in decision-making tasks. The researchers meticulously recorded the variations in pupil diameter as these individuals processed information and made choices, using this data to delve into the intricacies of the decision-making process. Through their analysis, the researchers sought to uncover the cognitive processes reflected in pupil dynamics, aiming to elucidate how these physical changes correlate with the mental activities involved in making decisions. This study stands out for its innovative use of biometric data, offering a window into new information on cognitive function and decision-making.

How academic research has been done in the past

For many years, the main goal of psychology has been to investigate the causes of human actions. Researchers have relied heavily on well-planned experiments to explore and explain different aspects of human behavior. However, this intense focus on understanding the causes behind behaviors means that much of psychology has developed complex theories that are not very good at predicting how people will act in the future. Using ideas and methods from machine learning – a method of predicting the dependent variable(s) using independent variables - could make psychology better at making these predictions. Machine learning offers new ways to look at data and to find patterns that can help forecast future behaviors. By emphasizing the importance of predicting behaviors rather than just explaining them, we can gain deeper insights into psychology and better understand human behavior.

The main objective of psychology is to understand why humans behave the way they do. This means not only explaining their actions but also predicting their actions. Based on this idea, if we list all the different reasons behind certain actions, including the factors that might change or influence these actions in various ways, then in theory, we could measure everything important about people's actions and predict how they will act in the future accurately. In theory, doing these two things seems consonant with one another, however, they are both statistically and practically divergent. From a statistical point of view, the problem is that the model that best captures the underlying process that generates the data we observe does not always do the best job of predicting future events. This is partly because of overfitting, a phenomenon in which a model might fit the current data too closely, including its anomalies and noise, leading to poor performance when predicting new, unseen data. Surprisingly, a model that does not fit the psychological or biological reality as closely, and might even seem implausible or too simple, can predict future outcomes better because it avoids overfitting. Moreover, there is no guarantee that the phenomena that the psychologists study are simple enough to be accurately captured by models that are easy for us to understand. It is possible that to predict human behavior accurately, psychologists might have to choose between creating complex models that predict behavior well but are difficult to interpret and simpler models that are theoretically appealing but not very good at prediction. From a practical point of view, researchers often do not know in advance whether a simple explanatory model exists for the phenomena they are studying. This means they have to decide, based on the specific situation, whether to focus on creating models that explain general principles simply and abstractly or models that aim to predict future outcomes accurately without necessarily fitting into our current understanding of psychology or biology.

What is machine learning?

In simple terms, machine learning is a statistical method of predicting the dependent variable using the independent variables. It is a prediction method that allows algorithms to become more accurate at predicting outcomes without being explicitly programmed to do so by learning from the data. It involves algorithms and statistical models that computers use to perform tasks by learning from and making data-based decisions. In machine learning, creating models that can accurately predict future events based on data is a complex task that involves

multiple key concepts. First, one needs to divide the data into in-sample and out-of-sample data. The in-sample data is used to build or train the model. It is used to teach the model what to look for and how to make decisions. The out-of-sample data, on the other hand, is used to test how well the model performs. This separation helps ensure that we are evaluating the model on data it has not seen before, which gives us a better idea of how it will perform on other unseen data. Then, there is model selection: choosing a model that can predict well while also not being too complex. If a model is too complex, its interpretability goes down, because it becomes more difficult to explain the intuition of the model, for example, which variables are driving the result. Finding the balance between a model's accuracy and interpretability is crucial because a model that is too complex might work well on the data it was trained on but fail to generalize to the new data. The third concept is adjusting the tuning parameters to prevent overfitting. It would be a poor practice if an overfitted model has perfected too much of the training data to the point where it is unable to perform well on new data. Therefore, an overfitted model will be able to perform extremely well on data that it has seen but its ability to predict when given data it has never seen before will diminish significantly. It is almost like memorizing the specific answers to a test that you are about to take. You will not be able to do well on the test unless the exact questions that you memorized are going to be on the test. Data mining, which combs through data trying to find patterns, is a phenomenon that may lead to overfitting. Data mining can lead to overfitting because the process of data mining can lead to capturing random noise instead of actual important relationships. The final concept of machine learning is known as cross-validation. Cross-validation, which is training and testing a model on different samples of data, is one of the most common approaches to estimating prediction error. By using subsets of data to train the model and statistically evaluate its predictive performance, cross-validation is an efficient method used to prevent overfitting.

Prior to the introduction of machine learning to psychology, most of the profession has been directed towards explanation instead of prediction. Yarkoni Westfall, a psychologist, believes that the reason psychologists have historically opted towards the explanation aspect is that machine learning was poorly understood as well as poorly developed. He believes with the development and improvement of machine learning in this modern day; it is now feasible to start leaning toward the predictive aspect of psychology.

Examples of academic research in cognitive psychology using machine learning

In a study from 2022, Valentina Bachurina, a researcher, investigated the potential of machine learning for predicting cognitive tasks accurately. The main idea of the experiment was to see the correlation between eye movement and concentration. Eye movements are closely linked to where we focus our attention because, often, what we look at aligns with what we are thinking about. Our eye movements play a key role in complex thinking and attention. The idea of the experiment was to examine the predictability of accuracy on different measures of focus through six levels of difficulty, each level having more colors to remember.

During the study, 62 adult participants were first presented with a color-matching task with six levels of difficulty. In summary, the color-matching tasks were presented as games played in two different ways. One was with balloons, and another with clowns. In the game, players look at colors on the screen and decide if they match the colors from before. They press a button to say if the colors are the same or different. The game gets harder with more colors to remember. In the balloon game, the difficulty level is a bit lower than in the clown game, but has more distractions. Players go through several rounds, trying to quickly and correctly say if the colors match. Their performances were measured by how fast and accurately they responded. The eye-tracking data that was acquired from the experiment was then used for the machine learning analyses. The extracted variables included duration of current fixation, total number of fixations in a trial, average pupil size during the current fixation, whether a blink was present before or after the fixation, amplitude of the current saccade in degrees of visual angle, presence of a blink in the current saccade, average velocity of the next saccade and the angle between the horizontal plane and the direction of the next saccade, and duration of all selected blinks in a trial (in milliseconds).

In previous psychological research, reaction time has often correlated with task performance and general intelligence. Variability in reaction time has been used to predict performance in many different scenarios, such as simulations for flight pilots or experiments to foresee cognitive decline. Generally, more difficult tasks require longer reaction times. Although task difficulty is known to impact performance, it is not commonly used to predict future performance. However, eye-tracking technology has emerged as a useful method to better model and predict performance, especially as wearable eye-tracking devices have become more widely available. Using data, Bachurina's experiment aims to use machine learning methods to predict the accuracy scores of individuals as they do tasks related to focus and mental attention.

In the research, it was discovered that while the difficulty of tasks and the reaction time of participants significantly predicted their behavior, eye movements alone were not as strong predictors. However, when examining eye-tracking indices, which measure how and where the eyes move, these indices were found to be effective in predicting outcomes. Notable features of eye-tracking that were influential in the predictive models included the number of fixations, indicating how often a participant's gaze settled on a specific area; the number of saccades, which are the quick movements of the eyes between points of focus; the duration of each fixation, or how long the gaze remains steady on one point; and the size of the pupil, which can vary under different cognitive loads and stimuli. These eye-tracking elements provided valuable insights into the cognitive process and mental attention of the participants during the tasks.

Machine Learning Application to Identify Young Offenders

Another example of psychological research into machine learning is MC Bonfante et al.'s (2023) research paper. In this paper, machine learning was used to identify whether deficits in cognitive functions contribute to antisocial and aggressive behavior. It conducts experiments on delinquent and nondelinquent youths to analyze their cognitive functions, using a dataset of

37 predictors to train algorithms for identifying potential young offenders. The three machine learning algorithms used in this experiment were SVM (Support Vector Machine), RF (Random Forest), and KNN (K-Nearest Neighbors), which I explain in the next few paragraphs. These methods were trained to distinguish between offenders and non-offenders.

The first machine learning algorithm was SVM. The SVM algorithm is crucial for analyzing the cognitive function data that differentiates between offenders and non-offenders. It is important because it effectively handles high-dimensional data and finds the optimal boundary between possible outcomes, making it a robust choice for classification tasks. Its significance in the experiment lies in its ability to identify complex patterns within the data, which can indicate underlying cognitive deficits associated with antisocial and aggressive behaviors. The experiment revealed that while the K-NN model performed best, SVM still showed notable efficacy, especially when trained with features selected by the filter method. The filter method involved selecting relevant data for the experiment. Imagine you have a lot of data points about something, but not all of them are useful for making predictions or decisions. The filter method helps to sort through all these data points and keep only those that are really important or related to what you're trying to find out. SVM's accuracy in the experiment demonstrates its relevance in predicting behaviors based on cognitive assessments, thereby influencing the experiment's outcomes and contributing to the understanding of cognitive functions concerning criminal behavior.

The second machine learning method was Random Forest, an algorithm used for classification tasks. It works by growing a collection of decision trees and then by outputting the average final decision. It is beneficial because it is able to handle large amounts of data with high accuracy, manage numerical and categorical data, and is able to cope with missing values. Random Forest was important to the experiment because it helped in feature selection. The Boruta algorithm used in the experiment was built around Random Forest and was used to determine the most important features of the data.

The third and final machine learning model used was K-Nearest Neighbors (K-NN). K-NN is an algorithm that is used to predict the classification or value of a given data point. It first chooses the number of data points it will look at (these are called the neighbors). Then, it measures the distance between the data points that you want to classify and finds the closest neighbors to your data point. Following that, it begins to classify by looking at the categories of the neighbors and choosing the most common one. The purpose of K-NN is to predict what category a set of data belongs to by analyzing the other "neighbors" and generating categories. In the Bonfante experiment, K-NN was crucial because it was able to provide the highest balance accuracy, meaning it was able to classify the events and data given to it with the most effectiveness. Basically, it was superior to any other machine learning model because it was able to classify young offenders from non-offenders with the most accuracy. During the experiment, the researchers had 34 different features they could use to make their predictions. However, using all 34 was not as useful as just picking the most helpful out of the 34. The K-NN model only used 19 of the features to make the best prediction, while the SVM model had to use 24

variables. This research highlights that youth delinquency can be predicted by various factors beyond individual behavior, such as racial and ethnic bias, domestic instability, and exposure to community violence.

To add on, the paper also highlights research done in Denmark in which researchers developed a machine learning model to forecast the need for future psychiatric treatment for patients. The study was extensive, involving 45,720 patients, and utilized a dataset with 39 variables that captured a range of information, including socioeconomic status, psychiatric history, and criminal history. This comprehensive approach allowed for a nuanced analysis of factors affecting psychiatric care requirements. The machine learning models used in the Danish study, such as logistic regression, random forest, and boosting, represent different strategies for analyzing and predicting outcomes. Logistic regression, for instance, is used to estimate the probability of an event occurring (for example, whether a patient will require treatment), by assigning a value of 0 or 1 based on the predictors then creating a curve of best fit to model the data. Boosting, another technique used in the study, is an ensemble method that combines multiple machine learning models to enhance predictive accuracy. By aggregating the predictions of several models, boosting reduces errors and improves the reliability of the predictions.

All in all, Bonfante's studies demonstrate the power of machine learning in understanding and predicting complex behaviors and needs, such as those related to youth delinquency and psychiatric treatment. The integration of diverse predictors and the use of advanced analytical techniques offer valuable insights into the factors driving these social and health-related issues.

How pupil responses track value-based decision-making during and after reinforcement learning

The final research that I introduce in my paper that demonstrates how machine learning could be used in psychology is Van Slooten's paper on how pupil sizes reveal information about decision-making. Van Slooten's experiment revolves around the idea of how the pupil dilates when people make decisions. These pupil size fluctuations reflect decision-making computations during and after a choice. The goal of her study was to explore the cognitive processes that were demonstrated through the pupil dilations. Using a reinforcement learning task to study pupil responses and using a machine learning model, she discovered that the pupil closely tracks reinforcement learning processes independently across participants and across trials. Her findings indicate that pupil size fluctuations can provide detailed information about the computations underlying value-based decisions.

The research utilized reinforcement learning models to investigate how value-based decision-making processes affected pupil size. The agent would receive reward when he or she did something right and punishment feedback when he or she did something wrong. The experiment involved 34 participants and involved a learning task. The participants were exposed to a series of trials where they had to choose between pairs of options, each associated with different probabilities of yielding a reward. These options were presented on a computer screen, and the participants indicated their choices via key presses. The probabilities were not disclosed

to the participants, requiring them to learn and adapt based on the feedback received after each choice. The task incorporated an element of randomness or noise, meaning that even the "better" choice in a pair did not always result in a reward, and the "worse" choice did not always result in no reward. This setup mimics real-world decision-making scenarios where outcomes are not always certain, even if the choices are generally sound. Pupil size was continuously monitored using an eye-tracking device to measure how cognitive processes, specifically related to reinforcement learning and decision-making, were reflected in physiological responses. The researchers focused on the dilation and constriction patterns of the pupil, particularly around the moments of decision-making and feedback reception.

The study specifically analyzed pupil responses during two critical phases of the reinforcement learning process: the period leading up to a decision and the period immediately following a decision, as well as the moment when feedback is received. The researchers observed that pupil size exhibited a pattern of dilation about one second before a decision was made, suggesting increased cognitive processing or anticipation of the choice. Following the decision, pupil size tended to constrict, particularly around a second after the decision, reflecting the processing of the outcome or feedback.

Furthermore, a Bayesian approach was used to model the decision-making process of the participants. The Bayesian approach is a statistical method used to make predictions by combining already established data with new data. This approach is similar to having an initial hypothesis and updating the hypothesis based on new data. Moreover, the Bayesian approach helps update your hypothesis by taking the new information to make it more accurate. The application of the Bayesian learning model was crucial in analyzing the data because it allowed the researchers to model the decision-making process as a dynamic system where the participants updated their decisions based on the feedback from their choices.

In conclusion, the study highlights how pupil size is a significant indicator of cognitive processes in decision-making and learning. The use of Bayesian machine learning was extremely important in dissecting the dynamics of how different individuals learn from their environment and make decisions based on their accumulated knowledge. The approach to the research provides a framework to connect psychological responses with cognitive processes, enhancing our understanding of how machine learning can be used in the psychological world.

Conclusion

All in all, my paper investigates how machine learning can be used to enhance the prediction capability for academic research in cognitive psychology. As discussed before, prior to machine learning, academic research in cognitive psychology has focused on explaining behavior rather than predicting behavior. Machine learning, which involves using statistical methods to predict outcomes based on various input data, has significantly enhanced the predictive capabilities in the field of cognitive psychology. This approach allows researchers to analyze how different factors (independent variables) can influence specific outcomes (dependent variables).

In the study conducted by Bachurina et al. (2022), the researchers focused on collecting data related to task difficulty, reaction time, and eye movement during certain activities. They then applied machine learning techniques to this data to predict how individuals might behave in tasks that were not directly tested during the experiments. This innovative approach allowed for a broader understanding of human behavior, extending the predictive power of the research beyond the specific tasks that were originally studied.

Similarly, Bonfante et al. (2023) embarked on a study involving both delinquent and non-delinquent youths, collecting comprehensive data on their behaviors and traits. They utilized machine learning to process this information, aiming to pinpoint characteristics that could predict a youth's propensity for aggressive behavior. This research is pivotal as it provides valuable insights into the factors contributing to delinquency and aggression, offering potential pathways for early intervention and prevention.

In the research by Van Slooten et al. (2018), the focus was on how the pupil size of adult participants changes in situations that require reinforcement learning. The collected physiological data were analyzed using machine learning to uncover insights into the decision-making process. This study highlighted how subtle physiological responses, such as changes in pupil size, can serve as indicators of cognitive processes involved in learning and making decisions.

The implications of these studies are vast and lead to important considerations for future directions of research. One key observation is the diverse range of machine learning models employed across these studies. This diversity raises questions about why researchers opt for different machine-learning models in various contexts. Are these choices driven by the specific nature of the data, the particularities of the behavioral phenomena under study, or the desired accuracy of the predictions?

Furthermore, if the use of different models leads to a variety of predictions, it prompts a critical discussion on the generalizability of these findings. Can results obtained from one set of conditions be reliably applied to another? Understanding the reasons behind the choice of different machine learning models and analyzing the consistency of their predictions across various contexts is crucial. This exploration could significantly enhance the robustness and applicability of machine learning in cognitive psychology, paving the way for more universally applicable and reliable predictive tools in the field.

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Effects of Blockchain and Decentralized Technology on Entrepreneurship of Refugees and Developing Countries By R. Kalyandurg

Abstract

In this paper, I aim to explore the potential benefits of decentralized technologies such as blockchain for entrepreneurs in both developed and developing countries, utilizing current research papers on topics such as blockchain financing, future blockchain applications, and Self Sovereign Identity (SSI). These novels include research experiments, future prediction from experts in decentralized technology through the Delphi Method, and current trend analysis.Through the use of these decentralized technologies, entrepreneurs can grow their business by tapping reduced financial costs and enhanced access to key financial services. By assisting these entrepreneurs financially, refugees and people of similar social status can better integrate into the economy and garner greater financial prosperity. To help aid the socio-economic crisis that refugees often experience when relocating to a new country, decentralized technologies can help entrepreneurial refugees gain access to important documents to receive financial help and grow their own business.

Introduction

Blockchain technology is characterized as a decentralized system, operated without a central entity such as a bank or governmental institution. A decentralized system distributes decision-making across multiple independent entities, promoting autonomous usage and transparency without relying on a central authority. It records secure transactions through a network of nodes, interconnected units that exchange information, providing the foundation for a myriad of today's cryptocurrencies. Cryptocurrencies are virtual currencies that operate through such decentralized networks, some of the most popularized and acute being Bitcoin and Litecoin. Moreover, blockchain is widely regarded as the future of commerce, predicted to store 10% of the world's GDP by the year 2025 [4]. It is also seen as a way to reduce fraud and increase transparency. Furthermore, blockchain technology has the potential to revolutionize the way data is stored and shared by eliminating the need for an intermediary, data can be processed and sent in a more trustworthy and time efficient manner. Its decentralized nature allows innovation across various sectors, such as finance, supply chain, and digital identity. Blockchain technology can be used to authenticate documents and records, making them more secure and resistant to tampering. It can also be used to track goods, services, and transactions, providing greater visibility into the supply chain.

Blockchain has significantly impacted the entrepreneurial landscape, as it offers a wide range of opportunities for aspiring business owners. Most notably, Blockchain facilitates entrepreneurship through decentralized finance, allowing greater access to financial services such as lending, borrowing, and trading without the need of banks or other intermediaries. Blockchain can empower distributed and decentralized payment systems that disintermediate part of the financial service industry. In particular, cross-border remittances for refugees can benefit through reduced costs, faster transactions, and greater identity verification.

Entrepreneurial immigrants from developing to developed countries can reap many of the benefits from blockchain. Currently, they face identity verification problems in their new countries due to the lack of proper verification taken with them. This denies them access to financial services such as loans, rendering them unable to take their business. However, Blockchain based technologies can solve these problems. For example, Self Sovereign Identity (SSI) can give immigrants a transportable, secure, digital identity to conduct commerce with.

Blockchain technology offers innovators the opportunity to create digital tokens that represent scarce assets, which can potentially reshape entrepreneurship and innovation. This revolutionary technology has the potential for a profound impact on both fields. One notable application of blockchain is its use in Blockchain-based distributed cryptocurrency technology and "smart contracts," allowing for the digital implementation of its blockchain. Research on cryptocurrencies and specific applications of blockchain technology has been conducted, but limited studies are exploring their economic and entrepreneurial aspects. However, existing research suggests that blockchain technologies open up various opportunities for entrepreneurship in areas such as unbanked practices, new business models, and startup financing. The relevance of these technologies in entrepreneurship is undeniable given the substantial evidence about implementing cryptocurrencies for startup financing. Thus there is an ongoing academic debate calling for further exploration using a robust conceptual framework. Over the past five years alone, the field of research dedicated to understanding blockchain has grown exponentially.

Blockchain does not come without its negative effects, however. Developing and maintaining blockchain infrastructure can be expensive, and require significant investments which may be taxing on startups with limited budgets. In addition, blockchain is not yet widely adopted and entrepreneurs may struggle to attract users with developmental technology. Legal and regulatory concerns may arise, as this technology is still evolving.

How can decentralized technologies help to benefit refugee entrepreneurs in both developing and developed countries? In this paper I will review the literature on Blockchain technology, and its effects on refugees and entrepreneurs in both developing and developed countries. I will argue that Blockchain technology can have a positive effect on refugee's ability to verify identity, receive financial services, and conduct commerce.
Literature Review

Blockchain Technology Facilitates Reduced Financial Costs
"An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends" Zheng, Xie, Dai, Chen, Wang (2017) [1] provides a brilliant insight on blockchain and its foundation. First, the paper details the benefits of blockchain: immutability, disintermediation, and high fault tolerance. It also outlines the challenges Blockchain faces: scalability, corruption among data miners, and proof problems. In the second section, the actual architecture of blockchain is introduced. A combination of helpful figures with explanations give an overview on the inner workings that allow Blockchain to function. In its simplest form, blockchain is a

sequence of blocks, each containing a permanent record to validate the transaction. It is mainly decentralized, running off a network of nodes, but can be centralized under one organization.. The third section describes some potential challenges that can possibly limit the advances of blockchain. Scalability remains at the forefront, as each node has to process and validate each block. Privacy, although nearly impossible to tamper with, can be manipulated in a number of ways. Through a dishonest intermediary, private information can be exposed. In the fifth section, the paper delves into the future applications of Blockchain. Blockchain can be combined with big data to store important data, allowing a tamper proof setting for major information. This technology can also be expanded to fields outside of finance. Smart contracts can also be executed through blockchain. Smart contracts facilitate automatic, self-executing contracts which eliminate the need for an intermediary. This reduces administrative costs for entrepreneurs, which can be especially helpful for refugees starting a new business.

  "Blockchain application and outlook in the banking industry" Guo and Liang (2016) [2] details the financial applications of blockchain and its potential in the banking industry. Payment clearing, the process of validating transactions between institutions, can utilize blockchain to provide a transparent, secure ledger that reduces the cost needed for an intermediary. Blockchain can also establish a credit mechanism, resolving the high costs of a centralized intermediary, as well as simultaneously improving efficiency, transaction lag, and operation risks. Blockchain can also mitigate manual interventions through the employment of smart contracts, digitizing procedures that rely heavily on paperwork. Blockchain based transactions have been accomplished in the real world, as seen in the world's first occurrence between Barclays Bank and an Israel based startup, reducing the cost as well as the time necessary. True disintermediation requires complete decentralization, however achieving this is almost impossible making true disintermediation unlikely. However by utilizing blockchain, we can create a possible intermediary that can validate transactions and payments at a decreased cost for businesses.

Blockchain enables access to financial services
  "Deployment of a Blockchain-Based Self Sovereign Identity" by Q. Stokkink and J (2018) [3] Poulwelse outlines an important future application of blockchain: Self Sovereign Identity (SSI). First, the article describes SSI and its solution to many of the world's current problems. Self-sovereign identity is an approach to digital identity that puts the user in control of their own data and identity information. It relies on decentralized technology, such as blockchain, to give users the ability to store and manage their own digital identities in a secure and private way. This can possibly help solve the digital identity crisis that is happening in many developing countries. Identity data is already fragmented through many institutions, and combined with growing identity theft a decentralized system could provide a secure solution by allowing users to control their own data. This could help reduce fraud and identity theft, as well as provide better access to public services. Countries like the Netherlands are already beginning to implement SSI into their society, and it is only a matter of time before the methods outlined in

this paper spread to the rest of the world, more importantly those in developing countries. This can benefit refugees by giving them a digital identity to use to gain access to financial loans to use when starting their own business.

A look into the future of blockchain technology" by D. Levis, F. Fontana, and E. Ughetto (2021) [4] looks into the future applications of blockchain technology. Blockchain has been on the rise for the past decade and will continue to be, predicted to store 10 percent of the world's GDP by the year 2025. This paper gives a holistic approach, rather than the specialized works that have investigated blockchain. Being such multidimensional technology, it is necessary to examine multiple aspects of blockchain to offer a comprehensive view on its future. First, they review the technology itself, going through the process of transactions and decentralization. They also go through blockchain "tokens", which are essentially digitalized shares of the company. Next, they delve into the possible applications, but through a more atomistic view. The financial sector, where blockchain mainly is in practice, has the brightest future. It can solve the problem of trust through its decentralization, as well as provide decreased transactional costs and increased financial access. Initial Coin Offerings (ICOs), fundraising methods for raising capital through blockchain, have also been implemented, though they contain inherent risks as many are not legitimate nor successful. In an ICO, companies offer tokens to investors in exchange for finance for their products. The paper also outlines an important strategy regarding future predictions: the Delphi Method. This method derives its predictions from a panel of experts about a specific topic, each evaluating possible futures. This allows for subjective, anonymous advice for companies to make long term decisions for their success. The first step requires the selection of experts, in this case experts in the field of Blockchain and consulting to give different points of view. Next, the authors of the study attended Blockchain events and researched the topic thoroughly to further expand their knowledge in the area, allowing for more comprehensive interviews with the expert applicants. After selecting their group experts, the authors of this study held two rounds to assess the probability of a scenario. The results from their Delphi survey show three major fields that Blockchain will improve: efficiency, security, and innovation. Through such detailed processes as the Delphi Method, this paper predicts the future of blockchain and its applications in a clearer picture for a multitude of fields.

Discussion

The integration of blockchain technology into the financial sector can reduce crucial costs to budding entrepreneurs. By removing the need for an intermediary, transactions can be validated at a quicker pace without the payment to a centralized ledger. Blockchain can also digitize tedious procedures through smart contracts. These contracts are self-executing, meaning they are automatically initiated through code. They provide secure, transparent ways to facilitate agreements and transactions and can become an integral part of blockchains application into the business world.

One of the most important implementations of this technology, Self Sovereign Identity (SSI), can change how data is processed and received worldwide. Self Sovereign Identity is a

digital identity management system run on blockchain that allows for identity ownership in the online world. It represents an important shift in how identity is managed in the digital realm. Some key changes are decentralization, complete personal control, reduced identity fraud, and a huge step forward for one complete internet identity. In simple terms, it is an online folder of all your important documents such as passports, medical records, and legal identification, all kept in an encrypted block that can be sent to institutions with a click of a button. Through a SSI, they can have all their important information kept in a block, sending it to governments, hospitals, and other businesses all through a decentralized platform.

Although Self Sovereign Identity is not widespread, it has the potential to change the way we think about sharing information. If adopted by developing countries, it can significantly address the unique challenges they face. SSI offers a secure portable identity that allows people to verify themselves regardless of displacement. Healthcare records can also be kept digitally, which can be crucial during emergencies such as the COVID-19 pandemic. Additionally, SSI is interoperable, and can be used across borders. It drastically reduces the dependency on paper documents. However, implementation may be difficult. Many of these countries do not have the proper infrastructure to support SSI. User education, scalability, and a proper framework need to be realized in order to apply Self Sovereign Identity to its fullest potential.

Conclusion

I believe that blockchain can have significant positive impacts on entrepreneurship for refugees and displaced persons through blockchain enabled technologies such as smart contracts and tokenization which can help them overcome some significant challenges. Blockchain can aid in intermediating commerce, cutting costs while allowing business growth through reallocation of funds into new technologies or equipment to benefit the business. Additionally, technology such as Self Sovereign Identity can aid refugee entrepreneurs by giving them a verifiable identity to receive financial services. These financial services can provide the capital needed to start their business and start building a credit history to receive more loans in the future.

In order to facilitate blockchain into the economy, the government must establish regulations and frameworks to ensure that the technology is secure and reliable. The government must also create an environment that is conducive to the adoption of blockchain technology, such as providing incentives and training for entrepreneurs to use the technology. Governments should also ensure that blockchain technology is accessible to all citizens, regardless of their economic background. They should also ensure that blockchain is integrated with existing legacy systems, to ensure that it is interoperable with existing systems. Finally, governments should create a unified governance structure for blockchain technology, to ensure that it is managed efficiently and securely.

Roadblocks to blockchain implementation include the need for a skilled workforce, the cost of implementation, and the lack of regulatory clarity. Additionally, blockchain technology can be vulnerable to cyber attacks, and it requires a lot of computing power and energy to

operate. As a result, it can be difficult for businesses to justify the cost and effort of implementing blockchain technology.

Solutions to these risks include the development of secure infrastructure, improved scalability and interoperability, and the creation of standards and regulations to ensure the safe use of blockchain technology. Additionally, businesses should ensure their systems are regularly tested and updated to protect against cyber threats.

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Spinal Cord Injury: Pathophysiology, Recovery Mechanisms, and Advancements in Regenerative Medicine By Davidoula Georgopoulou

Abstract

Spinal cord injury (SCI) arises from an abrupt and traumatic impact on the spine, resulting in fractures or displacement of the vertebrae. This traumatic event often causes loss of sensory and motor function and results in physical dependency and morbidity. Unfortunately, current treatments only offer supportive relief for individuals with lifelong disabilities. Regeneration in the central nervous system (CNS) poses challenges, making the healing process particularly difficult. Current therapeutic approaches encompass neuroprotective, neuro-regenerative, and immune-modulating pathways. To develop appropriate interventions for SCI, it is crucial to also understand its pathophysiology, including the events that occur during and after the injury. This review article will firstly highlight the fundamental pathophysiology of SCI, phases, multicellular interactions, and coping mechanisms targeting recovery pathways. Lastly, it will present regenerative medicine approaches using growth factors, stem cell therapies, and scaffolds for the treatment of SCI.

Introduction

The spinal cord is a principal component of the central nervous system (CNS). It is a long cylindrical structure that extends from the lower part of the brain stem. The exact point where the spinal cord ends can vary among individuals, but on average, it terminates around the first or second lumbar vertebra (L1 or L2). Beyond this point, the spinal cord tapers into a collection of nerves, which continues down the nerve canal and provides innervation to the lower body and extremities (1).

A spinal cord injury (SCI) is the damage to these clusters of cells and nerves responsible for transmitting signals between the brain and the rest of the body (2). SCI often arises from an abrupt and traumatic impact on the spinal column, resulting in fractures or displacement of the vertebrae (2, 4). The severity of SCI is determined by the duration of compression on the spinal cord and the degree of initial tissue damage (5). Despite clinical indications of complete functional loss, certain segments of the spinal cord may retain partial connectivity through remaining axons during the primary phase of SCI, indicating an incomplete injury state (5, 6). In cases of complete SCI, all sensation and muscle control is lost below the specific location of injury. The spinal cord is divided into four sections: cervical, thoracic, lumbar, and sacral, each protecting different groups of nerves that control different parts of the body. Therefore, the type and severity of SCI can also vary according to the specific section of the spine that is injured (2) (Figure 1).
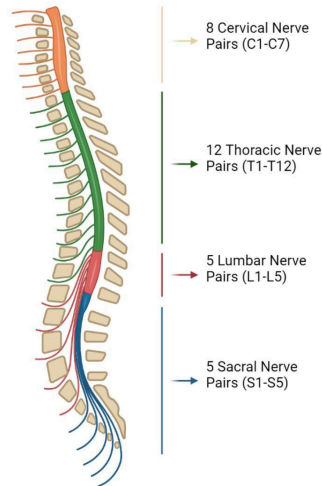
Figure 1: The spinal cord. Created with biorender.com

Over the past three decades, the global prevalence of SCI has risen from 236 to 1298 cases per million, with an estimated annual incidence ranging from 250,000 to 500,000 individuals (7, 3). The financial burden associated with SCI is substantial, with lifetime costs exceeding 3 million dollars per patient (3). However, despite this significant expense, the available treatments are currently limited and only offer supportive relief for individuals with lifelong disabilities. (8)

Understanding the complex pathophysiology of SCI and the factors contributing to the failure of existing treatments is essential. Within a functional spinal cord various cell types, including neurons, astrocytes, microglia, and oligodendrocytes interact. However, when an SCI occurs, these complex cellular interactions are disrupted and become chaotic, leading to a cascade of cellular responses, such as inflammation, cell death, and changes in the biochemical environment, which can be unpredictable and difficult to control (9). Moreover, tissue engineering, with its focus on regenerative potential, has garnered significant interest due to its incorporation of growth factors, stem cells, and biomaterial scaffolds. Tissue engineering could be a potential alternative treatment for SCI (10).

This review article highlights the fundamental pathophysiology of SCI, phases, multicellular interactions, and coping mechanisms targeting neuro-regenerative, immuno-modulatory, and neuroprotection pathways. It also presents tissue engineering approaches using growth factors, stem cell therapies, and scaffolds for the treatment of SCI.

Pathophysiology of SCI

The pathophysiology of spinal cord injury (SCI) involves a series of interconnected events, each contributing to and influencing the others. Sometimes, multiple events can occur simultaneously and lead to complex manifestations that pose challenges for treatment. (11)
Primary Injury

The initial phase of SCI is known as the primary injury (3, 4). The primary injury in SCI refers to the initial structural damage to the spine, such as dislocation or fracture of a vertebral body, which causes compression of the spinal cord due to the traumatic event. (12)

The primary causes of SCI can be classified into four main mechanisms (13, 14). The most frequently observed mechanism is impact plus persistent compression, which is commonly seen in cases of burst fractures where bone fragments continuously press the spinal cord or in fracture-dislocation injuries (15, 16, 17). Another mechanism, although less common, is impact alone with transient compression, often observed in hyperextension injuries. In these cases, there is a sudden impact on the spine without ongoing compression, resulting in temporary compression of the spinal cord, which can still lead to neural tissue damage and disruption of axonal networks (15). Distraction injuries occur when adjacent vertebrae are forcefully pulled apart, leading to stretching and tearing of the spinal column in the axial plane (14, 15). Laceration and transection injuries encompass a range of severities, from minor to complete severance, and can result from events such as missile injuries or severe dislocations (15).

Regardless of the specific mechanism of primary injury, the forces involved in SCI directly disrupt the normal flow of nerve signals. This damage leads to various physiological consequences such as spinal shock (temporary loss of sensation, reflexes, and motor function below the injury site), systemic hypotension (low blood pressure), vasospasm (narrowing of blood vessels, contributing to reduced blood flow and oxygen supply to the injured area), ischemia (lack of oxygen and nutrients to tissues, leading to cellular damage and further neural impairment), ionic imbalance (disruption in the balance of ions, such as sodium and potassium, in nerve cells, which can affect nerve signaling and function), and accumulation of neurotransmitters (build-up of chemical messengers in the nervous system, possibly contributing to excitotoxicity and cell death in the damaged spinal cord area) (18). Currently, the most effective clinical treatment to minimize tissue damage following the primary injury is early surgical decompression of the injured spinal cord within 24 hours post-injury (19, 20).

Secondary Injury

Following the primary injury to the spinal cord, a sequence of events is triggered, leading to a secondary injury phase. The secondary injury phase can persist for weeks and is divided into three stages: acute, sub-acute, and chronic injury. (11)

Acute Phase

Acute injury phase persists for 2 to 48 hours and during this stage, injured nerve and glial cells (cells that provide nutrients and support to the nerve cells) begin to die (21). Edema, inflammation, and hemorrhage define this phase, ultimately causing tissue necrosis. Inflammation and edema that occur in the injured area lead to localized swelling and complicate the neurological impairment further. Increased inflammatory and structural biomarkers in cerebrospinal fluid contribute to tissue necrosis (22). Additional secondary injury mechanisms, such as altered blood flow and cell death caused by neurogenic shock, further exacerbate the

damage. Neurogenic shock, a complication of SCI, disrupts the balance between vasodilator and vasoconstrictor influences on the arterioles and venules and results in hypotension, bradycardia (slow heart rate), depressed cardiac output (reduced volume of blood pumped by the heart per minute, leading to decreased oxygen and nutrient supply to tissues), and decreased peripheral resistance (reduced resistance to blood flow in the small blood vessels, contributing to the drop in blood pressure). If left untreated, neurogenic shock can have systemic effects, including spinal cord and organ ischemia, worsening neural tissue damage (23).

There are several forms of edemas caused by spinal cord ischemia, including cytotoxic, ionic, and vasogenic edema that lead eventually to cell death. Cytotoxic edema occurs due to an imbalance between solute and water influx in cells, resulting in cellular swelling, damage to the cytoskeleton, and eventual cell death (14). Ionic edema occurs when the integrity of the blood-spinal cord barrier (a physical barrier between the blood and spinal cord parenchyma) (24) is compromised, resulting in the loss of ions and water from the interstitial space. Additionally, endothelial injury and inflammation contribute to the enlargement of cell membrane pores, allowing the passage of large molecules derived from plasma and giving rise to vasogenic edema (15).

These processes also trigger free radical formation, and glutamate-induced excitotoxicity, and neurotoxicity. Glutamate, an excitatory neurotransmitter found in CNS, is excessively released post-SCI, and by overstimulating nerve cells, it leads to further cell death (26).

Sub-Acute Phase

The subacute phase represents a critical period where several injury mechanisms come into play. One such mechanism involves the disruption of cellular metabolism and energy production in mitochondria due to elevated levels of Ca^{2+}. Mitochondria are often referred to as the "powerhouses of the cell" and are responsible for generating the majority of ATP (adenosine triphosphate), the energy currency of cells (26). The rise in Ca^{2+} concentration is primarily triggered by increased levels of glutamate in necrotic cells during the acute phase of SCI. Although glutamate is essential for normal nerve function, in the context of SCI, excess glutamate can lead to an influx of ions, including Ca^{2+}, into cells. This influx of Ca^{2+} impedes mitochondrial respiration and thus, leads to energy depletion, triggers cytotoxic cell swelling, and creates an acidic environment in the axons. These interconnected processes contribute to cellular dysfunction and edema in the injured spinal cord (27, 25). Furthermore, the elevated Ca^{2+} levels also promote the production of ROS (reactive oxygen species) and RNS (reactive nitrogen species). These species can cause oxidative damage to cellular components, particularly lipids in cell membranes (26). Lipid peroxidation, a chemical process driven by ROS attack on unsaturated fatty acids in membranes, can compromise the integrity and function of cells (28). In the context of subacute SCI, these lipid peroxidation products can serve as markers of cellular damage (29). However, the detrimental effects of elevated ROS and RNS extend beyond lipid peroxidation and cellular damage and also play a significant role in initiating neuroinflammation, a critical process associated with SCI. Neuroinflammation involves the activation of various

immune cells, such as astrocytes, microglia, neutrophils, macrophages, dendritic cells, B and T lymphocytes (11). While inflammation is a natural response to injury and plays a role in tissue repair, excessive or prolonged neuroinflammation can lead to further damage to the spinal cord tissue and impede the regenerative processes necessary for recovery (26, 30).

Chronic Phase

The chronic phase represents the long-term aftermath of the spinal cord injury, which can last for months or even years after the initial trauma. During this phase, the pathophysiological processes continue to evolve and play a significant role in determining the overall outcomes and functional recovery of the patient. (11)

This phase involves crucial cell death processes, including ongoing apoptosis and necrosis. Apoptosis is a procedure during which cells that are irreversibly damaged initiate apoptotic pathways, and thus, lead to their own programmed destruction. It is also characterized by cell shrinkage and phagocytosis, meaning the degradation and recycling of damaged organelles and proteins. Necrosis is another cell death process that happens during the chronic stage and occurs due to injury or lack of oxygen. These cell death processes contribute to the progression of tissue damage and affect the overall state of the injured spinal cord (31, 32).

Acute axonal degeneration (ADD) is another notable manifestation of SCI. ADD is triggered by the influx of high levels of Ca^{2+} into axons, which leads to Wallerian degeneration (33, 34). Wallerian degeneration is a process that occurs in injured axons both in the PNS and the CNS. Wallerian degeneration involves the clearance of disconnected axon fragments and changes in Schwann cells in the PNS (35). Schwann cells, which are specialized cells that surround peripheral nerve fibers (36), undergo changes and proliferate to form columns of cells and provide a pathway for the regenerating axons to grow by removing the myelin debris. However, unlike in the PNS, where Wallerian degeneration can lead to axon regrowth and functional recovery, the regenerative capacity of the CNS, which includes the spinal cord, is limited (35). As a result, Wallerian degeneration in the context of the CNS often leads to scar formation (37).

Furthermore, demyelination occurs. Demyelination involves damage to the protective coating of nerve cells known as myelin. This damage to the myelin sheath slows down the transmission of messages along the axons and leads to the deterioration of both axons and oligodendrocytes (38). Oligodendrocytes are responsible for promoting the growth and myelination of axons (39). Their sensitivity to glutamate excitotoxicity during SCI leads to calcium influx, mitochondrial dysfunction, and oxidative stress, and thus, they undergo necrosis and apoptosis (27).

Glial scar formation, also known as gliosis, involves the activation and proliferation of glial cells, particularly astrocytes. (Figure 2) They multiply and migrate to the site of injury, forming a dense network of interconnected cells, known as a glial scar. (40) This scar acts as a physical barrier that isolates the injured area from the surrounding healthy tissue. While the glial scar initially serves a protective role by limiting the spread of inflammation and providing

structural support (41), it can also hinder axon regeneration by acting as a physical barrier. Additionally, the progressive enlargement of the lesion site and the development of a cyst are hallmark features of the chronic phase. The formation of the cyst indicates ongoing apoptotic responses, where cells undergo programmed cell death, contributing to the chronicity of the injury. (42)
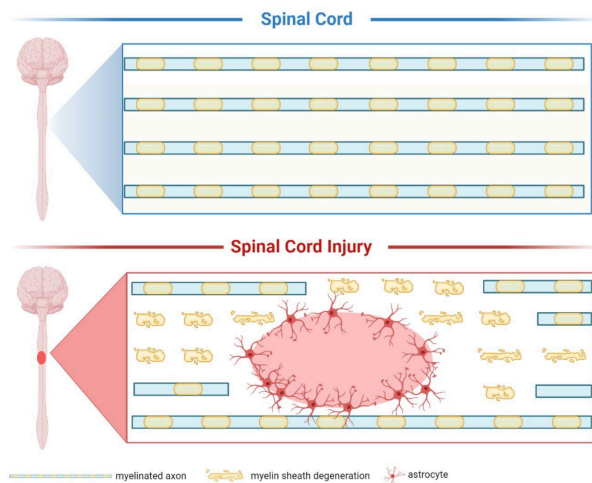
Figure 2: Gliosis. Created with biorender.com

Spinal Cord Recovery Pathways

The complex series of primary and secondary detrimental events accounts for the lack of success in numerous treatment strategies aimed at addressing SCI. Current therapeutic options encompass neuroprotective, immune-modulatory, and neuro-regenerative pathways. (11)

Neuroprotective Pathways

Neuroprotection plays a crucial role in preventing the progression of injury between neurons. The strategies available for neuroprotection can be categorized into four primary approaches: pharmacological, non-pharmacological, cellular and genetic, and methods based on regenerative medicine. (11, 43)

Pharmacological approaches include neuroprotection by drugs and therapeutic agents. One approach involves using neurotransmitter agonists and receptor antagonists to modulate neuroprotective pathways (11). Neurotransmitter agonists are substances that bind to and activate specific receptors on neurons, mimicking the action of endogenous neurotransmitters. (44) By activating these receptors, agonists can trigger signaling pathways that promote neuroprotection, and prevent neurological loss after SCI. Some neurotransmitter agonists that have shown promise in studies for SCI treatment are alpha 2-adrenergic (A2a) agonists (45). Receptor antagonists, on the other hand, block the activity of specific receptors, preventing the binding of endogenous neurotransmitters and inhibiting the downstream signaling pathways associated with neurodegeneration (44, 46). Some antagonists can modulate hypoxia (inadequate amount of oxygen reaching the cells), reduce excitotoxicity, inhibit necrosis, and prevent secondary injury mechanisms. Some examples are NMDA and AMPA receptor antagonists (46). It's worth noting that while agonists and antagonists targeting specific neurotransmitter systems have shown promise in studies, translating these findings to clinical treatments for SCI remains challenging

and no such treatments are currently available. Channel blockers are another pharmacological approach for modulating neuroprotective pathways in the treatment of SCI. By blocking specific ion channels, the influx or efflux of such ions can be regulated, leading to neuroprotection and improved functional outcomes. Sodium (Na+) channel blockers inhibit depolarization, reduce cellular swelling, and prevent excessive release of glutamate, which can trigger neuronal death. Calcium (Ca2+) channel blockers also play a crucial role in regulating calcium levels and maintaining homeostasis, preventing neurodegeneration (47, 48). By preserving cellular integrity, these blockers prevent destructive processes and improve neuronal survival (47). Moreover, following SCI, there is excessive production of reactive ROS and RNS, as byproducts of cellular metabolism in the brain and spinal cord, which lead to oxidative stress. (49) Oxidative stress contributes to inflammation, neuronal cell death, and secondary injury mechanisms. It also destroys proteins, lipids, and DNA (50). Anti-oxidative therapies aim to reduce damage and promote neuroprotection by targeting oxidative stress. Furthermore, inhibition of apoptosis-related signaling pathways represents another pharmacological approach for treating SCI. The apoptotic pathways are divided into two major pathways: the death receptor-initiated (extrinsic) pathway and the mitochondrial (intrinsic or Bcl-2-regulated) pathway (11). These pathways are initiated by stimulation of the caspases (cysteine-associated aspartate proteases). By targeting specific signaling pathways involved in apoptosis, it is possible to attenuate cell death and promote neuroprotection (51). Lastly, herbal and natural agents often contain various bioactive compounds that possess antioxidant, anti-inflammatory, and neuroprotective properties. Many natural constituents such as polyphenols, phenolic acids, terpenoids, curcuminoids, flavonoids, resveratrol, and alkaloids show neuroprotective activity (52).

Non-pharmacological approaches in the treatment of SCI encompass a range of strategies including the use of growth factors, vitamins, and cultured cells. These approaches have demonstrated potential in reducing complications associated with SCI, such as pain and swelling, while also improving motor activity. By employing non-pharmacological approaches, these techniques can offer short-term benefits. However, for optimal long-term clinical efficacy, it is often recommended to combine non-pharmacological interventions with pharmacological agents (53).

Further, cellular and genetic approaches hold promise for enhancing neuroprotective pathways in the treatment of SCI. Firstly, neurotrophic factors that are naturally occurring proteins, can support neuronal survival, growth, and differentiation (54). Sustained delivery of neurotrophic factors, such as nerve growth factor (NGF), brain-derived neurotrophic factor (BDNF), glial cell line-derived neurotrophic factor (GDNF), and neurotrophin-3 (NT-3), to the site of injury, can promote axonal regeneration, enhance synaptic plasticity, and improve functional outcomes (55, 56, 57). Gene therapy is also an innovative approach to treating SCI by introducing therapeutic genes into damaged spinal cord tissues. Various genetic therapy approaches have been explored for SCI, including growth factors promoting cell survival, neurotrophic factors enhancing neuronal growth and regeneration, anti-inflammatory factors reducing inflammation, and genes involved in axonal regeneration stimulating nerve tissue repair

(58, 59). Gene therapy techniques use carriers called vectors to deliver these therapeutic genes into the cells of the injured spinal cord. There are two primary types of vectors: viral vectors, which are modified viruses engineered to be safe and effective for gene delivery (60), and non-viral vectors, which are artificial carriers designed for gene transfer (61). Additionally, gene editing tools like CRISPR-Cas9 can also be employed to precisely modify specific genes (62).

Finally, regenerative medicine holds promise. It encompasses a broad range of techniques to replace, regenerate, and repair damaged or diseased tissues and organs. It can stimulate the body's natural regenerative capabilities or provide external interventions to restore tissue structure and function (63). A sub field of regenerative medicine, tissue engineering, has garnered significant interest due to its incorporation of neuroprotective or stem cells, growth factors, and biomaterial scaffolds (64). (See Figure 3) It integrates life sciences and engineering principles to fabricate tissue-like structures utilizing biochemical clues, live cells, and compatible materials (65, 66). In the context of neuroprotective treatments for SCI, growth factors, such as brain-derived neurotrophic factor (BDNF), insulin-like growth factor-1 (IGF-1), and transforming growth factor-β (TGF-β) are promising neuroprotective agents (67). Stem cell therapies also offer a promising approach and will be further discussed in this review article. These therapies harness the neuro-regenerative, neuroprotective, and immunomodulatory properties of stem cells (68). Various types of stem cell therapies, including neural stem cells (NSCs), olfactory ensheathing cells (OECs), Schwann cells (SCs), and bone marrow stem cells (BMSCs) are gaining recognition and popularity (69). Treatments based on biomaterials are an innovative option for SCI treatment. These biomaterials must have the following properties: biocompatibility, mechanical strength, biodegradability, hemocompatibility, porosity, and non-cytotoxicity, among others. Generally, all characteristics of the spinal cord tissue should be modeled by biomaterials (70). However, these technologies are still in the preclinical or *in vitro* stages of investigation and are therefore not available to patients (71).
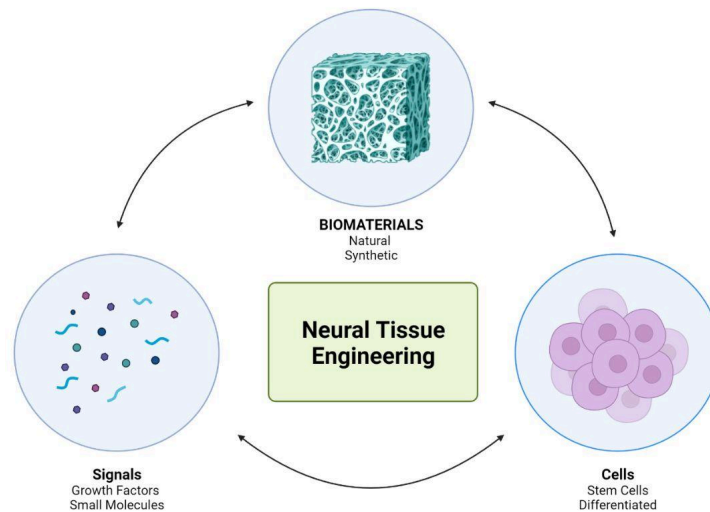
Figure 3: Neural Tissue Engineering Triad. Created with biorender.com

Biological Scaffolds/Decellularized Scaffolds

Biological scaffolds are biomaterials that provide a conducive environment for cells to adhere, grow, and differentiate. They are typically derived from natural sources (72). These scaffolds retain their original extracellular matrix (ECM) components, such as proteins, growth and bioactive factors, which play crucial roles in tissue development and repair (73). The ECM is a non-living complex network of proteins and other molecules that surrounds and help cells in tissues communicate with each other (74). It provides structural integrity (75), mechanical support (75), and biochemical signaling for cells (76). Decellularized scaffolds fit into the definition of biological factors, as they are created by removing cellular components from a tissue or organ while preserving the underlying ECM structure (77). By removing the cells, the potential for immune rejection is reduced, making decellularized scaffolds a valuable tool for regenerative medicine applications (78). These cell-free scaffolds demonstrate a high degree of compatibility with the target tissue. Due to their composition primarily consisting of ECM components, decellularized matrices exhibit natural biodegradability and rapid in vivo remodeling capabilities (79).

3D Printed Scaffolds

Compared to 2D scaffolds, studies demonstrated that 3D scaffolds exhibit enhanced tissue maturation and cell proliferation (80). The utilization of 3D printing technology offers notable advantages, including superior mechanical properties, improved control over scaffold design, and facilitation of differentiation and guidance of nerve cells. The complex nature of the CNS necessitates advanced strategies for neuronal regeneration, and 3D biomimetic scaffolds have shown remarkable potential, especially when considering personalized medicine

approaches (81). Personalized medicine refers to the tailoring of treatment strategies to individual patients based on their unique characteristics, such as genetic makeup, medical history, and specific needs (82). The use of 3D printing technology enables the fabrication of patient-specific scaffolds, taking into account the intricacies of the individual's CNS architecture (83).
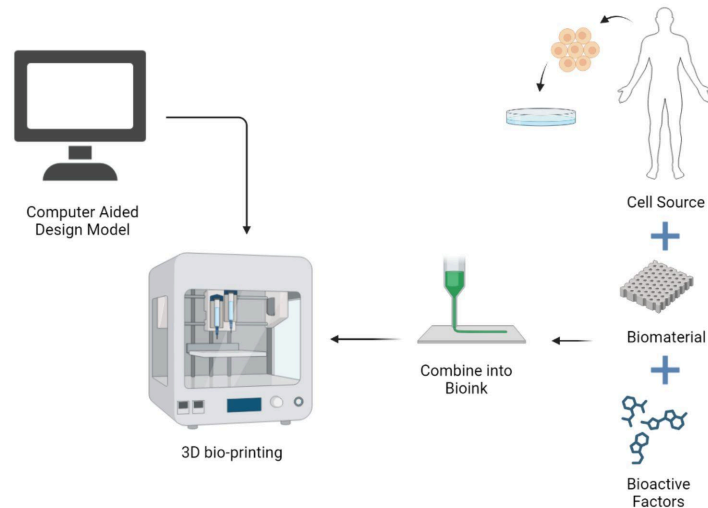
Figure 5: 3D bioprinting for neural tissue engineering. Created with biorender.com

Conductive Scaffolds

Conductive scaffolds possess electrical conductivity and are typically made from materials with inherent conductivity or are engineered to incorporate conductive elements. They can regulate signals to electroactive cells, promoting their cellular migration and proliferation. These scaffolds have shown promise in developing neural connections within damaged areas, as neurons are responsive to electrical signals. In both *in vitro* and *in vivo* studies conducted on cardiac and neural scar tissue, conductive scaffolds have effectively transduced external and internal electrical impulses conveying ECM signals. This transduction has led to improved organ function and behavior at a macroscopic level (84, 85).

Other Biomaterial Scaffolds

There are other kinds of scaffolds that aim to promote regeneration after SCI as well. For instance, gelatin methacryloyl/extracellular matrix (GelMA/ECM) hydrogel scaffolds use decellularization and electrospinning techniques (86). Electrospinning produces nanofibers or microfibers from a variety of polymers and other materials (87). These techniques promote neural stem cell differentiation, reduce inflammation, and enhance spinal cord regeneration (161). Another example is scaffolds made from chitosan, a biocompatible material with antimicrobial properties. It bridges the gap of spinal cord injury, supports structural integrity for a prolonged period, and inhibits glial scar tissue formation (84, 88).

Immuno-Modulatory Pathways

SCI triggers a complex immune response characterized by inflammation. Inflammation is a natural defense mechanism that initiates the healing process and removes damaged tissue. However, excessive or prolonged inflammation can lead to secondary injury and tissue damage

in the spinal cord (69). The immune system plays a significant role in the inflammatory response following SCI (11).

Astrocytes are non-neuronal cells found in the CNS, including the brain and spinal cord (89, 90). While not immune cells themselves, they play a vital role in the neuro-inflammatory pathway (91). Astrocytes produce and release small signaling molecules called cytokines and chemokines, which are crucial for immune system regulation (92, 93). These molecules include interleukins (ILs), tumor necrosis factor-alpha (TNF-α), and chemokine ligands (CXCLs), which activate and recruit immune cells, influencing inflammation. (94) Astrocytes can also recruit neutrophils, a type of white blood cell, through the cytokine signaling, and control the expression of adhesion molecules (95). These are proteins located on the surface of cells that mediate the attachment and binding of cells to each other or to the ECM, providing structural integrity (96). Astrocytes also regulate a specific pathway called STAT3. This pathway becomes activated when phosphate groups are added to the protein called STAT3, which is essential for the healing process, as it controls excessive inflammation that could harm the surrounding tissue (11). Understanding these immunomodulatory pathways mediated by astrocytes is crucial for unraveling the complex interactions between the immune system and the CNS.

Neutrophils, the most abundant type of white blood cell in the human body, are critical in the early immune response to SCI (97, 98). They are recruited to the site of injury within approximately 24 hours and aid in cleaning up cellular debris through phagocytosis (99). Neutrophils also release inflammatory cytokines, proteases (enzymes that break down proteins), and activate astrocytes and microglia, all of which help control neuroinflammation (95).

Microglia are considered the resident macrophages (white blood cells specialized in phagocytocis) of the CNS (100). Moreover, after SCI, monocytes from the bloodstream migrate into the injured spinal cord tissue and become macrophages (100, 101). Both microglia and macrophages promote neuro-regeneration by regulating the expression and release of various growth factors, including neurotrophin-3(NT-3), nerve growth factors (NGF), and thrombospondin (102).

T cells and B cells, types of blood cells, also play important roles in the immune response and processes of injury and repair in SCI. T cells can release pro-inflammatory molecules, including cytokines and chemokines, which have detrimental effects on neurons and glial cells (88-103). Regulatory T cells (Tregs) release anti-inflammatory cytokines and help limit inflammation. However, an imbalance between T cells and Tregs after SCI results in increased inflammation and cell death (104). B cells, on the other hand, initially suppress antibody production (production of blood proteins counteracting specific antigens) after SCI. The severity of the injury can influence their activity. Upper thoracic SCI can further suppress antibody production, while mid-thoracic injury may not affect it significantly (11, 102). Interestingly, B cells also produce a specific subset called regulatory B cells (Breg), which help regulate autoimmune responses. Breg cells control the activity of T cells by releasing anti-inflammatory cytokines like IL-10, and thus, support the healing process in SCI (105).

Moreover, immunomodulatory drugs are substances that can modify the behavior of immune cells, either by enhancing or suppressing their responses. Immunostimulatory drugs are utilized to promote immune responses in certain disease conditions, such as infectious diseases and tumors. On the other hand, immune-suppressive drugs are employed to reduce the immune responses following SCI (106). By reducing excessive inflammation, immunosuppressive drugs can help prevent further damage to the spinal cord tissue, allowing for a more favorable environment for healing (107). Combining immunomodulatory drugs with the understanding of the immunomodulatory pathways mediated by cells like astrocytes, neutrophils, microglia, and B cells can provide a comprehensive approach to optimizing the healing process after spinal cord injury (11).

Neuro-Regenerative Pathways

Neuro-regeneration refers to the healing process of damaged nervous tissues, including neurons, axons, synapses, and glial cells, following an injury. Neuro-regeneration encompasses either the elongation, sprouting, and growth of axons or the remyelination of nerve cells (108).

Promoting neuronal and axonal regeneration is crucial for functional recovery. Certain factors in the body, such as myelin inhibitors produced by oligodendrocytes, hinder axonal regrowth. However, researchers have identified strategies to overcome these inhibitory factors and facilitate regeneration (7-11). One approach involves using antibodies and inhibitors to block the activity of the myelin inhibitors. For example, a monoclonal antibody called IN-1 can prevent the inhibitory effects of myelin inhibitors, leading to improved axonal regeneration and locomotor function after SCI (98-109). Additionally, chondroitinase ABC (ChABC), derived from Proteus Vulgaris, has been found to inhibit the production of chondroitin sulfate proteoglycans (CSPGs), which are known to impede axonal regeneration. (109) ChABC also has the ability to release growth factors, reduce inflammation, and promote axonal sprouting, further enhancing regeneration (99-110). Another approach involves the use of self-assembling peptides (SAPs) as nanofibers. These SAPs can minimize damage by reducing inflammation, limiting the formation of scar tissue (astrogliosis), and preventing neuronal cell death. This supports axonal regeneration by providing a favorable environment for growth. (110)

Remyelination in the context of SCI refers to the restoration of the myelin sheath around damaged or demyelinated nerve fibers within the spinal cord (111). Since the myelin sheath acts as an insulating layer around nerve fibers (112), SCI hinders the proper transmission of nerve signals and results in loss of motor and sensory function (112, 113). Transplantation of stem cells is the most promising strategy to promote remyelination (11, 113, 114).

Stem cells are a distinctive group of cells that can self-renew and differentiate into different cell types once stimulated (115). These cells also have an inherent capacity for tissue repair and migration. Preclinical investigations exploring the use of stem cells as a therapeutic approach for SCI have exhibited considerable promise. Stem cell therapy has gained substantial popularity due to its potential to address multiple facets of SCI treatment, including facilitation of tissue regeneration and neovascularization, mitigation of nerve tissue degradation, and augmentation of the regenerative capabilities of endogenous cells (116). The selection of stem

cell types for therapeutic applications is predominantly determined by their potency, processing feasibility, and capacity for self-renewal (84).

Embryonic Stem Cells (ESCs)

Embryonic stem cells (ESCs) are cells derived from the inner cell mass of a developing embryo at the blastocyst stage, one of the final phases during which the germ cells retain self-renewing capabilities (117). These cells are pluripotent, meaning they have the ability to differentiate into any type of cell in the body, giving rise to all the specialized cell types and tissues. When treating SCI, ESCs can be differentiated into glial cells, neural cells, low-purity motor neurons, neural precursor cells, and high-purity oligodendrocyte progenitors (116). In the acute SCI model, the introduction of ESCs through transplantation demonstrated successful integration of transplanted cells, regeneration of nerve tracts, restoration of neuromuscular junctions, elongation of axons, and remyelination induced by oligodendrocytes (118). However, significant legal and functional shortcomings have limited the application of ESCs in SCI (119). Acquiring the ESCs results in the destruction of the blastocyst and thus, ethical concerns are raised (117). Another major obstacle that limits their use is teratoma formation (120, 121). These tumors are unique in their ability to contain various differentiated cell types, resembling a disorganized mixture of tissues derived from multiple germ layers (122).

Induced Pluripotent Stem Cells (iPSCs)

Induced pluripotent stem cells (iPSCs) are generated by reprogramming adult cells to return them to a pluripotent state (123). iPSCs can be differentiated into various types of neurons, such as dopaminergic neurons (124, 125, 126, 127), GABAergic interneurons (128, 129), neural cells (130, 131, 132), and neural progenitor cells (132, 133, 134). Direct transplantation of undifferentiated iPSCs at the site of injury has demonstrated beneficial effects on functional recovery and spinal cord regeneration (135). However, it is essential to acknowledge the potential risk of teratoma formation associated with the direct in vivo transplantation of iPSCs. Therefore, precautionary measures should be taken to mitigate this risk, such as inducing iPSCs to differentiate into specific cell types or lineages of interest prior to transplantation (136).

Mesenchymal Stem Cells (MSCs)

Mesenchymal stem cells (MSCs) are a type of adult stem cell found in various tissues throughout the body, including bone marrow (137), adipose tissue (138), umbilical cord tissue (139), and other sources. MSCs are multipotent, which means they have the ability to differentiate into a limited range of cell types (140). Mesenchymal stem cells (MSCs) are considered a promising source for cell-based therapies and tissue engineering owing to their regenerative attributes (140, 141), immunomodulatory (142), and immune-suppressive (141). Notably, transplantation of MSCs into animal models of spinal cord injury (SCI) has been shown to diminish inflammation, enhance bladder function, and augment the release of trophic factors. These combined effects contribute to the therapeutic potential of MSCs in the context of SCI treatment (143).

Neural Progenitor Cells (NSCs)/Neural Stem Cells (NSCs)

Neural progenitor cells (NPCs), also known as neural stem cells (NSCs), are found in the CNS. They have self-renewal capacity, high proliferative potential, multipotency, and heterogeneous nature (84). These cells have been successfully isolated from various sources, such as the brain (144), spinal cord (145), and dorsal root ganglion (146), indicating their wide distribution throughout the nervous system. *In vitro,* studies have highlighted the crucial significance of maintaining the stability and viability of NSCs, as they retain their self-renewal and differentiation capabilities even after multiple freeze-thaw cycles. Freeze-thaw cycles involve subjecting the NSCs to very low temperatures to freeze them and then thawing them back to their normal state. Freezing cells is a common technique used for long-term storage and preservation. By freezing NSCs, scientists can maintain their viability and functionality for an extended period, allowing for future use in experiments or potential therapeutic applications (147). Leveraging the inherent neurogenic (develop into neurons) and gliogenic (develop into glial cells) commitment of NSCs, they serve as a promising choice for repairing injured spinal cord tissue (116).

Neural Stem Cell Differentiation
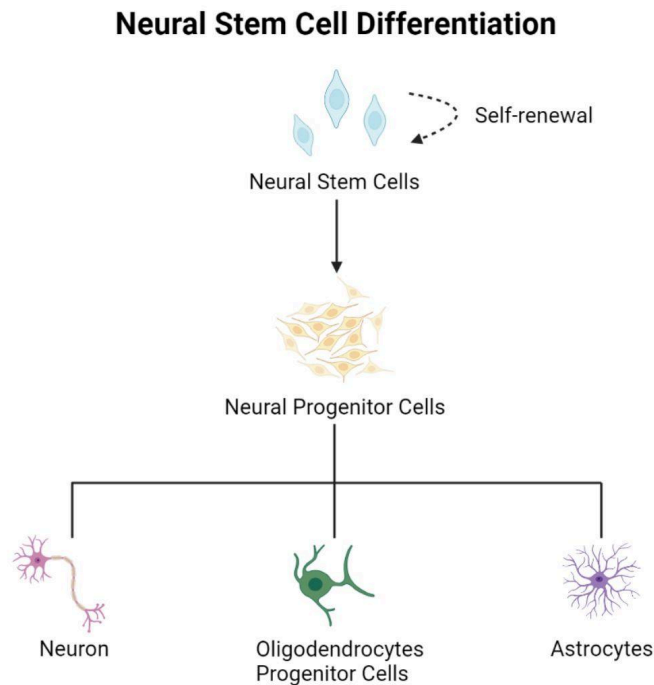
Figure 5: Neural Stem Cell Differentiation. Neural stem cells are tripotent cells that differentiate into neural lineage cell subtypes, such as neurons, oligodendrocytes, and astrocytes. Created with biorender.com

Olfactory Ensheathing Cells

Olfactory ensheathing cells (OECs) are a type of glial cells that form protective coverings around non-myelinated olfactory axons (148). These specialized cells play a crucial role in promoting neural regeneration by lessening the glial scar tissue (149). Notably, OECs have been observed to exhibit a wide range of beneficial effects, including the promotion of cellular interactions (141-150), regulation of neuroinflammation (151, 152), provision of neuroprotection

(143-152), stimulation of angiogenesis (153), clearance of cellular debris (141), and secretion of neurotrophic factors and ECM components (154).

Conclusion

SCI is a highly impactful condition and imposes significant strains on healthcare systems globally. In this review, we have discussed the pathophysiology of SCI and current treatment options with their benefits and limitations. It is important to understand that the pathophysiology of SCI is complicated and thus, a single solution is unlikely to overcome the diverse array of obstacles. Consequently, an integrative approach involving tissue engineering holds promise as a prospective avenue for future treatment.

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Gendered Process in 2001: A Space Odyssey By Arthur C. Clarke

GENDER

        Due to its variable and personal nature, gender is a term that is difficult to define. However, recent debate has identified two main theories about gender: gender as a process, and gender as an identity (Kessler-Harris 827). According to Kessler-Harris, the gender process is a "changing set of relationships intrinsic to particular visions of social order" (827). Aside from just personal expression and the way we see ourselves, gender is also about how we function and are perceived by society. Our presented gender is how we are viewed by others and affects how others see our roles in society and what we do to conform to those rules. Gender is not just produced internally, but in everyday social interaction (Berkowitz et al. 133). Because gender is socially constructed, it requires social interaction to function.

        According to performance theory, gender practice is a range of activities rather than a passive state" (Hollinger 32). In other words, gender is not who a person is, but how they interact with the world. These interactions and perceptions of gender form the basis for our social hierarchies and government systems today. They influence social formations and political decisions by changing how we see one another (Kessler-Harris 827). Gender identity and process goes beyond the individual, it affects society at large and can be found in social hierarchies and legislation, even if they are not strictly about gender. Everything society does is influenced by how people see each other -- gender identity and presentation play a large role in the way a person and their ideas are perceived.

        Conversely, gender identity is "the set of expectations and meanings an individual holds that relate to a role they occupy, a group membership they hold, or view of themselves as a unique person" (Smith & Smith 64). One's identity is how they see themselves, and how they expect others view them and treat them. It is the expectation for behaviors and traits that both they give themselves and society assigns to people that hold similar identities. Like the gendered process, identities form through socialization, personal experiences, and interaction with significant others, culture, and society as a whole (Smith & Smith 66). Someone's gender identity does not always come from a person's biological sex, although it is often influential (Palan et al. 364). Gender is an identity and can be changed, it is not something that is just assigned to a person. It is how they feel and perceive themself, not their physical characteristics. While a person's biology can influence the way they perceive themselves, ultimately it is their interactions with society that shape their gender identity.

        Modern western society has constructed a gender binary for social interactions, with most people falling on one side of a masculine-feminine scale. These masculinities and femininities are not pre-existing, but constructed in everyday interactions (Berkowitz et al. 133). As masculine and feminine mean different things to different people, here is a set of working definitions. A masculine gender identity tends to be more independent versus interdependent, and more task based personality, whereas a feminine gender identity tends to include more awareness on social interactions and more interdependence and community (Palan et al. 365).

Most people fall somewhere between the two poles, no one is purely masculine and no one is purely feminine (Palan et al. 374). As such, gender identity is superfluous and subject to change. While a person's identity as a "boy" or a "girl" or neither may never change, their placement on the masculine vs feminine scale might be due to external factors and situations. Gender identity [masculine vs feminine] causes "outputs" or typical behaviors. These behaviors are then grouped as displays and create gender categories, which "are influenced by broader definitions of gender in the culture at large" (Smith & Smith 65). People behave according to their dominant gender identities and traits, and those behaviors are then grouped into displays and form an overall gender presentation.

POWER DYNAMICS

According to Dana Berkowitz, gender presentation is accompanied by power and privilege (140). Gender plays a role in forming social hierarchies, and in most societies, one particular gender tends to have more power over the other. In the United States and many western societies, "men dominate women in terms of power and privilege" (Berkowtiz et al. 133). The US was founded by men, and focused on the rights of man. Our social hierarchy has placed men on top of all organizations or social groups. Because we see men in most positions of power, the United States has very masculine conceptions of power and the nation (Kessler-Harris 828). We then in turn apply this masculine definition of power to other countries and social groups, failing to recognize that they may have entirely different ideas of power and gender construct. Our gender presentations and 'process', or gender roles affect how we see others that may not have the same gender process. When faced with a different group of people, on a personal or national scale, humans tend to assign their own customs and traditional roles onto the other culture, and that affects the way they interact with that culture. If a society is largely patriarchal, with more of a masculine idea of power, then they are going to look for leadership in their idea of masculinity of the other group.

However, when examining gender and gendered discourse in media, one must be sure to look beyond the masculine feminine polarity. "Critiques of sex and gender polarities often leave those polarities in place" (Hollinger 25). Studying strictly traditional roles and binaries doesn't tend to lead to any discussion or progress to new identities and non-binary roles. When looking at any type of media for gender construction, one must keep in mind that, while yes, gender in western society follows a binary, fictional genders may lay outside of the contemporary definitions of gender. If one goes into research looking at purely masculine or purely feminine traits, then one fails to consider a combination of masculine and feminine traits. Even humans do not live in a strict binary, so it stands to reason that characters created by humans would not either.

SCIENCE FICTION

When considering science fiction, one must sort it into two categories, pure science fiction, or speculative fiction. Science fiction "denotes books with things in them we can't yet do or begin to do, talking beings we can never meet, and places we can't go" (Ketterer et al. 246). In

other words, it concerns things that are not yet possible. On the other hand, "speculative fiction employs the means already more or less to hand, and takes place on Planet Earth", or is already technologically possible, it just has not happened (Ketterer et al. 246). Most dystopian novels such as Margaret Atwood's *The Handmaid's Tale* or *The Hunger Games* by Susan Collins would be considered as speculative fiction, as they happen on earth in technologically feasible words. On the other hand books like *Dune* by Frank Herbert or Douglas Addams' *Hitchhiker's Guide to the Galaxy* would be considered science fiction as they involve places and technologies not yet possible.

Following these definitions, most novels or short stories depicting artificial intelligence (AI) would be considered under the label of speculative fiction, as AI technology is possible, just not as developed as in most of these stories. An AI is, simply, a program capable of recognizing outside factors, making real time decisions, and then learning from that decision (Kavanagh 13). As an AI is simply a well developed program, they have no gender characteristics or sense of gender identity, however, because they are created by humans, they are often humanized to display "gendered features or gender-specific behavior" (Heuser 129). Because humans are writing the non-human, the non-human will be portrayed with human characteristics. Humans cannot create something purely other, and anything, even characters, that we create will have human elements.

This idea of humanity transference applies to all parts of science fiction, not just AIs. According to Douglass Kilgore, "this genre devoted to social extrapolation has race as part of its operating system" (Kilgore 17). In other words, the views on race and racial hierarchies made their way into the text even when the text was not explicitly about race. Common ideas and beliefs of the time that works were written can be found in works, even if they are not the actual subject matter. Even if the story is not about gender identity and roles, that gendered process and system of thinking will make its way into the work regardless. Science fiction is generally used to explore what ifs, or take one contemporary aspect of society to a whole new level (Kilgore 21). While it is futuristic and often seems otherworldly, besides a few obvious changes such as a space setting or futuristic timeline, it is generally reflective of society at the time it was written.

GAP

Since its beginning in the late 19th century with Mary Shelly's *Frankenstein*, the genre of science fiction has been critiqued and examined for every possible theme and social comment. It is difficult to find a true gap in research, because most perspectives have already been thought of. What is left for the hopeful researcher is a handful of themes with an even smaller list of titles in which to look for them. Science fiction has been looked at in "african diaspora studies, critical race studies, queer theory, post colonial studies, visual culture, posthumanism (Kilgore 18), etc, and even the idea of gender performance as it applies to cyberspace has been touched on in Heuser's "(En)gendering Artificial Intelligence". What remains is the examination of gender presentation in various subgenres of science fiction and speculative fiction. This gap allows the question: To what extent do Hal's interactions with other characters in 2001: A Space Odyssey by Arthur C. Clarke reflect his assigned masculine gender identity?

METHOD

The main theoretical framework for this paper was taken from a blend of Smith and Palan et al.'s work. I used Smith's definition of gender as a presentation, constructed through interaction, and Palan et al's definitions of masculine and feminine displays and traits.. The type of method is a quantitative content analysis, with some qualitative analysis of character traits and tendencies to understand the complexity of Hal gender presentation. The general outline of the method follows. First, all passages containing interactions between Hal and other characters will be marked. Then, the number of gender displays of each type will be recorded. After all passages are recorded, the ratio of masculine to feminine displays will be calculated and analyzed to determine whether Hal matches his assigned masculine gender presentation.

In order to have a general understanding of the plot and how it impacts character interactions, it is necessary to read 2001: A Space Odyssey in full. I read the novel all the way through, taking notes of the plot lines and characters in order to give context in later analysis. I then marked and copied each interaction between Hal and another character from the novel. Labeling them as passages one through nine. I started each copied passage at either Hal's first line of dialogue, or when another character addressed him. I ended the passage when either Hal speaks last or the conversation with Hal ends. There were a few instances of the conversation continuing without Hal's input, but as they did not contain contributions from Hal, I left them out of the analysis. Any ellipses indicates a non- dialogue text break, where either the narrator was thinking or the setting was being established. Figure 1 below is one of such passages.

"Condition Yellow! Condition Yellow!"

"What's wrong?" called Bowman, though he had already guessed the answer.

"The AE-35 unit has failed, as I predicted."

"Let me see the alignment display."

…

"We'll I'm damned," said Bowman at last.

"So Hal was right all the time"

"Seems that way. We'd better apologize."

"There's no need to do that," interjected Hal. "Naturally, I'm not pleased that the AE-35 unit has failed, but I hope this restores your confidence in my reliability."

"I'm sorry about this misunderstanding, Hal," replied Bowman, rather contritely.

"Is your confidence in me fully restored?"

"Of course it is, Hal."

"Well, that's a relief. You know that I have the greatest possible enthusiasm for this mission."

"I'm sure of it. Now please let me have the manual antenna control."

"Here it is."

Figure 1. Passage 6, Hal is alerting Bowman and Poole to a failed communications system (Clarke 175).

       I then took each passage and looked for masculine and feminine gender displays as defined by Palan et. al. The analysis of the behavior was qualitative. I qualified masculine behaviors as any instance where Hal directed the interaction towards a specific task or structure, or was particularly assertive. A more explicit list follows: separation of the self, a concern for structure and function, manipulation of objects and people to perform tasks, independence, assertiveness, instrumentality, or competitiveness (365). I qualified feminine behavior as any instance Hal showed awareness for the psyche of the character he was interacting with, and behaved with any care or sensitivity. In other words, any time where Hal "gave primacy to facilitating the interaction", or displayed a sense of understanding, caring, nurturance, responsibility, or considerateness (365). This mainly presented itself in hesitations, concessions, or hedging remarks before relaying upsetting information. In the case of the passage below, Hal concedes the point to Bowman and prevents him from doing any demanding tasks.

       "Condition Yellow! Condition Yellow!"
       "What's wrong?" called Bowman, though he had already guessed the answer.
       "The AE-35 unit has failed, as I predicted."
       "Let me see the alignment display."
       …
       "We'll I'm damned," said Bowman at last.
       "So Hal was right all the time"
       "Seems that way. We'd better apologize."
       "There's no need to do that," interjected Hal. "Naturally, I'm not pleased that the AE-35 unit has failed, but I hope this restores your confidence in my reliability."
       "I'm sorry about this misunderstanding, Hal," replied Bowman, rather contritely.
       "Is your confidence in me fully restored?"
       "Of course it is, Hal."
       "Well, that's a relief. You know that I have the greatest possible enthusiasm for this mission."
       "I'm sure of it. Now please let me have the manual antenna control."
       "Here it is."
Figure 2. Coded Passage 6 (Clarke 175)

       After categorizing each display, I labeled each passage as masculine or feminine, depending on which behavior was seen in the highest frequency. If there was a masculine to feminine display ratio of four to one or higher in a passage, that passage was classified as masculine. If it was lowered, but still a masculine majority, then it was classified as undifferentiated, because there weren't enough masculine displays for the trait to be dominant. If there was a feminine majority of four to one or higher, then the passage was classified as

feminine. There were no instances of there being a feminine majority without a four to one ratio, but if there were it would be labeled undifferentiated as well.

As gender presentations are formed through whole interactions and not individual displays, a more accurate analysis of Hal's gender presentation is reached through examining the whole passages, not the individual displays. If a person displays more masculine traits in a single interaction, then the interacted will see the interacter as masculine, regardless of previous interactions. Because of this, I compared passages and interactions, and not the number of individual displays and behaviors.

DATA AND ANALYSIS

Similar to the classification of individual passages, the overall ratio of masculine to feminine passages needed to be four to one to qualify as a masculine presentation. The ratio of masculine to feminine passages was calculated in order to determine if Hal has primarily masculine or feminine gender displays. There were nine overall passages, with a five to one masculine to feminine passage ratio. There were three undifferentiated passages, but as they did not form the majority, they were left out of the final ratio.

PLOT

To begin, a general grasp of the plot is needed to understand the complexities of Hal's motivations and reasons behind his displays. *2001: A Space Odyssey* is the novel adaptation of Stanley Kubrick's 1968 film. The novel is told in five parts, each leading to a new understanding of humanity or the ancient alien race of the Firstborn. In the first part, a tribe of "ape men" -- a group of early human ancestors -- discover a mysterious monolith that scans them and takes control of their bodies to perform experiments on them. This leads to the eventual development of tools and the beginnings of the hunter-gatherer society. The second part details the discovery of one of such monoliths near a colony on the moon three million years later. When uncovered, it sends a signal out into space, prompting a manned mission to trace it to Saturn. Part 3 then describes the beginnings of said manned mission aboard the ship The Discovery, and begins the interactions between Hal, Bowman, and Poole. Hal is the only crewmember that is aware of their mission to seek alien life, he is told to keep it a secret from the other two. Part 4 describes Hal's slow descent into madness as he grapples with the dilemma of telling the truth to humans versus keeping this secret as he was ordered. He attempts to solve his dilemma by eliminating the crew members, getting rid of his need to keep a secret from anyone. He kills Poole with a space pod and attempts to kill Bowman by cutting off life support. Bowman is able to disconnect Hal before he is successful, which is where the interactions with Hal end. Part 5 then tells the story of how Bowman encountered the Firstborn and eventually joined them.

As stated earlier, the only interactions with Hal can be found in Part 3 and Part 4, and are centered around the running of the ship, or in the case of Passage 7, about the death of Poole. This does create the scene for more masculine interactions than feminine, due to the nature of maintaining a pressurized space craft.

EXCERPTS

> "Condition Yellow! Condition Yellow!"

"What's wrong?" called Bowman, though he had already guessed the answer.

"The AE-35 unit has failed, as I predicted."

"Let me see the alignment display."

…

> "We'll I'm damned," said Bowman at last.
> "So Hal was right all the time"
> "Seems that way. We'd better apologize."
> "There's no need to do that," interjected Hal. "Naturally, I'm not pleased that the
AE-35 unit has failed, but I hope this restores your confidence in my reliability."
> "I'm sorry about this misunderstanding, Hal," replied Bowman, rather contritely.
> "Is your confidence in me fully restored?"
> "Of course it is, Hal."
> "Well, that's a relief. You know that I have the greatest possible enthusiasm for
this mission."
> "I'm sure of it. Now please let me have the manual antenna control."
> "Here it is."

Passage 6. A conversation about a failing communication system between Hal, Bowman, and Poole (Clarke 175).

The above excerpt has a 5:1 masculine to feminine display ratio, allowing it to be classified as masculine. The pieces of dialogue highlighted in yellow are mostly focused on the task, Hal is trying to demonstrate his capabilities and remind the crew members of his task. The dialogue highlighted in blue was classified as feminine due to the reason that Hal was trying to not cause any additional work or stress to the crewmembers, and was focussing on their participation in the interaction not the task at hand. By making the concession, he has redirected the focus of the conversation away from the task, and onto interpersonal communication. He then turns around again in the next few dialogues to bring the focus back to the task of fixing the AE-35 unit, displaying masculine behaviors. This passage was marked as masculine as it had a 5:1 masculine to feminine display ratio. That means that there is a high enough difference in masculine and feminine displays, that the overall interaction would come off as masculine to whomever Hal is interacting with.

There were 5 masculine passages overall, similar to this one with masc-femme ratios of 4:1 or higher. They all were focussed on the task, whether that be fixing the AE:35 unit, discussing mission parameters, or trying to stop Bowman from dismantling Hal's code in the case of Passage 9.

> "Too bad about Frank, isn't it?"
> "Yes," Bowman answered, after a long pause. "It is."

"I suppose you're pretty broken up about it?"

"What do you expect?"

Hal processed this answer for ages of computer time; it was a full five seconds before he continued: "He was an excellent crew member."

Passage 7. A conversation between Bowman and Hal about the death of Poole (Clarke 184)

The above excerpt was classified as feminine. All of Hal's displays are focused on the welfare of Bowman, and aren't trying to persuade him to do a specific task, just soothe some hurts. In phrasing his remarks as questions, and demonstrating his version of thinking before he speaks, Hal comes off as somewhat caring, albeit awkwardly. While ultimately, this interaction serves as a way for Hal to try to regain Bowman's trust after killing Poole, in the moment it does present itself as genuinely caring and altruistic, marking it as a truly feminine passage. This was the only passage to be classified as feminine or have a feminine majority. From this, it can be inferred that while Hal does have the capacity for feminine behaviors, he tends to only use them to get what he wants, and direct attention to the task he wants to complete. This further shores up the conclusion that Hal's presentation is majorly masculine.

"Er- Dave ,I have a report for you."

"What's up?"

"We have another bad AE-35 unit. My fault predictor indicates failure within twenty-four hours."

…

"I don't understand it, Hal. *Two* units can't blow up in a couple of days."

"It does seem strange, Dave. But I assure you there is an impending failure."

"Let me see the tracking alignment display."

…

"Have you any idea," he said, "what's causing the fault?"

It was unusual for Hal to pause so long. Then he answered: "Not really, Dave. As I reported earlier, I can't localize the trouble."

"You're quite certain," said Bowman cautiously, "that you haven't made a mistake? You know that we tested the other AE-35 unit thoroughly, and there was nothing wrong with it."

"Yes, I know that. But I can assure you that there is a fault. If it's not in the unit, it may be in the entire subsystem.

…

"Well, I'll report it to Mission Control and we'll see what they advise." He paused, but there was no reaction. "Hal," he continued, "is something bothering you -- something that might account for this problem?"

Again there was an unusual delay. Then Hal answered, in his normal tone of voice: "Look, Dave, I know you're trying to be helpful. But the fault is either in the antenna system--or in *your* test procedures. My information processing is perfectly normal. If you check my record, you'll find it completely free from error."

"I know all about your service record, Hal--but that doesn't prove you're right this time. Anyone can make mistakes."

"I don't want to insist on it, Dave, but I am incapable of making an error."

There was no safe answer to that; Bowman gave up the argument.

"All right, Hal," he said, rather hastily. "I understand your point of view. We'll leave it at that."

Passage 5. A confrontation between Bowman and Hal about a failed communication system (Clarke 171-174)

The above excerpt has a 2.5:1 masculine to feminine ratio, causing it to be classified as undifferentiated. In the text highlighted yellow, Hal is trying to remind Bowman about his capabilities to perform his tasks and isn't backing down. He is focussing on himself and ignoring Bowman's attempts to make him see reason. This is a prime example of masculine display. It is extremely task oriented and egocentric, and isn't allowing Bowman to intercede or caring about his role in the conversation. In contrast, the dialogues highlighted in blue are times where Hal either made a concession or hedged his remark, showing consideration for the interaction itself. He ends the display with task oriented language, but his initial prefaces of "Er" and "I don't want to insist on it" show that he is aware of how his words are affecting Bowman and consideration of the interaction itself. This passage, as well as two others, is an example of an undifferentiated passage. This means that the amount of feminine and masculine displays were close enough in frequency that the passage did not lean one way or the other. As such, passages like Passage 8 were not included in the final ratio due to their lack of preference.

"Something seems to have happened to the life support system, Dave."

…

"Hello, Dave," said Hal presently. Have you found the trouble?"

…

"I think there's been a failure in the pod-bay doors," remarked Hal, conversationally. "Lucky you weren't killed."

…

"Hey Dave," said Hal. "What are you doing?"

…

"Look here, Dave," said Hal. "I've got years of service experience built into me. An irreplaceable amount of effort has gone into making me what I am."

…

"Dave," said Hal. "I don't understand why you're doing this to me.. . . I have the greatest enthusiasm for the mission.. . . You are destroying my mind.. . . Don't you understand?. . . I will become childish.. . . I will become nothing.. . ."

…

"I am a HAL 9000 computer Production Number 3. I became operational at the Hal plant in Urbana, Illinois, on January 12, 1997. The quick brown fox jumps over the lazy dog. The rain

in Spain is mainly in the plain. Dave-- are you still there? Did you know that the square root of 10 is 3 point 162277660168379? Log 10 to the base *e* is zero point 434294481903252. . . correction that is log *e* to the base 10.. . . The reciprocal of three is zero point 3333333333333333333333 . . . two times two is . . . two times two is . . . approximately 4 point 101010101010101010 . . . I seem to be having difficulty -- my first instructor was Dr. Chandra. He taught me to sing a song, it goes like this, 'Daisy, Daisy, give me your answer, do. I'm half crazy all for the love of you.'"

…

"Good . . . morning . . . Doctor . . Chandra.. . . This . . . is . . . Hal . . . I . . . am . . . ready . . . for . . . my . . . first . . . lesson . . . today.. . ."

Passage 9. Hal's dialogue when being dismantled (Clarke 200-203).

The passage above contains Hal's dialogue from when he was being dismantled by Bowman. While at the beginning of the passage he has maintained his personality and decision making skills, towards the end he starts to revert back to his base code and loses his personality. This passage was the hardest to analyze because of Hals' deterioration. It was hard to tell when he started to lose mental ability and the personality he was coded with. In the end, I took the segments where he began to pause in between his words as the segments where his personality was being erased, and discounted them from the overall analysis of the passage. His initial statements were coded as masculine, and the rest of the passage was not used in the analysis of his presentation, as he was losing all of the code that gave him the masculine presentation. Because of that, this passage was classified as masculine and counted in the final ratio. However, even if it wasn't, the masculine to feminine ratio world still be four to one and count as a masculine presentation.

As seen earlier, Hal's overall gender presentation does match his assigned masculine identity. And while he does display some feminine traits, they ultimately serve to guide the characters to performing the task he wants them to. In the case of Passage 7, he is trying to re-establish trust with Bowman in order to not be shut down. Most other instances of feminine displays are used to preface a masculine interaction or lower tensions and take the focus away from Hal's actions. And while all displays are inherently performative, Hal's feminine displays seem as if they are mainly manipulative and not genuine. From this, the conclusion can be drawn that although Hal does have feminine displays, his overall presentation both in terms of whole interactions and individual displays is primarily masculine, matching his assigned identity. However, it should be noted that Hal is in an environment designed to be task based, and is therefore set up for masculine interactions.

DISCUSSION

It has been established that although Hal is a non-human character, he still is written with human behaviors and displays. He is not a male human crewmember of The Discovery, but he still displays similar human characteristics and reflects the gender norms of the time *2001: A Space Odyssey* was written. While that may not seem significant, the notion that even a

non-human character can reflect societal values as complex as gender means that human values can be traced through different characters, from any setting.

It further supports the theory that all human creations will reflect human values, even if the goal is to do the opposite. It expands the realm of anthropology and learning about societies beyond our time, because we can take an even closer look at stories and legends to discover the everyday people. So much history has been lost due to poor records and warfare, but the legends of these cultures remain. We can look at their stories to find their everyday lives and values, and build our understanding of the past. We can also track how different values have changed over time, how they have influenced our values today. This idea of transference goes beyond just gender norms as well. Gender presentation cannot be examined without the presence of human mannerisms and turns of speech, and so other aspects of human society can be examined as well. It opens a new realm of self discovery and would allow us to be able to better understand the societies before us, so we can better predict those after us. Understanding that fiction and the stories we tell, no matter how fantastical, reflect our real lives can create new opportunities to further our understanding of ourselves.

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Extracurricular Correlation within a South Central Texas High School By Riley Stew

Introduction

Since public High Schools began to fund extracurricular activities, many advantages have been tied back to participating students. Extracurriculars (E.C) are defined as activities usually through a program that take place outside the classroom and outside school hours that act as an extra level of positive substance in a student's life. For example, most public High Schools in the Texas area offer E.C. in the form of sports, theater, choir, dance, etc. E.C. benefits include allowing students to stay out of trouble by occupying time and dominating life outside of school hours (McNeal), investing in a positive socio-emotional process, promoting physical well-being (Vermillion), and higher in-school testing scores (Vermilion). More notably, E.C. reduces the likelihood of participants dropping out of school altogether (McNeal).

High School dropouts often fall into the box of having lower levels of academic skills, as well as having poorer levels of mental health and physical health (McNeal). In turn, High School dropouts cannot give back to their communities as most dropouts also have a higher possibility of partaking in criminal behavior and an increased possibility of joining the underclass (McNeal). So it seems obvious that dropping out of High School lacks reason and only accompanies negative qualities. Some common factors in dropout rates include socioeconomic identity, race, and a disconnection from school. To keep a connection with school, higher involvement in the form of E.C could impact students and keep them engaged in school. On top of that, the public school system is supposed to support all students and adequately prepare them to enter the workforce or, more preferably, college or post-secondary schooling. Therefore, any implementation from educators is based on keeping students in school, "Much of education policy is understandably focused on finding effective ways to help the majority of students."(Wai, Jonathan, and Frank C. Worrel). As previously claimed, E.C. helps to contain students' engagement within schools. This then keeps students from dropping out of high school due to higher levels of involvement (Neely, Vaquera). So, it seems that a direct way to keep dropout rates low in Texas would be by having high extracurricular funding and promoting involvement in Texas public schools.

The idea of how much time students spend in their E.C is raised by Elizabeth Covay and William Carbanoro. Their article, "After the Bell", explores classroom behaviors and any tie-in with Academic Achievement. This raised awareness for me before conducting my research as to how time spent in E.C could correlate with grades, as well as what activity a student participates in. "...It is important to examine the connection between how students spend their leisure time and their classroom behaviors." (Covay & Carbonaro), as well as another question that I aimed to answer in my research, of how much time was spent in E.C. Not only time within practice, as addressed on the hour scale, but also how many practices students participated in weekly. This question raised in their article allowed me to re-think how my research would work to gather information regarding E.C involvement. I worked to collect information in an attempt to answer the raised question, "Does the frequency of participation matter?" (Covay & Carbonaro). This

concept of how time is spent in E.C is explored by Greg H. Frith and Reba Clark in Academic Incentives or Nonessential Functions, "Many students do spend an inordinate amount of time on sports and other social activities and not enough on academics." This article explores ways in which teachers can focus on helping with classroom tasks whilst states involve themselves heavily in activities outside the classroom.

Through surveying, the direct pattern in which E.C. correlates with grades can be revealed. My gap question of, "In what way do extracurriculars correlate to student grades in a Central Texas High school and how can that help schools identify areas to fund to improve grades?" will be revealed and evaluated throughout this paper. The research focus surrounds the correlation of grades to E.C in a central Texas High School. The conclusion of the reached data will be used to identify the patterns in which E.C has the highest grade correlation. From that conclusion, I will be able to identify what E.C should receive more funding in areas in Texas that have a higher dropout rate. This will be in an attempt to keep dropout rates at a low capacity in High Schools due to E.C involvement.

Hypothesis:

Before observing if there is a definite pattern in which activity a student participates and its correlation with their grades, we must make a broad assumption of the outcome. This will be so that we can see how other research has influenced how this study will be conducted and its ideal outcome. The ideal outcome may be a completely different scenario than my research conducted within a specific Texas Central High School.

I believe that there will be a strong divide between Performing Arts and Sports. This divide may mean either higher grades in Sports with lower grades in the Arts or: lower grades in Sports with higher grades in the Arts. From this, the conclusion can be reached that either Arts or Sports -whichever activity has higher grade averages- produce students with higher grades. Within observing students in an un-formal setting I can guess that the arts will have lower grades yet have higher rehearsal/practice times. The inverse may be true for sports, with higher grades and lower practice times. This would mean that sports take up less student time while also having a positive correlation with student grades. This also means that sports deserve higher funding to excel in their programs, to keep students engaged and to produce students with higher grades. However, as tackled by Mark Vermillion in "*Sports Participation and Adolescent Deviance; A Logistic Analysis*", sports only act as a social builder for connection and have little relationship to in-classroom assistance. Sports involvement might also just contribute to a better connection and understanding within establishments and therefore make navigating those establishments easier, "Sports participation could simply be one more mechanism by which students develop a stronger bond with current institutionalized arrangements."(27).

Method:

To identify grade correlations within outside-of-school activities, direct surveying was used. QR codes for an attached Google survey were placed in E.C. epicenters, such as outside

locker rooms, and passed out during rehearsal times. After communicating with fine arts directors I attended a band, theater, AV, and choir class and drew attention to the QR codes posted in their respective rooms. This was because at first, the arts did not turn in as many responses as sporting activities. Initially viewed as a limitation, I later realized that since the arts are more spread out they do not have as central of an epicenter as sports do. This is why I had a separate approach to collecting the fine arts data when compared to sports.

The main goal of the QR codes was to collect enough participants to have three students per E.C. and then average out their grades. The averaging of grades occurred in 5 portions: overall, math, science, history, and English. To receive this information, the Google survey supplied to students contained the following questions:

Last Name:

First Name:

These two questions were mandatory to track who had already submitted surveys and to guarantee that there would not be two submissions from the same student. However, these questions are confidential and were not tracked beyond that.

Please list what course you are in this year.

Math:

English:

History:

Science:

These questions were to see placements such as AP or honors classes that may affect the student's grades. These class placements were also taken into consideration further in my research.

Please list your specific grade for each class you are enrolled in. (End of the year/Final Grade)

Math Grade:

English Grade:

History Grade:

Science Grade:

These questions were used to collect the students' grades so that they could be tracked, compared to, and eventually averaged out to their respective E.C. activities and compared to other E.C. activities.

To find the averages for each grade with an E.C., 3 students' grades will be averaged out. This is conducted by adding up each student's score for each grade and then dividing by 3, or divided by how many classes were submitted by the students that they are enrolled in. This specification alludes to the fact that some students are enrolled in multiple classes for the same subject (Explained further in the "Limitations" section of this paper). Student 25D for example, is enrolled in AP Chemistry, AP Physics, and Anatomy & Physiology as well as being in soccer. All of these are science classes that all contributed to the total science score for soccer.

These next questions were used to track what E.C. the student participates in and then their involvement within that activity.

What is your primary extracurricular?

On Average, how many days a week do you participate in your extracurriculars?

Option one) 0-1

Option two) 2-3

Option three) 4-5

Option four) Every day of the week (7 days)

How long on average do your practices/rehearsals go?

Option one) Under an hour of practice

Option two) 1-2 hours

Option three) 2-3 hours

Option four) 3-4 hours

Option five) 5+ hours

The grading scale by which I will be following is from The University of Texas in Austin. This university has roughly 52,000 students according to 2023 statistics represented on their website. The University of Texas has about 93.2% of its student body from Texas, meaning that a study conducted in central Texas being put to the standard of the UT grading system is a fair reflection. An A - the highest on the grading scores - is a score of 93-100. An A- is only slightly below, being a 90-92. The grading of Bs includes 80-89, with a B+ being 87-89, a B being 83-86, and B- being 80-82. Grading of Cs include 73-79, C+ being 77-79, C being 73-76, and C- being 70-72. Ds scores include 60-69, with a D+ being 67-69, D being 63-66, and D- being 60-62. A failing grade, classified as F, consists of a 0-59. These grades, with their letter correspondence, might not be used as significantly within the actual research but will come to significance later in the conclusion.

To get the average grades in each math, English, history, and science class, 3 students' grades will be averaged out; this was used to allow multiple students per E.C to be taken into account in the averages. This method was also used to ensure that there were no students who were either academically advanced or academically challenged, as that would throw off the averages if they were left alone.

Findings

The following is the outcome of my research, conducted in a Central Texas High School in the middle of the academic school year from surveys given to students to gather their participation in E.C. and their grades in search of correlation between activity and grade averages.

Hours spent in E.C to Grade Averages

Amount of Practices/Rehearsals Weekly to Grade Averages
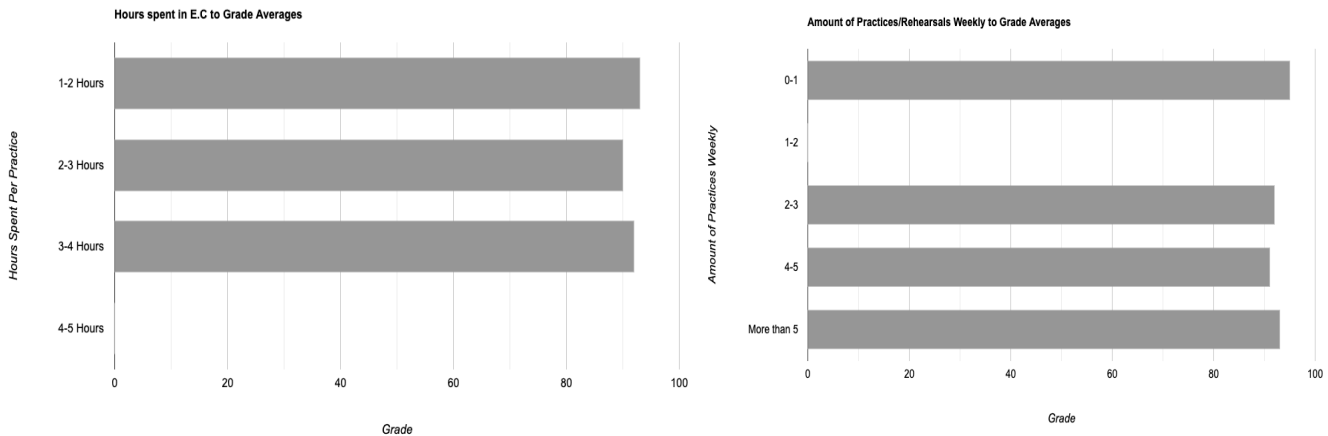
Firstly, I collected the total surveyed answers of Hours spent in E.C to grade average, and the Amount of Practice Weekly to grade averages. As you can see by the above graph, there is no definite relationship between amounts of practice and hours of practice time. I was also not pleased with this graph because as well as not showing a correlation between these two factors, it also lacks important information such as what E.C each student is enrolled in. This left me unfulfilled with this analysis and drove me to look in a different direction to find any relevant correlation.

Next, I looked at the grade average in the 4 core classes about each specific E.C activity. This was a broad look into students' grades, as these visuals allowed for an extensive look at averages before the fixed analysis of grades was conducted.

The four core classes and the 11 E.C activities shown represent the grade median for all three students surveyed. Again, this graph is broad and was not as satisfactory and thorough as the correlation could, ideally, be observed. To further look into grade averages, I identified the entire grade average from all core classes and tied that into each E.C.

This new analysis of the grade averages with each E.C. is what will be used going forward to discuss grade averages. Whilst using this graph with the University of Texas grading scale, we can observe both the Arts and Sports. Starting with Arts activities, Band has an A, Theater with a B+, Orchestra with an A, Choir with a B, Cheer/Dance with an A-, and finally Audio Visual (AV) with an A. Sports activities, in comparison, include Basketball with an A-, Baseball/Softball with an A, Soccer with an A, Football with an A, and Tennis with an A. When comparing Sports and the Arts, sports have a 94 average meaning that all sports come together to contribute to an A average. In contrast, the Arts has a 91 average, meaning that the Arts come together to produce an A- average. With not even a number scale difference the difference between grade averages is very slim. Sports barley has a higher average with a very negligible difference.

This brought the next process within my research: observing the differences, if any, with sports and the arts and their respective practice/rehearsal times and concluding from the difference in averages with Arts to the Sports, if there is a notable difference due to

practice/rehearsal patterns within the two categories. Depending on the results, those patterns could be attributed as the catalyst for hosting students with either higher or lower grades. This would, in turn, mean that practice/rehearsal times are a bigger contributor to differences in grades than just the involvement in either Sports or the Arts.
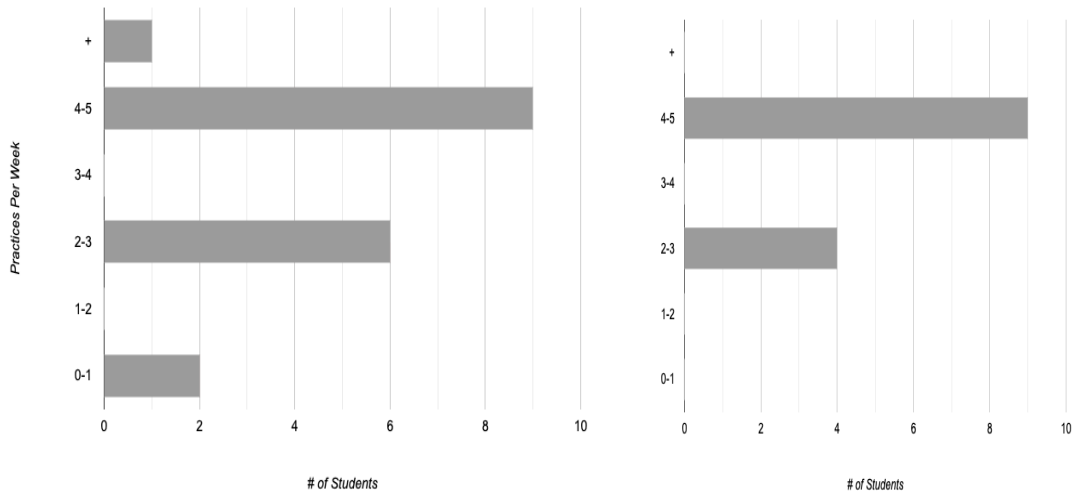
The above graphs of hours spent within practice/rehearsals compare Sports (on the left) to Arts (on the right). As represented, Arts has longer practice/rehearsal times, reporting more students who participate in 3-4 hours of practice weekly. Interestingly, the Arts also has more students that reported 1-2 hours in practice weekly. This conclusion illustrates that the arts typically have a more sporadic report of times spent in practices/rehearsals. This also proves the assumption that Sports has a more uniform practice pattern across all sports.

For a continued look into times spent within rehearsals/practices, I analyzed the responses from students who provided the number of times per week that they practice as well. This will show the amount of practices/rehearsals that each E.C has and not just the hours that students spend in those practices.
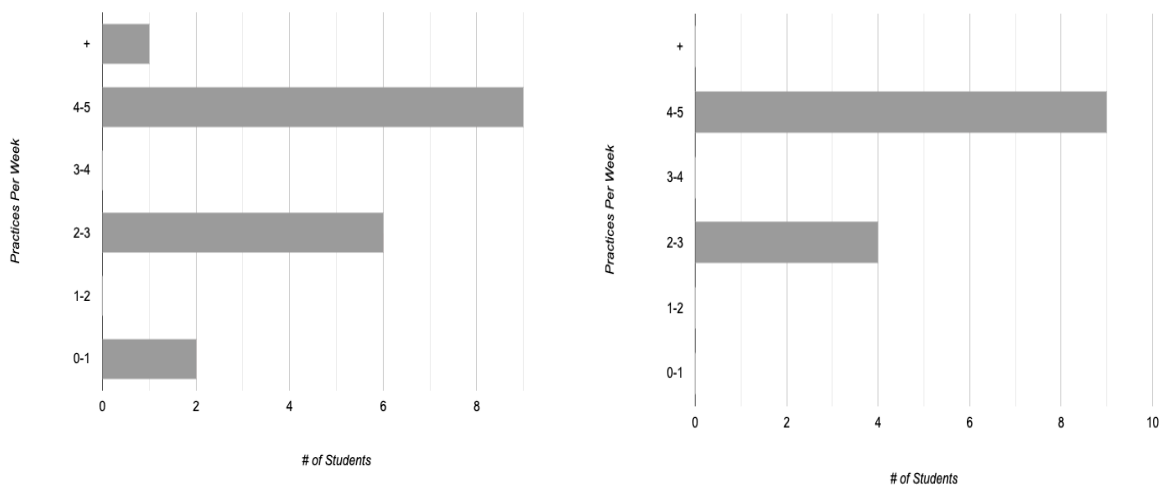
Here is the graph showing practices per week for the Arts (left) and Sports (right). Again, there is no definite relationship between practices per week to the arts and sports, yet the arts reported more sporadic practice/rehearsal time patterns when compared to Sports practice times.

These two previous graphs and analysis of the surveyed students was not satisfactory. There is a small observed correlation to Sports having a higher grade average and less practice time, but this relationship is not very easily observed. On top of that, the Arts reports were sporadic and not as uniform as the Sports. With this observation in the lack of correlation, I was led to find another possible form of comparison between two E.C and their practice patterns to find a satisfactory method to see the distinct differences between two contrasting activities. The most thorough way to analyze the difference is to compare the E.C with the highest grade average and the E.C with the lowest grade average. Interestingly, the activities that harbor both the highest and lowest grades are activities within the Arts. Orchestra has the highest, with a grade average of all four classes being 97. In contrast, Choir has an 84 average for all four core classes. In order to compare these two activities both within the Arts I will look at reported rehearsal/practice times. By doing this, we will be able to see if there is any difference in practice patterns and apply this finding into looking into other E.C activities, thus allowing us to analyze practice patterns and see if they harbor any correlation to grades.
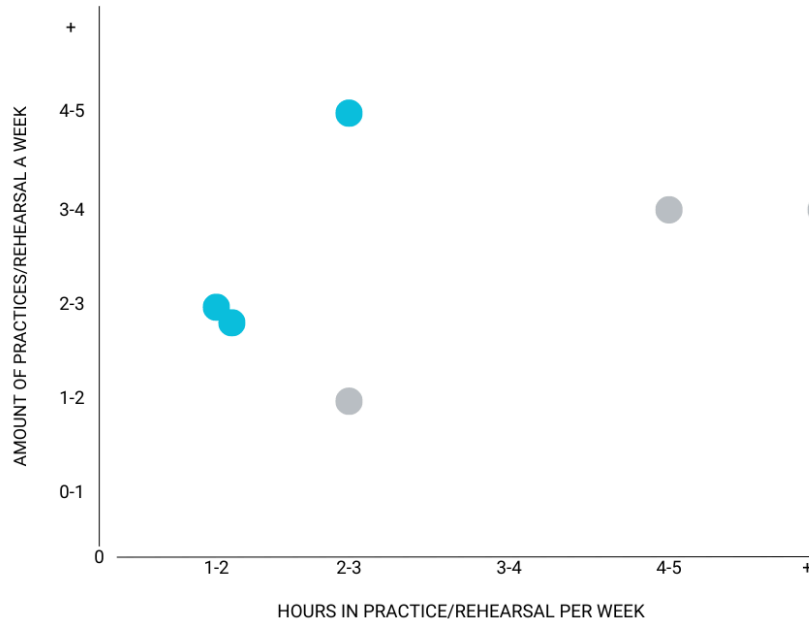
Within the Choir (turquoise) and Orchestra (gray), the Choir harbors 2 students with 2-3 practices weekly and 1-2 hours reported in those practices. The other Choir student reports 4-5 practices a week with 2-3 hours in those practices. Initially, it would seem that all students that participate in the same E.C within the same school should report the same hours, yet the

difference can be attributed to students that participate in said activity outside of school. In choir's sense, this can be seen as this student hypothetically having extra vocal lessons or being enrolled in more than just one choir class, resulting in more practices and times within practices. To reiterate, the Choir has an 84 average or a B average. Orchestra on the other hand has a higher average of 97 with all three students reporting different practice times. One student has 1-2 practices weekly with 2-3 hours in that practice. The other two students report 3-4 practices weekly but one reports 4-5 hours of practice weekly and the other selected the "+" option, signifying more than 5 hours of practice weekly. Again, this can likely be attributed to that student participating in extra practices either independently or within an organization separate from the school.

As observed in the graph, the Orchestra has fewer practice, but longer hours spent participating in said practices than with Choir. Therefore, within this comparison, a relationship between higher grades and less sporadic rehearsal can be seen. Of these less sporadic practices, there is more time spent in those practices. This directly contrasts with Choir, which have more practices weekly but less time in those practices. With fewer practices but longer expansions of those practice times, students experience higher grades. Notably, however, one student from Choir and Orchestra participated in 2-3 hours of practice with the only difference being the amount of actual practice they each had. This led me into my next analysis of what I deemed the *2-3 Students*.

The 2-3 Students have one similarity and many differences. The similarity is the hours of practice they experience weekly and the differences are activity, grade, AP enrollment, and continuity in rehearsals. The Choir 2-3 hour student is identified as student 20B, and the Orchestra student is identified as student 10B. Student 20B has a 92 average and 1 AP enrollment. In contrast, Student 10B has a 98 average and 5 AP enrollments within their core classes. This means that student 10B is enrolled in more rigorous core classes yet has a higher grade average. The only separating factor outside the classroom is the E.C that each student is enrolled in and the continuity in rehearsals, as student 20B has 4-5 hours of practice and student 10B only has 1-2 hours of practice. Notably, each of these reports revolves around the same hours within those practices. This comparison leads me to a theory: more practices with less time within those practices or inversely, fewer practices with more hours spent in practices, result in high grades.

To follow up on this newly found data, I went on to compare practice/rehearsal times of the E.C activities with grade averages above 92: excluding Orchestra. These activities represent an A average and include Cheer/Dance, A.V, Basketball, Baseball/Softball Soccer, Tennis, and Football. I wanted to further observe if the before-listed phenomena of less concentrated rehearsal resulting in higher grades could be true within these activities.

To restate what I was looking for within these activities, more weekly practices with less time within practices or the inverse of less weekly practices to more hours in practices. This I believe would be true for all the E.C with an A average and if it is, the conclusions can be reached that less concentrated rehearsal/practices results in higher grades.
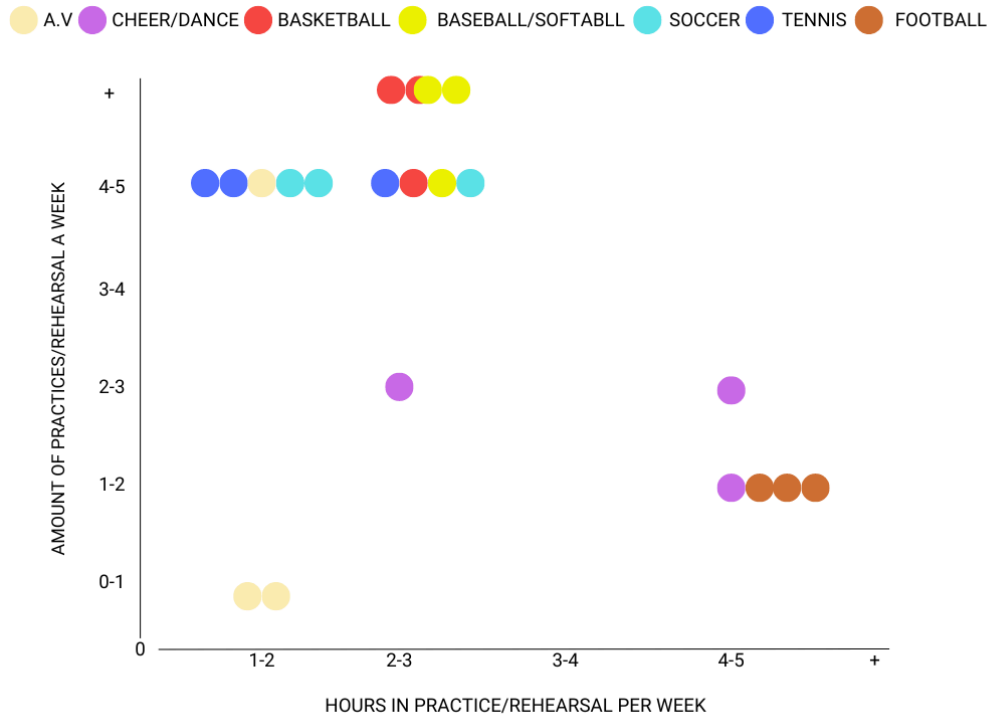
Several noticeable E.C that follow this rule of less concentrated practice/rehearsal times include Tennis, Soccer, and Football. Even with these activities being more prominent in this pattern, other activities also follow this rule but to a lesser extent. Tennis (dark blue) and Soccer (turquoise) show 4-5 practices weekly and between 1-2 and 2-3 hours within practice weekly. These two activities in particular are notable because Soccer has the highest grade average (excluding Orchestra) with a 96 average, and Tennis with a 95 average, making it a 4-way-tie, or second highest grade, (excluding Orchestra) with A.V, Football and Baseball/Softball. Along with Tennis and Soccer, Baseball/Softball and Basketball also host the same pattern of fewer hours within more practices weekly, with Baseball/Softball having an average grade of 95 and Basketball with a 92 average, even with very similar reported practice patterns/times. *So, that small margin difference of 3 points is entirely due to smaller factors such as class enrollment and student individualism.* Again, within this pattern is Football, representing less amounts of weekly practices and longer times spent in those practices. All 3 Football (brown) students that were surveyed, stated that there were 1-2 weekly practices and they spent 4-5 hours within those practices. Football also has a 95 average, again tied for second in a 4-way tie with A.V, Baseball/Softball, and Tennis when excluding Orchestra. This means that of the highest averages of grades, the top activities experience low concentration within practices/rehearsals.

Limitations:

Several aspects within my research could have affected the outcome and allowed my results to vary greatly than if this study was conducted outside of a South Central Texas High School. Since my method of study involved a simple Google form that could easily be replicated

or reused, the place in which the survey is sent out could very likely change the actual survey results.

A direct support to this claim is the prowess of the South Central High School my specific study was conducted. This school is #1,048 on a National ranking and #125 for all Texas High Schools as explored by US News and World Report. The school also has a 99% graduation rate making this school exceptionally above average as the State graduation rate is below that at 85% as of 2023. The school also ranks #12 in the grand San Antonio MetroPolitan area. This means that this school is academically accelerated and most likely houses academic competition within the classroom that may linger over into E.C competition. With more students involved in more rigorous classes and competitions in the academic sense, this school provides students with higher grades. This means that if this study were to be conducted at a different school with different rankings, results may be vastly different.

With such high standards within the South Central Texas High School, several students involve themselves with multiple E.C activities. This is seen in student 17B who participates in Softball and Theater. However, their scores were only used in Softball. This is again seen with Student 16D who participates in Basketball and Soccer. Their score was only used in Basketball's average.

As well as being an academically demanding school, many students are enrolled in multiple core classes. This course affected my studies as I was only looking into the 4 core classes. This was not suspected, yet was taken into consideration well. I was complying with grade scores for grade averages. To adjust for this to accurately find the mean grade I averaged out the enrolled core classes together to even a final score for that extracurricular. A direct example of this is student 25D who is enrolled in 3 science classes. This student was used in the Soccer averages whilst being enrolled in AP Chemistry, AP Physics, and Anatomy and Physiology. Student 25D had a 100 in Physics, a 99 in AP Chemistry, and a 99 in Anatomy and Physiology. This results in this student's science score being averaged out to 99.3. This means that for this student I used the 99 score as his science average. The 99 was what contributed to the rest of the Science score as well as to the scores for Soccer.

Conclusion/Outcome:
From observing my research conducted with a South Central Texas High School, I have reached a possible process in which schools could direct E.C involvement to increase grade averages as well as by proxy reduce dropout rates. There was not a major difference between Arts and Sports but my original hypothesis was correct. My hypothesis that the Arts would host lower grades but more practice was proven true through the surveys sent out to gather grades, classes, and E.C involvement. However, since the margin of difference was so slim with the Arts having a 91 and Sports having a 94 the patterns from which E.C occurred were analyzed further. This means my gap question of in what capacity do grades correlate with an E.C activity - will be found through how those E.C conduct their practices and rehearsals.

With less concentrated rehearsal and practice, there will be higher grades. To elaborate on this, the higher amounts of practice times to lower hours spent in those rehearsals or inversely, fewer practice times with higher hours spent in those practices result in higher grades. (To illustrate this point the next page contains a visualizer.) This pattern is seen in 5 classes that had the highest average of an A or above 92. A.V. has a 95 with low practices but higher hours in those practices. Tennis has a 95 average with more practices with low hours spent in those practices. Baseball/Softball has a 95 average and more practices of 2-3 hours. Soccer has a 96 average with more practices weekly with few hours in those practices. Basketball also has a 92 with more practices with low hours in those practices. For the flip of this pattern, Football has few practices with a high amount of practice weekly. Again this pushes my conclusion that less concentrated practice/rehearsals result in students with higher grades.

MORE PRACTICES/REHEARSAL WITH **LESS TIME** IN PRACTICE/REHERSALS

LESS PRACTICES/REHEARSAL WITH **MORE TIME** IN PRACTICE/REHEARSAL
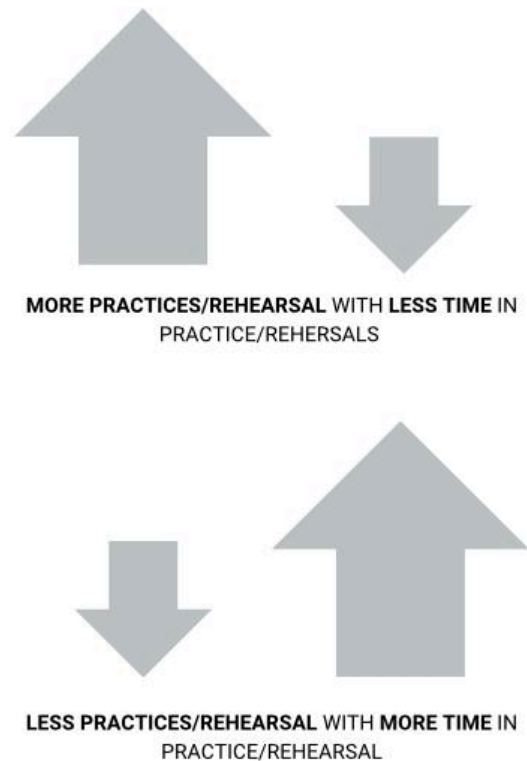
In order to facilitate higher grades and higher in-school involvement through E.C, by proxy reducing dropout rates, less concentrated practice/rehearsal patterns can be implemented by both the Arts and Sports. This style of E.C involvement is not dependent on whatever the E.C activity is, meaning it is applicable to nearly any activity. So, it is made apparent that E.C does not affect grades directly, but rather their practice and rehearsal times have a direct correlation with grades. Within these practices, there must be less time spent in those practices in one of two ways: more practices with less time spent in those practices, or less practices with longer times in those practices.

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Ecopreneurship in India: An empirical study of perceived incentives and barriers for sustainable businesses By Nidhi Reddy Gangumalla

Abstract

This empirical study investigates the perceived incentives and barriers of environmental entrepreneurs in India. Environmental entrepreneurs can help to increase the production of eco-friendly products and raise awareness about the growing problem of global warming. The study employs an online survey that was sent to several environmental businesses and organisations to gather insights about the respondents' demographics, entrepreneurial attributes, incentives and barriers. The survey identifies three main themes. Firstly, many participants had a neutral opinion about possible incentives that can motivate them and only showed a higher preference for financial support provided by the government. Secondly, respondents reported that they incur significant expenses to maintain their ethical operations. Lastly, the survey revealed that a crucial challenge faced by the respondents is the lack of awareness among consumers. Overall, the findings of this study contribute to a better understanding of these entrepreneurs' perceptions and behaviour, creating actionable recommendations for numerous stakeholders, such as business leaders and policymakers, who are interested in developing a welcoming environment for ecopreneurs. The study's findings would also benefit the public sector policymakers and the government, enabling them to foster an environmentally sustainable and economically viable business ecosystem in India.

Introduction

With the rise in global temperatures and frequent occurrences of natural disasters, preserving the environment around us has become increasingly important. In 2023 alone, there were 398 natural disasters worldwide, which caused around $380 billion in damage (Pandey). Moreover, CO_2 emissions in 2023 reached a record high of 37.4 billion tonnes ("Executive Summary – CO2 Emissions in 2023 – Analysis"). These instances show the increasing need to address the problem of global warming and climate change. There has been rapid industrialisation and urbanisation across the globe, placing immense pressure on the available natural resources and the ecosystem. It has led to a rapid depletion of resources, and thus, the need for sustainable business practices has never been more pronounced. It is important that public attention is directed towards understanding environmental protection issues and comprehending how they can contribute to safeguarding them. These contributions can be in the form of conscious spending habits, promoting awareness among friends and family, participating in clean-up drives, or composting their food waste. When consumers engage in conscious spending habits, unnecessary spending decreases, thereby reducing resource wastage. Furthermore, it would result in increased consumption of eco-friendly products. Ecopreneurs, entrepreneurs with an environmental objective for their business, could help produce these eco goods and services and encourage consumers to purchase them. Walley and Taylor (38) highlight

that ecopreneurs can be considered as change drivers. With their influence in mass markets and public awareness, ecopreneurs could lead the way in tackling climate change.

India is a diverse country, with the world's largest population and a fast-growing economy. Consumer spending in India had reached 25,600 billion INR by the 4th quarter of 2023 ("Consumer spending in India from 2nd quarter of 2018 to 4th quarter of 2023"). A report shows that there has been a change in the spending patterns of Indian citizens. There has been an increase in expenditure on discretionary items such as clothes and entertainment, while spending on food items has decreased comparatively (Bhavsar). These spending habits could suggest that consumers in India have grown less conscious about their expenditure. Therefore, there is a growing need for ecopreneurs in India to encourage customers to obtain environmentally safe products. However, ecopreneurship is still developing in India. There are very few publications being released on ecopreneurship each year as it is in its early stages. This study aims to address the need for empirical research in the field of ecopreneurship in India while providing practical insights for fostering a more environmentally conscious and economically viable business system.

The focus of this study is specifically on ecopreneurship and its perceived incentives and barriers in India. It explores what incentivises and demotivates owners of ecopreneurial businesses to increase their risk-taking ability, investment, market share, product portfolio or customer base. The study aims to address two main questions:

1. What are the perceived incentives among ecopreneurs in India that impact decision-making and business performance?
2. What are some perceived barriers that prevent individuals from becoming an ecopreneur?

This research serves as a timely and relevant exploration of ecopreneurship in India. This paper has been divided into five sections, beginning with an introduction and followed by a comprehensive literature review, methodology employed in the study, an insightful discussion of results, and a concise conclusion.

Ecopreneurship

There has been extensive discussion among researchers on ecopreneurship and sustainable businesses. However, there exists a subtle contrast between these two terms. Ecopreneurship refers to a field of entrepreneurship that focuses primarily on the environmental objectives of the business and sells green products and services to its customers. Schaltegger mentioned that the word "ecopreneurship" was formed by combining the terms "ecological" and "entrepreneurship". As a result, he describes ecopreneurship as "entrepreneurship through an environmental lens" (Schaltegger 47). Schaper (qtd. in Sindhu et al. 312) described 'ecopreneurs' or 'green entrepreneurs' as those set of entrepreneurs who believe in the concepts of sustainability and are environmentally concerned. Dean and McMullen (qtd. in Sindhu et al. 312) defined ecopreneurs as those entrepreneurs who combine environmental awareness with

their business activities in a drive to shift the basis of economic development towards a more environmentally friendly basis. Drucker and Noel (qtd. in Sindhu et al. 312) emphasised that ecopreneurs create a specialised space for themselves in the market in the form of an 'ecological niche'. In contrast, sustainable businesses are those businesses that aim to have a positive impact on the environment, community or society. They can be considered to be more inclusive and they address all the sustainable development goals (SDGs) while ecopreneurship only addresses environmental issues.

Entrepreneurship and Ecopreneurship in India

Entrepreneurship has been on the rise in India. The Indian Government has been promoting entrepreneurship through its Startup India initiative by funding, providing tax exemptions, and creating incubators and innovation labs. Through this scheme, close to 3700 start-ups have been funded. According to NASSCOM, India now is among the top ten countries having the highest number of startup incubators and accelerators in the world. The number of incubators and accelerators in India grew by a sharp 40% in 2016, with more than 40 of them seeing the light of the day.

However, ecopreneurship is still at a developing stage in India. With very few publications being released on ecopreneurship each year, the system is still in its early stages. However, India has had a rich tradition of reusing and recycling, from composting to reusing old garments as cleaning cloths during the 1900s. Due to rapid urbanisation and modernisation, there has been a quick depletion of resources, water scarcity, and an increase in greenhouse gas emissions (Joshi 7). Greenhouse gas emissions in India have increased by over 330% from 1990 (Pandey). Ecopreneurship could offer solutions to address these problems in India. The Centre for Innovation Incubation and Entrepreneurship (CIIE), established in 2002 with support from the Government of India's Department of Science and Technology, has invested in 10 cleantech start-ups, along with other start-ups.

Reporting on the increasing market of sustainable products, a recent study by Bain & Company found that 52% of consumers in urban India are expected to increase spending on sustainable brands in the next three years (qtd. in "Over 60% willing to spend more on sustainable brands"). The consultancy said over 60% of consumers in India are willing to pay a premium for 'sustainability products' ("Over 60% willing to spend more on sustainable brands"). These trends suggest an increase in the desirability of sustainable products for Indian customers. Another study conducted in two business schools in India surveyed 205 students and found a positive correlation between a consumer's attitude towards the environment and their intention to purchase environmentally sustainable products (Mandliya et al. 1655-1659). This further shows the need for an increase in awareness about sustainable products to encourage conscious buying habits among consumers, thus increasing the market size. However, a study with 120 respondents showed that while 70% were aware of green products, 40% mentioned that they never considered them while purchasing. This revealed that although respondents' awareness level is quite high, their conversion into purchase intention is low (Kumar et al. 37-38).

Incentives for Ecopreneurship

At the centre of any entrepreneurial venture lies incentives: the motivations and rewards that trigger individuals to embark on the risky - yet potentially rewarding journey of starting and scaling their business. Perceived incentives are universally accepted incentives that are constructed socially. They are considered to be factors that motivate entrepreneurs to assess and make certain decisions. They are someone's imagination of an opportunity. While support (capital; resources; advice, etc.) might be present for entrepreneurs, other 'incentives' reside in individual entrepreneurs' perceptions. Perceived incentives for entrepreneurs emerge through individual evaluations of the entrepreneurial environment and may subsequently lead to the maximisation of potentially lucrative opportunities.

Entrepreneurs embark on their ventures when they find some factors that appeal to them, encouraging them to start their businesses. These are considered to be the entrepreneurs' incentives. According to the incentive theory of motivation proposed by Skinner (qtd. in Vi 1022), people act by the action of incentives, which are used to encourage people with a lack of interest in useful activities. They are incentivized by the possibility of earning huge profits, maintaining their autonomy, putting their own ideas into practice creatively, and gaining popularity and social status.

The government and its initiatives play a significant role in the decision-making of firm owners and prospective entrepreneurs. Some policies may increase investment in the country, while others discourage potential entrepreneurs and firm owners from setting up their businesses. Some commonly perceived government incentives include subsidies, tax breaks, grants, low-interest loans for start-ups, provision of support infrastructure and mentorship ("Government Schemes for Startups"). These incentives motivate entrepreneurs to start or grow their businesses as they benefit from the government. Market-related developments such as increasing customer base and growing demand can also encourage entrepreneurs in particular sectors as they can access a more extensive customer base through the market. Access to finance also plays an important role in incentivizing entrepreneurs as financial resources can provide entrepreneurs access to good quality raw materials, distribution channels, infrastructure, and workforce and allows them to cover their initial start-up costs. In 2015, the government launched the Pradhan Mantri MUDRA Yojana, which provided loans of up to 1 million rupees to small enterprises ("Mudra - Micro Units Development & Refinance Agency Ltd."). Since its inception till 2018, a total of 103.8 million self-employed individuals have availed the benefits of MUDRA Loan by withdrawing a total credit of Rs. 4.6 trillion (Rajak 8). This highlights that when financial institutions, government and private investors are inclined to support enterprises, entrepreneurs are incentivized.

However, the incentives of green entrepreneurs partially differ from those of traditional entrepreneurs, as green entrepreneurs are, to a certain extent, motivated by economic and environmental concerns and values (Pachaly 11). The values of an entrepreneur act as an incentive as they guide an entrepreneur's behaviour towards sustainable entrepreneurship.

Environmental values refer to the beliefs of a company that encourage them to protect and preserve the natural environment. Yasir, Babar and the other authors believe that these environmental values are the reason environmental entrepreneurship has been on the rise in the direction of achieving the Sustainable Development Goals (Yasir et al. 5). According to Masurel (qtd. in Lehner et al. 5-6), green entrepreneurs are mainly motivated by two stakeholders: internal and external. Internal stakeholders include employees, management and founders while external stakeholders include the government. Entrepreneurs are motivated when they get access to government benefits provided for green businesses. Furthermore, green entrepreneurs are also incentivized to improve their firm's image (qtd. in Lehner et al. 5-6).

According to another survey by Bain & Company, Indian consumers are willing to pay over 20% premium for 'sustainable products', the highest figure across 11 countries against the average of 12% (Gupta). A survey by Rakuten Insight found that 54% of Indian consumers stated that it was very important that the products they purchased were sustainably made or environmentally friendly. Only 7% of consumers believed that sustainable consumption is not important ("Importance of sustainable products purchased in India as of February 2022"). These results underscore a growing market demand for sustainable products in India, which creates entrepreneurial opportunities for eco-businesses. Additionally, domestic banks have implemented several green initiatives to increase financial opportunities for eco-businesses. Domestic banks such as the State Bank of India, the IDBI Bank and the ICICI Bank have begun to fund renewable energy projects; SBI has a new Green Home Loan scheme to support environmentally-friendly residential projects; ICICI bank has been funding projects that contribute to the mitigation of the GHG emissions and financing clean technologies, etc. (Soundarrajan and Vivek 39). It is the very combination of personal values, accommodating environment and changing consumer demand that incentivises ecopreneurs.

Barriers for Ecopreneurship

While entrepreneurship may be glamorised often, it is not always a path to success. The journey is accompanied by several challenges and barriers that can hinder progress and delay dreams. Perceived barriers are the obstacles or difficulties that entrepreneurs face, which prevent them from achieving certain goals or objectives. The term "perceived barrier" refers to one's assessment of the difficulty of social, personal, environmental, and economic barriers in a particular behaviour or their desired goal status on that behaviour (Peng and Walid 3). Another study defined barriers as the degree to which entrepreneurs feel hampered by the institutional environment when starting their businesses (Hoogendoorn et al. 1134).

Entrepreneurs face several barriers while setting up and operating a business. Their perceptions of barriers affect their attitude towards entrepreneurship negatively, influencing their choices while making decisions. It is important to consider these barriers that prevent the growth and development of new entrepreneurial ventures in order to change an entrepreneur's negative perceptions (Kanu 35). Research conducted in the various management institutions under the University of Pune surveyed 500 management students to identify potential barriers to choosing

entrepreneurship as a career choice. Some of the common barriers were huge requirements of capital, lack of entrepreneurial experience, which could lead to failure, availability of labour with proper skill sets, and high corruption (Pahurkar et al. 5610). Another literature review highlighted similar barriers to entrepreneurship, especially SMEs, such as lack of access to finance, lack of proper knowledge, lack of skilled workers and management skills, economic influences, and corruption (Kanu 35-39). Starting up a business involves high risk, and these barriers demotivate individuals from pursuing entrepreneurship.

Author(s)	Identified Barriers
Pahurkar et al. (entrepreneurship)	Huge requirements of capital, lack of entrepreneurial experience, availability of labour with proper skill sets, and high corruption
Kanu (entrepreneurship)	Lack of access to finance, lack of knowledge or information, lack of skilled workers and management skills, lack of infrastructure, economic influences and the market, cultural and social barriers, and corruption
Linnanen (ecopreneurship)	New market creation, financing barriers, and ethical justification for existence
Lehner et al. (ecopreneurship)	Cultural-structural barriers - Assumed little benefit, not considering threat reduction, unawareness of individual impact, perception of unnecessary work Resource barriers - lack of human resources, lack of financial resources, lack of time, and lack of sustainability knowledge

Table 1: Studies on barriers to entrepreneurship and ecopreneurship

Moreover, ecopreneurs also face huge financial barriers due to the lack of public funding for sustainable SMEs. There is a high risk associated with green businesses, like entrepreneurship, due to the challenge of creating a new market. Compared to entrepreneurship, there are a few differences in the barriers to ecopreneurs. According to a framework proposed by Linnanen, there are three main barriers to ecopreneurs: the challenge of market creation, financing barriers, and ethical justification for existence. He argues that ecopreneurs face a challenge due to the lack of awareness among target customers, unfamiliarity with green businesses among investors to gain funding, and complicated business operations as a result of high ethical standards (Pachaly 10-12). Another researcher highlighted that the barriers for SMEs to become more environment-friendly can be categorised into cultural-structural barriers and resource barriers. While cultural-structural barriers refer to the entrepreneur's attitudes, opinions

and assumptions like assumed little benefit, not considering threat reduction, unawareness of individual impact, and perception of unnecessary work, resource barriers look at the resource constraints that are restricting SMEs from being more environmentally sustainable such as lack of human resources, lack of financial resources, lack of time, and lack of sustainability knowledge (Lehner et al. 8-9).

Methodology

The methodology used in this study required the administration of an online survey that collected insights from environmental entrepreneurs based in India in 2024. Consisting of four different sections and 22 questions in total, the survey was designed to gather information regarding the respondent's demographics, entrepreneurial attributes, and perceived incentives and barriers within their ecopreneurial pursuits. Prior to full-scale deployment, the survey was pre-tested with a small group of respondents. This pre-testing phase intended to identify and rectify any possible deterrents, biases, or ambiguities for participants, thus improving the instrument's reliability. The target audience for this survey was environmental entrepreneurs situated in India. Respondents were selected based on their company's activity and its contribution towards the environment. The survey was shared in a local zero-waste Whatsapp group in Hyderabad (a city in South India) and the following keywords were included in a Google search: "ecopreneur"; "social enterprise"; "environmental cause"; "India"; "environmental businesses"; "non-profit organisations". Companies and self-employed ecopreneurs were selected based on their short "about" page and contacted through email, LinkedIn, and Instagram. However, only 10 forms were filled. The low response rate could be a result of a lack of time to complete the form, disinterest towards participating in the study, or lack of incentive. Participation could have been improved by offering incentives, expanding our potential base of respondents, and refining survey distribution channels. Unfortunately, resource constraints prevented the implementation of incentive mechanisms. Consequently, the target audience was expanded to include non-profit organisations committed to environmental sustainability and conservation.

The survey instrument, itself, was divided into four sections. The complete list of questions is included in the appendix. The purpose of the first section was to explore the demographic variables of the ecopreneur, such as age group, gender, and income, to identify potential relationships between their perceived incentives and/or barriers with these variables. The second section aimed to explore the entrepreneurial attributes of the respondents, like the amount of time spent per day, the number of years since the inception of the business, and perceptions about ecopreneurship. The third and fourth sections focused on perceived incentives and barriers, respectively, through Likert-scale and open-ended questions.

Comparative insights were obtained from existing literature, specifically the methodologies employed by Sindhu et al. (316-317) and Mukonza (9-10). The study conducted by Sindhu et al. gathered data from entrepreneurs through an online questionnaire sent to several email IDs. However, email IDs were accessed through an alumni-base while the present project

accessed email IDs from websites and Google searches. Another study in South Africa (Mukonza 9-10) used a 5-step approach, which includes several primary research methods like interviews, questionnaires, observations, and focus group discussions. Similar to our study, questionnaires were sent to everyone through email. However, in Mukonza's study, respondents were contacted by telephone, which increased their response rate. Furthermore, ethical issues were taken into consideration and participants were informed that their information would be used for a research study, their anonymity and confidentiality would be maintained and that the study adhered to data protection regulations.

To analyse the data, first, descriptive statistics were employed to summarise key findings, providing an overall view of the participant's perceptions, entrepreneurial attributes, and insights on ecopreneurship. In addition, the data was subjected to cross-tabulations, using suitable statistical methods, allowing to investigate relations between various demographic variables, entrepreneurial attributes, and perceived incentives and barriers among ecopreneurs. Qualitative data from open-ended questions was analysed through thematic analysis, facilitating the identification of repetitive patterns in the participant's responses. Statistical tests such as chi-square test of association, ANOVA (Analysis Of Variance) for Likert-type questions and categorical variables couldn't be conducted as a result of the low response rate. Thus, data was triangulated to build reliability and compensate for the low response rate. This combined approach for data analysis ensured a better understanding of the respondents' answers and enabled the identification of important insights relevant to the study's objectives.

Results and Discussion

This paper investigates the underlying incentives and disincentives of an individual's decision to engage with ecopreneurship in India. To explore these factors, an online survey was employed and sent to environmental entrepreneurs in India through email and other social media platforms. This section will discuss the insights gained from the survey through the combination of open-ended and closed-ended questions, employing methods such as cross-tabulations and thematic analysis.

Out of the 140 ecopreneurial ventures and non-profit organisations contacted, only 16 participated in the study, resulting in a low response rate of 11.4%. Of these respondents, 56.2% identified themselves as male, while 43.8% were female. Around 43.8% of the respondents were between 30-39 years of age and 46.7% considered themselves middle-income, earning between ₹5 lakhs to ₹15 lakhs per year.
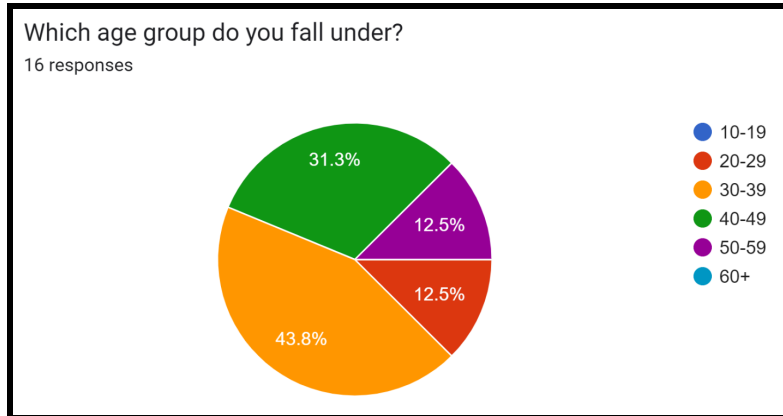
Figure 1: Age group of the respondents of the survey
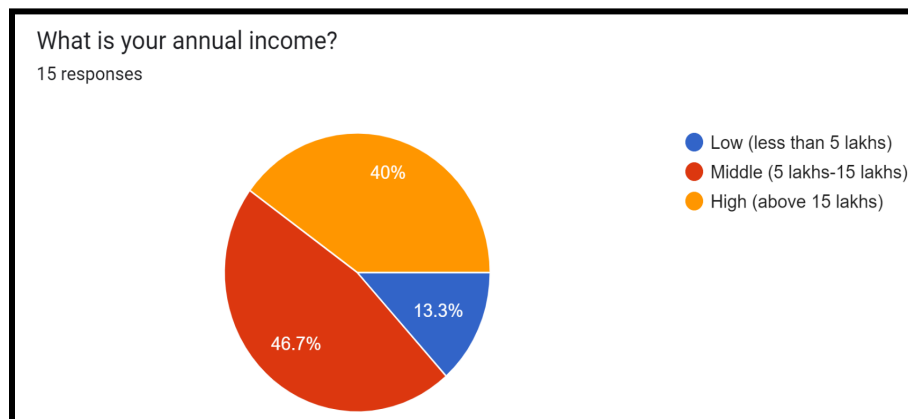
Figure 2: Income levels of the respondents of the survey

While investigating the entrepreneurial attributes of the respondents, we hypothesised that there would be an inverse relation between the number of hours worked daily on the business and the number of years it has been since the business started, assuming that a more established business would suggest lower working hours, although this has not been confirmed by empirical research. However, after conducting cross-tabulations, no evident association was found between these two variables. It may be interesting to investigate whether the size of a business and working hours are related in future research, as this was beyond the scope of the present study.

How long has it been since you started your business?	How much time do you spend per day on your business?	COUNTA of How long has it been since you started your business?
1-3 years	1-4 hours	1
	5-8 hours	2
	8+ hours	3
1-3 years Total		6
3-5 years	5-8 hours	1
	8+ hours	3
3-5 years Total		4
5+ years	5-8 hours	2
	8+ hours	3
5+ years Total		5
less than a year	1-4 hours	1
less than a year Total		1
Grand Total		**16**

Table 2: Cross-tabulation of "number of years since business was established" and "amount of time spent per day on business"

Perceived Incentives

An interesting finding from the perceived incentives section seemed to relate to the responses towards the Likert-scale questions. The majority of the Likert-scale questions from this section capturing information about incentives are neutral. This neutrality shows that respondents are uncertain about how incentives provided by the government could improve their business operations. On the other hand, it can also suggest a lack of interest in incentives in order to avoid the involvement of third parties within their businesses. The only question where participants show greater agreeableness seems to be about direct financial subsidies. There is a greater preference for direct financial modes of support, compared to non-financial. The results show that entrepreneurs would prioritise their autonomy over anything else in order to maintain their locus of control (LOC) in the business. Non-financial support would have a negative impact on their LOC, thus leading to those neutral responses. It is only material (financial) resources that they seem to be lacking. Thus, the results from the Likert-scale questions show that the respondents do not prefer anything that intervenes with their own aims, operations of business, regulatory frameworks, etc.

The Stand-Up India scheme implemented by the Indian government in 2016 provides lower caste citizens with a bank loan between ₹10 lakhs (12,000 USD) and ₹1 crore (112,000 USD) for establishing a greenfield enterprise, a first-time venture in the industrial, services, or trading sector ("Stand - Up India: STANDUP INDIA SCHEME FEATURES"). According to the survey's results, this scheme would be preferred by ecopreneurs due to their interest in direct financial aid. Furthermore, the StartUp India Seed Fund Scheme (SISFS) provides entrepreneurs funds to develop their proof of concept and prototype with a total outlay of ₹945 crore (113,160,000 USD) ("About Startup India Seed Fund Scheme"). The SISFS would also help incentivize ecopreneurs as a result of the availability of direct financial support. The Indian government also introduced a scheme known as ASPIRE (A Scheme for Promotion of Innovation, Rural Industries, and Entrepreneurship), which aims to establish a network of technology centres and incubation centres to promote entrepreneurship ("ASPIRE"). There may be a lack of interest from ecopreneurs for this scheme due to their disinclination towards non-financial support that may interfere with their business's functioning.

Moreover, many respondents confirm that ecopreneurship is a 'value-driven' sector. A literature review by Khan et al. (70-72) discusses how social entrepreneurship is focused on creating social and environmental value and thus, can be used as a method to challenge environmental and social problems. It creates value for society and also brings returns. A case study (Pless 450-451) of Anita Roddick, founder of Body Shop, highlights how responsible leaders are driven by a value-based vision and how their sense of responsibility is rooted among values that have been developed by the influence of life experiences and people. Ecopreneurs can be considered responsible leaders due to their commitment towards environmental values. Several ecopreneurs in the present study mentioned in the open-ended questions that they were motivated by "the blessings they get when they see results"; their "son"; "finding joy and meaning in what they do"; their "love for nature"; and "passion for forest conservation". One of the respondents even mentioned that they "needed to live a life more congruent to their environmental and social justice values". Despite being driven by values, financial injections from the government for their ventures would be encouraged.

Perceived barriers

Most respondents believe that sustainable businesses incur operating costs as they pay a price for sticking to their ethical standards. This is the price of practising ethical ecopreneurship and the price of not engaging with greenwash practices. This shows the tradeoff between profitability and their sustainable mission, where businesses involved in eco-friendly practices struggle with higher expenses. Some of the respondents expressed this concern through the open-ended questions by mentioning that they face "financial challenges"; there are "high costs of research"; "high costs of organic agriculture" and "high logistics cost"; "patent capital is expensive"; and that there is a "cash crunch with farmers". These voices add to the results from the Likert-scale questions about sustainable businesses and their high production costs.

Furthermore, the respondents think that a major cause of their troubles is beyond their own control, namely the need for sustainability awareness among consumers. Through the open-ended questions, numerous respondents highlighted that there is a "lack of consumer awareness"; "awareness among individuals, communities, and government" is needed; "only have to bust myths"; and that the "market is the limiting factor today". Ecopreneurs would encourage some government intervention to raise awareness as long as this is not directed to their own business/operation. They stated that the government should "educate youth more"; "focus on stringent measures"; and improve "public awareness" among consumers. Thus, awareness seems to play a significant role in decision-making for ecopreneurs. However, further research can investigate whether this unfamiliarity can be attributed to a lack of awareness among the general consumer public or if it is a question of whether environmentally sensitive consumers lack the financial means to engage with eco-businesses.

Conclusion

Ecopreneurship is a field of entrepreneurship that is based on the environmental objectives of the business and sells green products and services to its customers. The study aimed to identify some perceived incentives and barriers for ecopreneurs to offer insights that support ecopreneurial leadership. As a result, the study explored factors that could motivate or disincentivize them. The results of the study revealed that ecopreneurs responded with neutrality to incentive-based questions and prioritised direct financial support over non-financial support from the government. This shows that they do not prefer non-financial government support that could interfere with their own business operations and would, instead, like to maintain control over their venture. Thus, they only seem to lack the financial resources required to run their firm. Moreover, the study discovered that ecopreneurs face high costs for conducting their operations virtuously. As a result, this creates an opportunity cost between profitability and their sustainable mission. Thus, the government should introduce schemes targeted towards ecopreneurs, such as providing subsidies, grants, and tax breaks to ease their financial challenges. The government could also increase investment in sustainable infrastructure like renewable energy projects, recycling facilities, and eco-friendly transportation as mentioned by one of the respondents in the survey.

Adding on to their preference for monetary support, the study showed that lack of awareness among consumers is a huge barrier for ecopreneurs. This obliviousness has limited the market size for these firms. Consequently, the government should implement more policies and campaigns focused towards promoting and increasing awareness about some of the steps that citizens could take to better the environment. The government can implement awareness programs specifically for the youth by integrating them into the school curriculum. In addition, the government can introduce regulatory frameworks to incentivize circular practices in the economy as reported by one of the respondents from the present study. Researchers can further investigate the cause for this lack of awareness and whether it can be attributed to the lack of financial means to engage with eco-businesses. Furthermore, the study confirmed that ecopreneurs are driven by the social and environmental values associated with their venture.

These values motivated them to start their business and help address societal and environmental challenges. By supporting ecopreneurs, we are helping to improve the economy through an increase in the output of sustainable products, mindful use of resources during production, and promoting awareness about sustainability among consumers. Thus, empowering this segment of entrepreneurs is important as they can contribute to achieving broader societal and environmental goals.

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Union Activity Over Forty Years By Aryan Shah

Abstract

       The year twenty twenty-three was a record-breaking year for union activity. To help understand why 2023 was an important year for union activity, we must look through a historical context at how unions have changed throughout the past forty years. In this paper, I analyze data from the Current Population Survey and conduct a literature review. Through my analysis, I conclude that Right-to-Work laws, social dynamics, and economic pressures are important factors explaining changes in unionization in the United States.

Introduction

       2023 was a record-breaking year for union activity, with approximately 460,900 workers participating in thirty-three major work stoppages (Poydock 2024). This is the most work stoppage in more than two decades and more than three times the number of workers striking as in 2022, portraying a strong year for union activity as a whole. Last year, the economy's record-breaking number of strikes included enormous work stoppages from big names like Verizon workers and Hollywood actors to smaller workplaces. Both of these major stoppages paralyzed their individual industry for months. In 2023, the first ever simultaneous work stoppage also occurred against the big three Detroit automakers (General Motors, the Ford Motor Company, and Chrysler) in the history of the United States (Boudette 2023). Not only were these work stoppages historic, but so were the wage gains and the new protections that had to do with new technologies such as artificial intelligence and electric vehicles. To understand the full context of what causes people to form and join unions, this paper studies the issue from a historical perspective rather than just the last five years. Figure 1 shows us that before the recent period, from 1940-2017, where the graph ends, union membership decreased substantially after rising from 1920 to 1940.

Figure 1
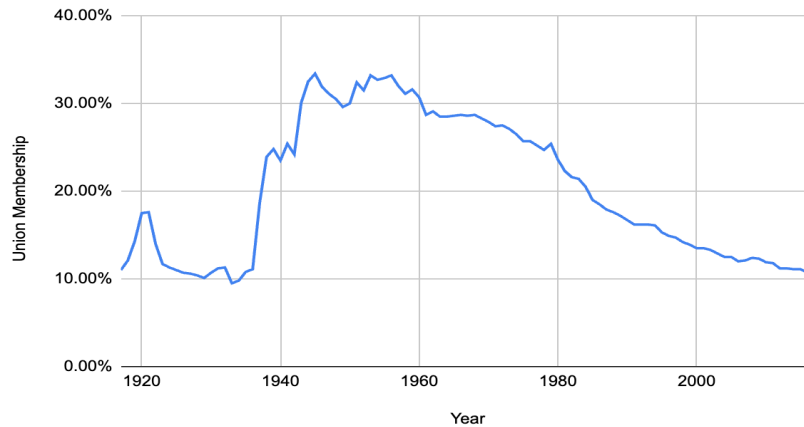
Note: Percent of workers in a union over time from 1917-2017. Source: Piketty (2017)

In this paper, I will explore the factors contributing to union activity. There are many factors from the political, social, technological, and economic domains. The manufacturing and service industries have seen significant changes as a result of economic globalization, including a noticeable drop in unionization rates. This movement is supported by growing corporate dominance that is undermining strong unions. Right-to-work laws have become crucial because of their impact on all unions. Technological developments are a double-edged sword: they have created new job opportunities and increased efficiency, but they also put existing employment patterns under pressure and could undermine unionization efforts. Furthermore, the changing societal perceptions of unions and the variety of the workforce highlight the dynamic social environment in which unions function. These elements interact in complex ways, affecting union activity differently across geographical regions of the United States, as evidenced by variances in unionization between the West and East Coasts and across different states. Understanding these dynamics is vital in order to comprehend the current condition and future trajectory of union activities.

Political: Right-to-work laws
One factor that has contributed to declining unionization is the Right-to-Work laws enacted in many states. Right-to-work laws, which originated with the Taft-Harley Act, have increased especially over the past forty years.

Figure 2
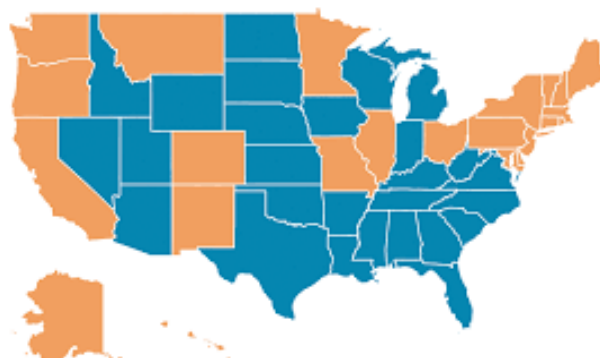
Note: This table shows which states have Right-To-Work laws. Blue: Yes, Right-To-Work Law. Orange: No, Right-To-Work Law. Source: (wisevoter.com)

Right-to-work laws allow workers to work for an employer without being members of a union. These laws are based on the principle that gives workers the right to decide whether or not they want to join or financially support a union. Twenty-seven states have passed this legislation (see Figure 2).

The idea behind Right-to-Work laws is to ensure that employment is not dependent upon union membership or the payment of their dues. This gives workers the freedom to associate with unions. Many often see these laws as promoting individual worker rights, which contribute to a more flexible labor market. The term "flexible labor market" usually refers to a labor market where workers are free to devote their services in response to a change in their wages (Kenton 2023).

To fully grasp how Right-to-Work laws came into play, we will have to look back in history. The origin of Right-to-Work laws in the United States dates back to the 1947 Taft-Hartley Act, which amended the National Labor Relations Act (NLRA) of 1935 (Munck 2024). The National Labor Relations Act (NLRA) of 1935, also known as the Wagner Act, established the rights of workers to organize unions and take collective action such as strikes. It also created the National Labor Relations Board (NLRB) to oversee and enforce labor relations in the United States. However, by the mid-1940s, there was some skepticism among some business leaders and the general public concerning labor unions becoming too powerful. Widespread strikes led some to argue that unions were harming the economy. In response, the Taft-Hartley Act was passed, aiming to balance the rights of labor and management. It restricted the activities and power of labor unions through several requirements, including prohibiting closed shops (where only union members can be hired), permitting states to pass Right-to-Work laws that outlaw union shops (where workers must join the union after being hired), and establishing the federal government's right to intervene in strikes that pose a national emergency. This act marked a significant turning point in the United States labor policy, reflecting a more cautious approach towards union power and setting the stage for today's landscape.

In the past forty years, there has been a notable increase in the number of states adopting Right-to-Work legislation. These laws tend to be adopted by more conservative legislatures. Proponents argue that by offering a more flexible labor market and cheaper labor costs, Right-to-Work legislation boosts economic growth. However, opponents claim that these laws weaken labor unions, reduce the power of collective bargaining, and result in lower employee salaries and benefits.

The impact of Right-to-Work laws on union activity is multifaceted. These laws have been seen to have caused a decline in union membership rates in the states where they are enacted (Fortin 2022). Unions struggle to maintain membership levels and secure funding because they are unable to demand dues or membership from every employee represented in collective bargaining. This has decreased unions' ability to negotiate with employers effectively, advocate for workers' rights, and engage in political rallying. On the other hand, in order to increase attempts to attract and keep members, several unions have focused on showcasing the tangible benefits of union membership. Furthermore, the resistance to Right-to-Work legislation has sparked alliances between political allies, unions, and workers' rights groups, advancing a larger movement for economic equality and labor rights (Reed 2023).

Right-to-work legislation has a significant role in the environment of union activity and reflects broader changes in economic policy and labor relations. Their effects over the past 40 years highlight the necessity of continuing research and discussion regarding the most effective strategies to strike a balance between the interests of businesses, employees, and society at large. The lessons from the past of Right-to-Work legislation will surely guide our efforts going forward in the fight for economic justice and workers' rights.

Political: Differences between public and private sector unions

Over the past forty years, significant changes have been brought about by globalization, technical breakthroughs, changes in economic policy, and adjustments in the dynamics of the labor market. Differentiating between unions in the public and private sectors, each with unique goals and working environments, is essential to comprehend these changes. This portion of the paper attempts to investigate these variations as well as the elements influencing the development of union activity in both industries.

The move from manufacturing to service-based economies has contributed towards a decrease in union membership. Union activity has been significantly impacted by this shift. Union density has decreased in the private sector as a result of the fall of manufacturing jobs, which are frequently highly unionized, and the emergence of high-tech and service-oriented businesses, which are usually less unionized.

Public sector unions include teachers, firefighters, and police officers, among the workers that public sector unions represent. The ability and goals of public and private sector unions to bargain is one of the biggest distinctions between them. Unions in the public sector bargain with the government, which is not motivated by financial gain. As a result, the effects of negotiation outcomes go beyond the workforce and have an impact on public policies, services, and budgets.

Furthermore, the public sector bargaining legal framework and cultural expectations frequently highlight the continuation of critical services, sometimes restricting strike actions or placing them under particular legal restrictions.

Private sector unions interact with privately held companies and enterprises. These unions work in a market-driven setting where pressures from competition and profitability have a big impact on the dynamics of bargaining. In contrast to the public sector, private sector collective bargaining and strikes have a direct impact on a company's bottom line, influencing distinct strategies and results. Additionally, the possibility of employment relocation to less expensive areas or nations is a problem that private sector unions must deal with; this is a problem that public sector employees are less affected by.

The public's opinion of public sector unions' roles and their level of political engagement also vary. Given their close ties to public spending and programs, public sector unions are frequently more noticeable in political discussions. Because of their prominence, they may become the focus of political campaigns and budgetary measures meant to cut back on government spending and size. Unions in the private sector, on the other hand, might concentrate more on matters pertaining to their particular industry, such as labor legislation and trade regulations. With a few notable exceptions, economic globalization, technical developments, and modifications to labor laws have altered union activity and made it challenging to organize private-sector unions.

Knowing the differences between unions in the public and private sectors is essential to comprehending the dynamics of the labor movement and union operations over many years. These variations, which are formed by different situations, demonstrate how flexible the labor movement is in a changing workplace.

Geographical: Migration

Migration has been a pivotal force in shaping labor movements and union activity globally. As workers cross borders in search of better opportunities, they bring with them not only their skills but also their experiences. These experiences usually include their struggle against exploitation and inequality. This portion of the text delves into how migration affects union activity and reshapes labor movements in the context of a global economy.

The influx of migrant workers into a country or industry often leads to the revival of union activities. The United Farm Workers (UFW) in the United States and César Chávez's initiatives are two examples of how the migration of migrant workers has historically sparked a revival of union organizations. As a migrant farmworker himself, Chávez took advantage of the growing numbers and unhappiness of migrant workers in the mid-20th century to fortify and organize the UFW. This union sought to raise the pay and working conditions for farmworkers, many of whom were immigrants who had to make do with subpar living conditions and exploitation. The UFW secured higher wages and safer working conditions for migrant farmworkers by drawing national attention to their situation through nonviolent strategies like marches, boycotts, and strikes. This case highlights the possibility for good change in labor

rights and circumstances by showing how the influx of migrant workers could revive union activities (Pawel 2013).

Throughout the past forty years, migration has had a significant impact on labor markets and the tactics used by unions to defend the rights of their members. Globalization and major geopolitical changes in the 1980s caused a surge in migration. Labor markets were largely unprepared for the influx of migrant workers, who were either fleeing political unrest or in search of better prospects. These workers were initially hard for unions to integrate since they were frequently employed in union-difficult-to-join industries like construction and agriculture (McNicholas 2020). With the start of the twenty-first century, there were significant shifts in the environment surrounding union activity and migration. Migration flows increased as a result of the pace of globalization and the growth of organizations like the European Union, which promoted labor mobility. Due in large part to the fact that native worker membership was dropping and migrant worker numbers were increasing, unions around this time started to adjust and realized that integrating migrant workers into their ranks was imperative. Offering services in a variety of languages and focusing on concerns unique to migrants, like discrimination and legal difficulties, were among the initiatives undertaken.

The interaction between union activity and migration has become even more complex in recent years. Due to the extraordinary levels of migration brought about by the global refugee crisis and political unrest, unions are finding it difficult to effectively fight for a more diverse workforce in the face of growing nationalism and anti-immigrant sentiment. Despite these obstacles, unions have shown creativity by partnering with community organizations and migrant organizations to advance policies that help migrant workers' rights (Lee 2023).

Technological: Rise of New Tech (disadvantages for unions)

Over the past four decades, the technology landscape has undergone significant transformations, impacting various societal aspects, including labor and union activity. The introduction of new technologies has had both positive and negative effects on the labor movement. While advancements have led to improved efficiency and the creation of new job sectors, they have also presented challenges. This portion of the text explores the negative impacts of new technologies on union activity, focusing on automation, the gig economy, and the digitalization of the workplace.

Robotics and artificial intelligence-driven automation have completely altered the nature of labor, eliminating jobs in historically union-heavy sectors like manufacturing, shipping, and service industries (Smith 2014). Not only have traditional occupations been lost as a result of this transformation, but the jobs that remain now need to be more skilled and technical. Consequently, the industries that unions have historically represented have shrunk, which has reduced union membership. In addition, unions' capacity to bargain for improved pay, job security, and working conditions has been undermined by the automation-driven corporate agenda, which contributes to inequality.

The rise of the gig economy, driven by online marketplaces such as TaskRabbit, Uber, and Lyft, creates an additional technological challenge to labor union activity. Unions face considerable obstacles due to the unstable nature of gig employment, which is characterized by unpredictable compensation and a lack of job security. Unions' ability to successfully represent gig workers and advocate for their rights is challenged by the differences between gig labor and regular employment systems. Moreover, new obstacles to union organizing have been brought about by the digital change in the workplace. The adoption of digital communication tools, remote work policies, and digital surveillance technologies has changed workplace dynamics, affecting unions' ability to engage with and organize their members. The reliance on virtual interactions can restrain traditional union organizing efforts, which often depend on physical proximity and face-to-face meetings to build unity. Additionally, the use of digital surveillance by employers can intimidate workers, preventing them from participating in union activities for fear of retaliation.

In conclusion, the beginning of new technology over the last forty years has posed significant challenges to union activity. The rise of automation, the gig economy, and the digitalization of the workplace have contributed to a decline in union membership and activity. These developments have raised concerns about job security, income inequality, and the overall nature of work, prompting unions to adapt their strategies. To address these challenges, unions must embrace new tools and approaches to advocacy and organizing, ensuring that the benefits of technological advancements are more equitably distributed and that workers' rights are protected in an evolving economic landscape.

Technological: Rise of New Tech (opportunities for unions)

Technology has had an enormous effect on union activities over the last forty years, bringing in a new era in the interaction of labor activity and technology. The beginning of the technology revolution has changed the nature of work and how unions function, interact with members, and defend the rights of employees. This portion explores the complex ways that technology affects union operations, highlighting how it can improve advocacy efforts, member participation, and organizational effectiveness.

A wide range of tools and platforms brought about by the internet era are revolutionizing communication within the labor movement. Meeting, gathering, and strike-planning has become much easier with the rise of social media, online forums, and messaging apps. When it comes to workplace difficulties, unions can mobilize members quickly thanks to the instant nature of digital communication, which improves the responsiveness and agility of union actions. A prime example is the 2018 teachers' strikes in the United States, often called the "Red for Ed" movement. Technology also makes data-collecting, analysis, and distribution easier, giving unions the ability to negotiate with companies using solid evidence. Big data analytics give unions a strong platform on which to advocate for better wages, benefits, and working conditions by giving insights on industry standards, workplace conditions, and salary patterns (Hammerling 2022). Furthermore, the rise of online discussion and negotiation platforms facilitates the

globalization of the labor market by bringing participants from various physical places together. Technology has also completely changed how union members participate and engage. Members can vote on important issues, participate in conversations, and keep up to date on union activities through digital platforms that have dynamic and user-friendly interfaces. This strengthens the sense of community and solidarity among members. In conclusion, the incorporation of technology into union operations over the past four decades has largely had favorable results, changing the ways in which unions organize, engage, and represent the interests of their members.

Social: How does workforce diversity affect union activity?

Today's labor markets are seeing an increase in the diversity of their workforce, which reflects broader societal movements towards inclusion and equality across a range of dimensions, including race, gender, ethnicity, and sexual orientation. This paper investigates the relationship between workforce diversity and union activity, especially in light of the main research topic on the origins of union activity and how it has changed over the last 40 years.

Unions faced a lot of criticism in the past for their lack of inclusivity, since their membership and leadership did not adequately reflect the varied workforce that unions aimed to represent (Roach 2022). But union aims and tactics have changed along with the expectations of society about diversity and inclusion. The expansion of union objectives is one of the main ways that a diverse workforce influences union action. Unions are realizing more and more that their diverse membership has a range of needs and concerns, not just traditional economic ones.

Diversity in the workforce can also boost union participation by increasing the pool of potential members. A varied workforce gives unions a chance to become more relevant and appealing to a larger range of workers. Unions can draw members who may have previously felt disadvantaged or underrepresented by aggressively promoting diversity and inclusion among their ranks and leadership. Since a wider range of workers are represented, this inclusivity not only strengthens the union's unity and power but also increases its negotiating leverage with employers.

Diversity in the workforce does not, however, come without difficulties for union activities. Because members of diverse workforces may have different objectives and interests depending on their individual backgrounds and experiences, diversity can also cause fragmentation within unions. Because of these differing viewpoints, unions must negotiate intricately within their own ranks before putting on a united front for employers. To keep union activities cohesive and effective, these internal dynamics must be effectively managed.

The correlation between union participation and employment diversity over the past four decades is reflective of broader cultural shifts. The growing recognition of diversity and inclusivity as crucial social values has impacted labor union strategy and agendas in addition to workplace regulations. Unions' ability to adapt to the changing requirements of its membership will always be crucial to their continued relevance and efficacy as society changes.

Social: Public opinion and attitudes towards unions

Over the past 40 years, public opinion and views about unions have significantly shaped union activity. The public perceptions of unions and media representation impact union activity. Understanding these social elements is essential to understanding the dynamics that underlie in union activity and how it has changed over time.

By the late 20th century, most people believed unions were vital guardians of workers' rights, promoting fair pay, manageable hours, and safer working conditions (Bahn 2022). Because public support served as the backbone of union campaigns and strikes, this positive image helped to contribute to high levels of union membership and involvement.

In addition, the way that unions are portrayed in the media has a big impact on public opinion. Public support for unions has decreased when they have been portrayed as restrictive or obstacles to economic advancement. Public support for unions in the United States declined in the 1980s because they were frequently portrayed as obstacles to economic expansion and competitiveness. This was especially true during the 1981 air traffic controller strike, which resulted in President Reagan firing nearly 11,000 striking employees (Rosentiel 2011). The reputation of unions has been damaged by unfavorable media coverage, which frequently highlights incidents of corruption in union leadership or disruptive strikes. An example is that like the 1981 air traffic controllers' strike in the U.S. shows how media portrayal can sway public opinion against unions (Green 2019). Similarly, coverage that focuses on union demands without contextualizing the workers' conditions or the inequalities they aim to address can lead to a skewed public perception.

Laws and political environments have a significant impact on how the general public feels about unions. Governments that support labor generally pass laws that strengthen unions, strengthening public view and encouraging union activity. On the other hand, governments that support business interests and reform may create a climate in which unions are negatively seen. Legislation that weakens union power or increases the barriers to unionization has a direct effect on public opinion by portraying unions as less important or advantageous. Younger workers have shown a continued interest in unionization in recent years, especially in non-traditionally unionized areas like technology and services. This change reflects a shift in public opinion toward unions, which may be brought about by rising income disparity, unstable employment, and worries about workers' rights in the gig economy. Interest in joint bargaining and unions as tools for achieving justice and equity in the workplace has revived in part due to the public's rising consciousness of and support for social justice movements.

Economic - Globalization

Over the past forty years, globalization has had a substantial impact on union activity by changing the labor market, employment trends, and labor laws and norms. The global integration of markets has resulted in increased competition and the outsourcing of jobs to countries with cheaper labor costs, which is one of the main factors influencing changes in union activity. This trend, along with the end of traditional, unionized sectors and the increasing occurrence of

insecure job situations, has put pressure on unions to change their tactics in order to keep the rights of their members. Due to the promotion of labor market flexibility, frequently at the expense of job security and workers' rights, these policies have reduced the bargaining power of unions. Due to the scattered nature of service sector jobs and the dominance of contract or part-time labor, unionization has become more difficult as the economy has shifted towards a service-oriented one.

On the other hand, globalization has also given unions unusual opportunities for international agreement and collaboration despite these obstacles. Global union networks and alliances have grown over the past 40 years, allowing labor movements to promote just labor laws and practices worldwide. Unions seek to prevent the race to the bottom in labor standards and create a fairer global labor market by utilizing their global platform, a prime example of this being the International Trade Union Confederation.

In summary, union activity has faced tremendous obstacles and exceptional potential due to globalization. Understanding these processes plays a pivotal role in changing union tactics, guaranteeing that the progress of labor movements corresponds with workers' concerns globally.

Economic- Manufacturing and services
Over the past 40 years, there have been significant changes to the manufacturing and service sectors of the U.S. economy, which have had an effect on union activity in several ways. Traditional unionized jobs have declined in the industrial sector due to automation and the movement of production plants to nations with cheaper labor costs. Due to the loss of positions essential to the union's strength, union membership has decreased. On the other hand, the service industry has grown, but union organizations have difficulties because of the nature of these positions, which are frequently contract or part-time. Figure 3 provides evidence for this: it displays five example industries, showing the unionization rate in Transportation is three times that of healthcare and eight times that of real estate, while the rate in mining is four times that of real estate.

<div align="center">Figure 3</div>
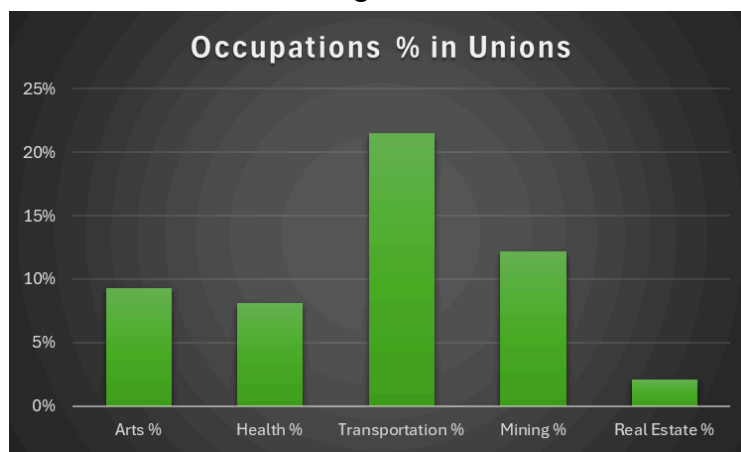
Note: This chart displays five different occupations and the % of their workers in unions. Source: Current Population Survey (via IPUMS).

These developments have also forced unions to adjust, concentrating more on uniting workers in the service industry, promoting raises in the minimum wage, and fighting for better working conditions. Thus, the economic foundations of these industries have a significant impact on the variables that shape union activity, affecting strategies and focal points. This evolution is a reflection of the larger economic trends that have redefined the field of union activity, including technological advancement, globalization, and the shift to a service-oriented economy.

Economic- Rising corporate power

Growing corporate power has a big impact on union action and gives labor movements opportunities as well as obstacles. Corporate power over the economy and politics has grown over the past 40 years as a result of globalization. This change has weakened traditional unions in manufacturing and the public sector by bringing about outsourcing and the adoption of anti-union policies. Furthermore, because multinational firms frequently operate in many legal and regulatory settings, their growth has increased the complexity of organizing and bargaining.

This expansion of corporate power has also sparked union activity in previously untapped markets. Workers in the gig economy, technology, and service sectors—sectors where union participation was once minimal—are becoming more interested in unionization as a result of the widening gap between executive income and worker earnings and the increase in job instability. As a result, unions are adjusting by utilizing digital methods for organizing and focusing on more general social justice problems in order to encourage agreement throughout various industries. The labor movement has demonstrated its adaptability and durability through the evolution of union policies in response to growing corporate power. This evolution is a reflection of the dynamic interaction between labor activism and economic factors.

Conclusion

The United States saw a notable revival of the union movement in 2023, marked by historically high levels of worker participation and work stoppages. This comeback is a reflection of the many forces that have shaped union action in the last forty years. Economic, social, technological, and political factors have all been crucial in determining how unionization has developed. The political environment and the spread of Right-to-Work legislation have had a significant impact on union membership and strength, resulting in more union support across the nation. Social developments have made it necessary for unions to adopt adaptable techniques in order to be relevant and effective. These changes include changes in the makeup of the workforce and how people view unions. Both opportunities and problems have been brought about by technological improvements, which have put traditional occupations in jeopardy and opened up new areas for union activity, particularly when it comes to wage increases and protections for newly developing technology. Globalization and corporate supremacy have changed traditional industries economically, making it difficult for unions to work in a market that is changing quickly. The extraordinary events of 2023—which included historic wage and

technology protection discussions and significant strikes affecting both large and small workplaces—highlight the adaptable and strong character of unions in the front of these difficulties.

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<center>**Nuclear Reactions By Joshua Tsang**</center>

Abstract

  Nuclear reactions are the primordial construction of our universe. All matter is divided into particles. These particles composite into groups, and they ultimately are stabilized by the fundamental forces—powerful forces of the universe that convince us that matter is solid. The interactions between each fundamental force create a subtle rift in the nature of particles. In addition, the behavior of nature at and below the scale of basic particles proves to be strange, impossible, or paradoxical. Considering the basic composites of particles, a nuclear reaction involves breaking reality—penetrating barriers created by the fundamental forces. Nuclear reactions rely on even more complex concepts entailing energy distribution, simultaneous properties, and of course, the probability of breaking reality. Nuclear reactions break composite particle groups apart into new groups, so they require massive energies to trigger and/or sustain. The energy conserves, accounting for the new particle groups. To the final extent, nuclear reactions yield massive explosive force, as they are the basic power of the universe.

I. Introduction

  Humans exist because of the sun; the sun and all the other stars exist because of nuclear reactions. Nuclear reactions are fundamental, but in turn, they exist because of subatomic forces. They exist in many forms and happen everywhere all the time. They are confusing. What are nuclear reactions; why, where, and how do they occur? There are five sub-topics to understanding nuclear reactions coherently: the particles, fundamental forces, quantum mechanics, nuclear reaction processes, and special relativity.

Particles

  All matter is made of particles. The most essential particle is the atom—the basic building block of matter—which is grouped with another or more atoms into molecules. Every atom is mostly empty space, but they contain three types of particles: protons, neutrons, and electrons. Protons have a positive charge, neutrons have no charge, and electrons have a negative charge. Atoms are distinct with the amount of protons in them, so each has an atomic number corresponding with the count of protons to make up different elements. The protons and neutrons are confined in the nucleus—making them nucleons—and the electrons orbit in rings around the nucleus. Nuclei with distinct amounts of neutrons are called isotopes, which are variations that remain the same element. Isotopes are lighter or heavier atoms determined by the number of neutrally charged neutrons. Particles that are smaller than the atom are called subatomic particles. Nucleons are composite particles and they are made up of smaller subatomic particles called up and down quarks. These quarks effectively make up the "flavor" of a nucleon (proton or neutron). In a chemical reaction, atoms are being manipulated and moved around in molecules; no atoms are created or destroyed. However, in a nuclear reaction, the actual subatomic particles are interacting or changing. There are also special subatomic composite

particles called alpha and beta particles and massless elementary particles called photons. An alpha particle is made of two protons and two neutrons. A beta particle is a high-energy electron. Photons are massless particles made of energy that travels in waves. Photons are very important to understanding the quantum mechanics of particles. Other subatomic particles are not essential to understanding nuclear reactions. These are the most basic particles that are involved in nuclear reactions.

II. Fundamental Forces

There are four fundamental forces in the universe: the gravitational, electromagnetic, strong, and weak forces. Three of these forces involve and control nuclear reactions; gravity is less important on the atomic and subatomic scale (Four Forces).

Electromagnetic Force

The electromagnetic force is a long-range interaction far beyond the atomic scale that makes opposite-charged objects attract and like-charged objects repel. The electrostatics make the protons repel each other in nuclei, but a strong force overcomes this. Electromagnetism primarily acts in nuclear reactions through Coulomb's law. Coulomb's law explains how particles with like charges repel and particles with opposite charges attract each other proportionally. Charged particles have a barrier called the Coulomb barrier, and they must push through it to make nuclear reactions occur. The nucleon needs to overcome the Coulomb barrier for the strong force to fuse it into the nucleus. Electromagnetism generally works with weak interaction to emit particles from the nucleus to lower the energy states of excited nucleons. The electromagnetic force determines the dynamics between the nucleons in nuclear processes. The strong force and the electromagnetic force are dominant in nuclear reactions.

Strong Force

The strong force is the strongest fundamental interaction at the length of $10^{-15}\mu m$; for comparison, the diameter of a human hair is about 70 microns. It binds matter on an atomic and subatomic scale. It holds together particles with the same charge, binding nucleons together in nuclei. Most of the atom is empty space, but this force of attraction is strong enough to convince us that objects are solid. At this scale, the strong force is a hundred times more potent than electromagnetism. The binding effect overcomes the Coulomb force. It is a million times stronger than the weak force. Despite its power, the strong force is limited to only the atomic world. Strong interaction energy makes up the mass of nucleons. The strong force binds quarks together. Individual quarks make up only 1% of the mass of a nucleon.

Weak Force

The weak force interacts with subatomic particles to make them change or move. The weak force is most prominent in beta decay, which can happen during or after nuclear reactions. The weak force is the only interaction that causes radiation by changing the flavor of a nucleon

through quarks. The weak force can transform a neutron into a proton, switching its charge to positive. The weak force dictates the composition, stability, and formation of nuclei. This mechanism forms isotopes, which are variations of element nuclei. Radioisotopes will decay and transform into other elements. The weak force is generally involved after processes such as nuclear fusion and nuclear fission, but it still influences aspects of the various nuclear reactions. It is limited to less than the diameter of a proton, but it works with the Coulomb force to move particles around. The weak and electromagnetic forces allow the emission of beta particles for another process called nuclear transmutation.

III. Quantum Mechanics

Quantum mechanics is a fundamental theory in nuclear physics and physics in general that describes the behavior of things at the atomic and subatomic scale like the particles in nuclear reactions. The four main concepts relating to nuclear reactions are wave-particle duality, probability and quantum superposition, energy quantization, and quantum tunneling. The entire theory of quantum mechanics is paradoxical, in that particles are simultaneously particles and waves. According to Louis de Broglie's hypothesis, every particle has an associated wavelength. This wavelength is inversely proportional to the particle's momentum. The equation $\lambda = h/(mv)$ illustrates the wave-like characteristics of particles through the integration of wavelength (λ), an energy-describing figure called Planck's constant (h), and the particle's momentum ($p=mv$). For instance, if particles are heading towards a barrier with high energies and critical speeds, the wave-like aspects of the particles may extend into the barrier, overcoming fundamental forces with high momentum. Because particles exhibit wave properties, it is extremely likely for them to interact and interfere with each other (Krämer).

Wave-particle Duality and Quantum Superposition

Wave-particle duality implies that quantum superposition can occur through these probabilistic interferences. For example, in a wave function, the particle is located in the entire wave and smeared in many locations until it is measured.

Quantum superposition is a guiding concept in nuclear reactions, where a quantum system exists in multiple conditions simultaneously until it is observed or measured. After the wave function is measured, it collapses, and the particle takes on a more defined location, and momentum, energy, and other properties are revealed. Erwin Schrödinger's thought experiment called Schrödinger's cat elaborates on probability and superposition. In this paradox, there is a box containing a radioactive atom, a vial of poison, and a cat. We do not know when this radioactive atom will break down and release energy, but it will. When it does, the vial will break and the poison will kill the cat. We do not see inside the box, so the situation exists as either the cat being dead, or the cat being alive. There is a 50-50 chance; that the cat is both alive and dead. Once the box is opened, one of the options is selected (Howgego).
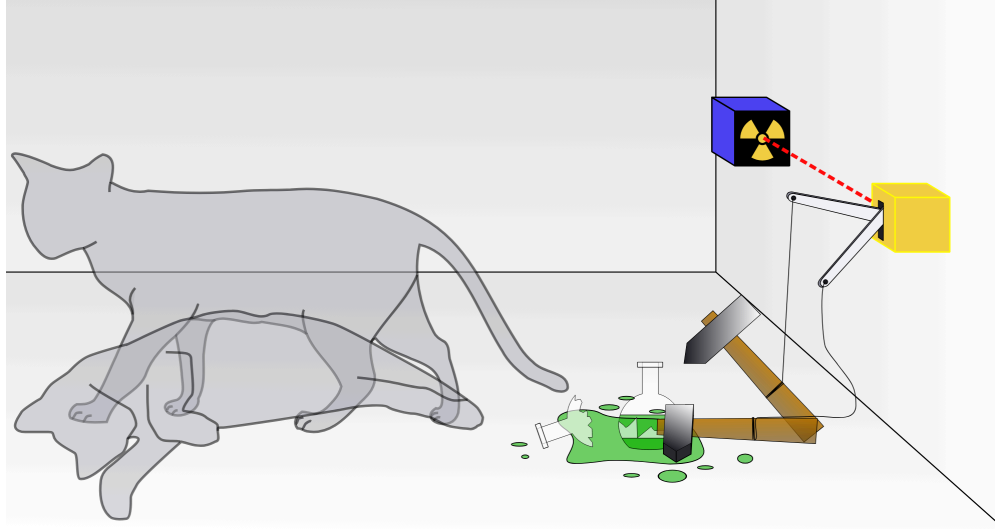
A depiction of Schrödinger's Cat

Energy Quantization

Wave-particle duality also results in the quantization of energy, an essential principle of understanding the energy output by atomic nuclei in nuclear reactions. Energy quantization refers to discrete points or levels of quantum-scale energy in general, evident in atomic energy (Contributors to Wikimedia projects). This concept means that energy levels within particles cannot just have any value; they come in specific amounts/discrete values. The particle in a box model illustrates the quantization of energy. In this hypothetical one-dimensional box, there is a particle confined. It has infinitely high energy walls. Again, particles always exhibit dual wave-particle behavior, wherever they are. When confined within a box, their actions adhere to specific guidelines known as boundary conditions. These conditions stem from the necessity for the particle's wave function to reach zero at the box's boundaries because the probability of being inside or outside the walls is zero. There have to be wave functions that are zero at both boundaries, while also satisfying the wave equations. There is only a small set of sine/cosine functions that do this, and each of those functions has discrete energy. The particle in the box is allowed to have only discrete and distinct energies. The energy levels of the particle are quantized. This model's wave function describes the probability amplitude of finding the particle's position. Each of these energy sets corresponds to a specific wave function, which represents the probability of finding the particle at different positions within the box. The particle-in-a-box scenario is a simplified model used to understand how particle confinement leads to quantized energy levels and relates to wave-particle behavior (Contributors to Wikimedia projects). It is a fundamental concept in quantum mechanics for studying matter at atomic and subatomic scales.
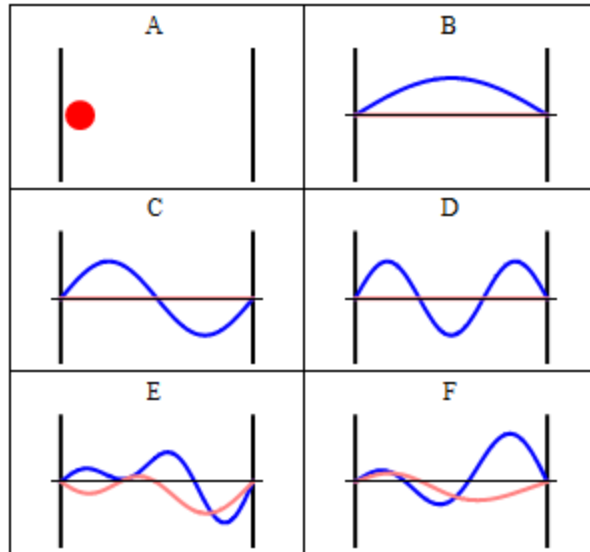
Model A: a depiction of a particle in classical physics.
Models B-F: The wave functions need to be zero at the ends

The energy levels of electrons orbiting a nucleus are analogous to the energy levels in the particle in a box.

All particles are arranged inside an atom with different energy levels before a nuclear reaction starts. During and after a nuclear reaction process, the quantum system changes from one state to another so the energy levels of the particles are quantized. But the energy levels must add up to be the same due to the conservation of energy law. During any transition, energy must be exchanged in discrete amounts. Any displaced energy from a particle must be re-emitted to conserve the missing energy. For example, when an electron transitions from a higher energy point to a lower one within the nucleus, it emits a photon with energy equal to the difference in energy between the initial and final states of the nuclear reaction. This quantized energy exchange is consistent with energy conservation, as the atom's total energy remains constant. To summarize, energy quantization is a concept in which particles often take on discrete energy levels, and any change to the system rearranges the energy levels in particles (Contributors to Wikimedia projects). Still, the total amount of energy stays constant.

Quantum Tunneling
Finally, quantum tunneling is the fundamental event in which the particle wave has a probabilistic chance of penetrating an energy barrier (Contributors to Wikimedia projects). For example, consider the particle in a box scenario one more time; this model is somewhat comparable to a nuclear reaction. Hypothetically, the wall barriers have infinitely high energy, but in reality, there can be no indestructible walls. The general idea of quantized energy levels and the probabilistic nature of particles directly correlates to overcoming energy barriers. If you were to take the box and lower the energy levels of the barriers akin to real life, there would be an extremely low probability of the quantized particle slipping through the classically forbidden

region. The classically forbidden region is a space where a particle classically lacks the energy to overcome a potential barrier, but because of the wave properties of every particle, quantum mechanics dictates that there is still a probability of a particle penetrating the barrier (Krämer). Essentially, when the walls are finite, the boundary conditions do not have to be zero, allowing the particle to be found on the other side of the wall. This is quantum tunneling, and it can happen to any particle that faces a barrier. In a nuclear reaction, nucleons can tunnel through the barriers of atomic nuclei made of fundamental forces. Particles have intricate and often counterintuitive behavior. Quantum mechanics is essential to comprehending phenomena like nuclear reactions.

IV. Processes of Nuclear Reactions

All of these fundamental concepts influence and allow nuclear reactions. The basic definition of a nuclear reaction is a process in which a nucleus changes identity or characteristics (Contributors to Wikimedia projects). The important processes of nuclear reactions are fission, fusion, and decay, as well as neutron capture, spallation, and transmutation. The two general/classifying reactions are transmutation and decay.

Nuclear Transmutation

Nuclear transmutation is a general umbrella process that includes fission and fusion that directly correlates to how the weak force changes the flavors of nucleons. It is defined as when another nuclear process changes the number of protons in a nucleus, generally resulting from the weak force. Neutrons remain irrelevant to elements and transmutation. The atomic number of the affected nucleus changes and therefore, it becomes a new element/isotope (Energy). This process can be natural or artificial. For example, our sun is powered by nuclear fusion, a form of nuclear transmutation. Understanding it through a transmutation perspective is crucial but simple. In the sun, hydrogen atoms combine to form helium atoms. The atomic numbers (protons) just add and transmute. In other stars, once the hydrogen burns out, the helium may start to transmute to heavier elements like carbon and oxygen. Nuclear transmutation is the most basic process in understanding nuclear reactions: an atom's structure changes (Energy).

Nuclear Fission

Nuclear fission is the predominant and first nuclear reaction to represent the concept of "splitting the atom". It involves a nucleus that splits into two or more other nuclei. Fission may be induced artificially by firing a nucleon toward the nucleus or naturally through nuclear decay. Nuclear fission usually coexists with another nuclear reaction during a process; it is the general process of when an atom is split. Uranium-235 and plutonium-239 are mainly used in nuclear reactions. Fission starts with a heavy nucleus colliding with another nucleon. The nucleus becomes unstable, so it splits.

Neutron Capture

Neutron capture is a process in which a neutron enters a nucleus, like in fission. The neutron is used to overcome the Coulomb force because of its neutral charge easily. Next, the neutron fuses with the nucleus, but the nucleus enters a catastrophic state of instability. To become energetically favorable, the nucleus starts a new process called spallation. Spallation is the process when the nucleus splits into two other nuclei, primarily associated with fission (Contributors to Wikimedia projects).

Nuclear Fusion

Nuclear fusion is more complex than fission; it is a reaction in which two or more nuclei fuse to form one or more different nuclei and subatomic particles. Fusion requires enough energy to overcome the Coulomb barrier. This is why fusion occurs naturally in stars. Stars are a conundrum of intense pressure and very hot plasma. Gravity condenses the atoms together, and the plasma burns at ten million degrees Celsius. These extreme conditions in the sun allow nuclear fusion reactions to naturally occur. Deuterium and tritium are both isotopes of hydrogen in nuclear fusion reactions. A fusion reaction starts when nuclei get close enough for the strong force to take over. If the nuclei have enough energy to outweigh the Coulomb force, the strong force will bind them together, creating a larger nucleus.
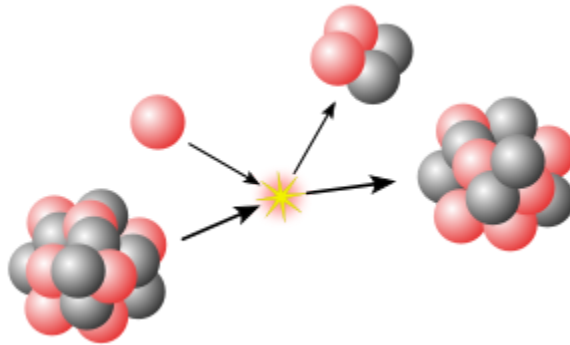
A nuclear fission-fusion reaction

Nuclear fusion and fission are interchangeable. For nuclear fusion to happen, there must be a spallation of nucleons for nuclei to combine.

Nuclear Decay

What is nuclear decay? Nuclear decay is the essence of "radiation". When an object is radioactive, it is usually made of unstable material, which decays at a faster rate. A larger amount of neutrons in an isotope generally causes the instability. The weak force mainly causes radioactive nuclear decay. An object decays at the rate of a half-life. The half-life is the measurement of the time it takes for a substance to decrease to half of its initial value. Nuclear decay is a natural process in which an unstable nucleus shoots out particles. The weak force drives this transfer of energy for the nucleus to become energetically favorable and stable again.

The nucleus decays by releasing particles. Those emitted particles make up "radiation". The weak force makes it so that every object decays. Objects can have completely different rates, ranging from minutes to billions and trillions of years.

The three main forms of decay processes are alpha decay, beta decay, and gamma emission. In alpha decay, the parent nucleus subtracts and releases an alpha particle (α), becoming a new nucleus. An alpha particle is made of two protons and two neutrons, identical to a helium nucleus.
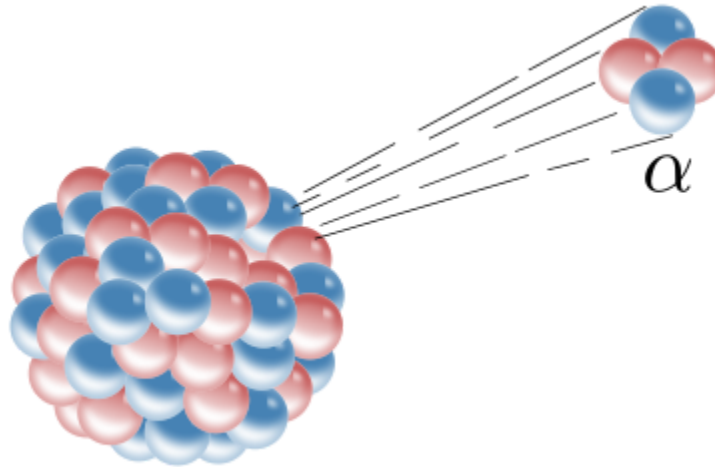
The emission of an alpha particle

In beta decay, there are two processes: beta-minus decay, and beta-plus decay. In both these processes, the quarks in a nucleon are changed, transforming the nucleon into another nucleon. This results in the emission of particles. Like all other decay processes, beta decay is driven by the weak force's ability to change the properties of particles. Beta-minus decay occurs if a nucleus has too many neutrons. Beta-plus decay occurs if a nucleus has too many protons. Beta decay has many complex possibilities, but it is important to understand that when the nucleons change flavor, particles need to be ejected to uphold the laws of particle physics.
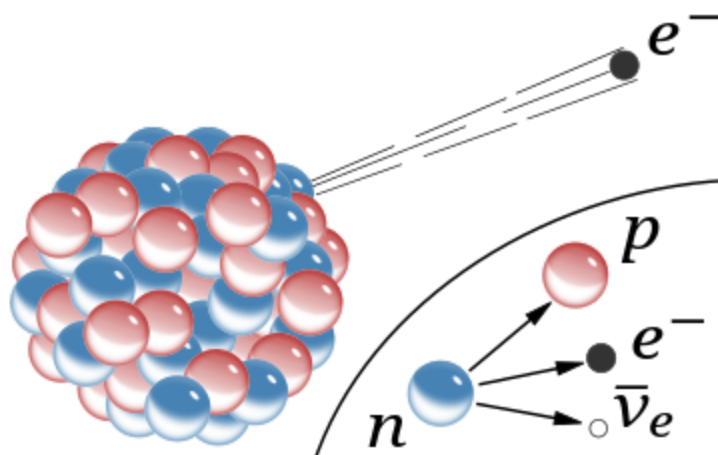
The many different subatomic beta particles that may be emitted.

Lastly, gamma emission is the most dangerous type of radioactive decay, where gamma rays are emitted. Contrasting with alpha and beta decay, this process does not eject any charged particle. This type of decay releases a form of high-energy electromagnetic radiation known as a gamma-ray photon (γ). These special types of photons that make up a gamma ray are highly ionizing. Ionization is basically an ongoing process in which ions are formed by a gain or loss of an electron from an atom ("Ionization - Energy Education"). In this process, the atomic structure of the nucleus is not changed at all. Instead, the energy state changes. Gamma rays are usually emitted if the nucleus is in an excited energy state, as in a nucleus in a nuclear chain reaction. In a nuclear chain reaction, the nuclei split, releasing massive explosive force, and creating immensely powerful bursts of gamma rays. Gamma emissions are typically seen as the primary form of radiation: the "real" and dangerous radiation, as in the effects of nuclear explosions.
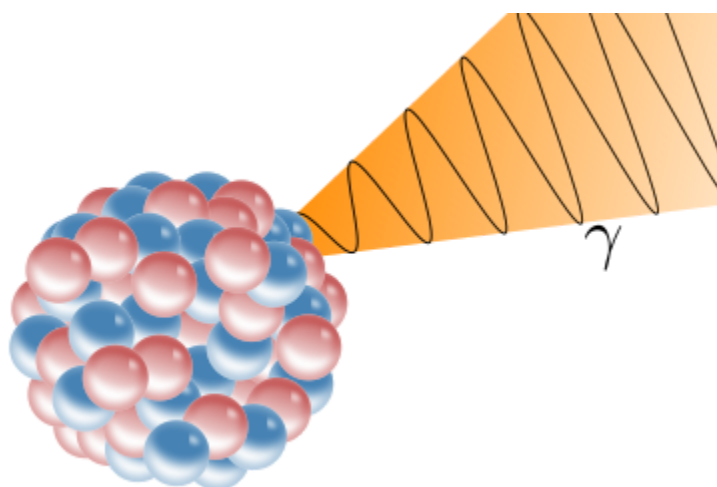
Gamma rays are especially ionizing

V. Energies of Nuclear Reactions

Special Relativity

Relativity was Albert Einstein's theory regarding mass, time, space, and the motion of objects. It is split into two theories: special relativity and general relativity. Special relativity is crucial to understanding the output of nuclear reactions; general relativity involves gravity and does not relate to nuclear reactions. Special relativity is relevant to special cases, and it is generally used for discussions of huge energies, ultra-fast speeds, and astronomical distances, without the complications of gravity (Einstein's Theory). It indubitably explains how nuclear reactions are volatile.

Special relativity proposes two fundamental ideas: the speed of light in a vacuum is the same for any observer, regardless of the observer's location or motion, or the location or motion of the light source; the laws of physics are the same for all reference frames that are not speeding up or slowing down relative to each other (DOE Explains). A frame of reference is the environment in which an object is thought to be at rest. When humans are standing still or sitting on Earth, they are rotating, orbiting the sun, and being moved around millions of miles an hour by the galaxy and the cosmos. But in this frame of reference, humans are at rest when standing still or sitting. If a frame of reference is moving relative to another, they both still have a different perspective on time and space. Three-dimensional space, one-dimensional time, and how they are measured construct the space-time continuum (DOE Explains).

Important to nuclear reactions, Einstein's theory of special relativity was expressed in two fundamental equations: $E = mc^2$ and $\gamma = 1 / \sqrt{(1 - (v^2/c^2))}$. The first equation translates to "energy (E) equals mass (m) times the speed of light (c) squared (2)" (DOE Explains). It is a concise representation of the profound interconnection between mass and energy in the universe. The equation asserts that mass can be transformed into energy and vice versa, with the speed of light (c) to the power of two acting as the conversion factor. Mass and energy are changeable and interchangeable, while the speed of light remains the same. This insight underpins the understanding of why nuclear reactions are so powerful. The speed of light is intensely high, and because it is squared in Einstein's equation, even tiny amounts of mass contain huge amounts of energy. Special relativity theory also indicates that as an object moves faster, its observed mass increases. While this increase is negligible at everyday speeds, as an object approaches the speed of light, its observed mass becomes infinitely large. Consequently, an infinite amount of energy would be required to make an object move at the speed of light. Therefore, it is impossible for any matter to travel faster than light speed because if you try to increase the energy, you also increase its mass. The more mass an object has, the more energy it takes to travel faster than lightspeed. Einstein determined the kinetic energy through this formula: $KE = m\gamma c^2(\gamma - 1)$. The second equation is the Lorentz factor equation. It is used as a conversion method relating to special relativity.

Special relativity introduces sub-concepts like time dilation, where time is perceived differently in various frames of reference (DOE Explains). Consider an object that is going lengthwise (L) at a very high velocity (V). When the object is stationary, it has a length of L; but when the object is going at a speed of V, the object will have a length of L/γ. The length

constracts, explained by the Lorentz factor. Time dilation is based on the Lorentz factor. Special relativity, involving inertial frames without acceleration, elucidates the interchangeability of mass and energy, particularly pertinent in nuclear reactions like fission and fusion where small masses release vast energy. A tiny amount of fissile material converts to an incredibly large amount of energy. PBS Nova explained, "If you could turn every one of the atoms in a paper clip into pure energy — leaving no mass whatsoever — the paper clip would yield [the equivalent energy of] 18 kilotons of TNT. That's roughly the size of the bomb that destroyed Hiroshima in 1945." This is why nuclear reactions are so explosive. Such processes are termed "relativistic" when velocities approach significant fractions of the speed of light.

In short, special relativity not only revolutionizes our understanding of the atomic world but also provides a fundamental framework for comprehending the intricate interplay between mass, energy, and the fabric of the spacetime continuum.

Energy Generation

Because of how special relativity explains to us how powerful nuclear energy is, it is evident that we use artificial reactions to harness this power. We use it in nuclear fission reactors, thermonuclear fusion reactors, nuclear breeder reactors, radioisotope thermoelectric generators (RTGs), and nuclear weapons. Nuclear fission reactions utilize controlled self-sustaining fission reactions of heavy isotopes, usually Uranium or Plutonium. Thermonuclear Fusion reactors utilize the fusing of light isotopes of hydrogen, usually Deuterium or Tritium. A nuclear breeder reactor generates more fissile material than it consumes, and they are designed to extend the nuclear fuel supply for electricity generation ("Breeder reactor"). Like a conventional reactor, radioisotope thermoelectric generators convert the heat of decaying material into electricity. They are nuclear batteries used in unmaintained situations such as in satellites and space probes. Finally, nuclear weapons produce large energy bursts utilizing sudden chain reactions within a condensed space. In a fission bomb, explosives detonate inward, crushing the fissile material inside and setting off the chain reaction within. This is when quantum tunneling occurs. The atoms reach critical mass and everything detonates within a fraction of a millisecond. Nuclear energy is an extreme power that humans have access to.

VI. Conclusion

To summarize, the fundamental forces enable fluidity, but stability within an atom. The strong force binds all matter into nuclei; the electromagnetic force controls the behavior between charged particles; the weak force underlies forms of radioactivity, by changing the unique structure of nucleons. Because of these factors, quantum mechanics furthers probability by introducing the nature of wave-particle duality. All particles are waves, which allows convoluted interactions between energy barriers; because particles are waves, they exhibit superposition, where it is difficult to locate a probabilistic position unless measured. Energy can only be distributed in small amounts, so with the right probabilities for sufficient energy, particles can tunnel through and penetrate energy barriers. These concepts correlate directly to the processes

of nuclear reactions: transmutation and decay. Every nuclear reaction displays a redistribution of nucleons, splitting and frequently fusing. They release tremendous amounts of energy. Special relativity explains how this energy release affects the particles' behavior. All of these understandings are crucial for comprehending the complex dynamics and energy transformations occurring within condensed durations of before, during, and after nuclear reactions.

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Compelling Force: Examining AFRICOM's role as a gravity well of power By Arseny Biryukov

Abstract:

This essay's goal is to understand and synthesize United States Africa Command's (AFRICOM's) role within Africa in relation to the various forces and actors on the continent, such as terrorist groups and China. Arguing that AFRICOM has an outsized influence on events in Africa, this essay underscores elements of power dynamics, sovereignty, and asymmetrical interdependencies. The essay highlights relevant examples of AFRICOM's influence such as Operation Flintlock, examines how China has been attempting to gain power over the region, and draws a conclusion regarding AFRICOM's purpose in the broader world stage.

Key words: Power, Sovereignty, Interdependence

The modern era is one of unpredictability, complexity, and instability. Interconnectedness and globalization have made it possible for events on one side of the world to affect the other, creating invisible strings that tie everything and everyone together, driving world events as if by fate. Institutionalism and liberalism have taken root across the world, and international laws and intergovernmental organizations now play key roles in influencing states, ostensibly bringing an end to an age characterized by power competition and violence. This uprooting of the historic dynamic, in which military force dominated international relations, contrasts starkly with the reality of the various expeditions undertaken by the US military in the 21st century, ranging from Iraq to Afghanistan to Libya, as well as anti-terrorist operations conducted by AFRICOM thousands of miles from home.

These emerging realities and their implications for the global system, in conjunction with the American great power rivalry with China, compel a reexamination of the true nature of power, sovereignty, and relations between states in the modern day. In order to track the aforementioned emerging realities and re-examine the application of key concepts, it becomes necessary to investigate the true purpose and value of the American military-industrial complex's operation and establishment abroad, specifically in the context of AFRICOM, in a world that rhetorically rejects hard power and violence.

By examining the most affluent military in human history, core themes of power dynamics and competition between China and the US, the relevance of conceptualizations of international legitimacy in the face of power, and the leveraging of asymmetric interdependencies by the two superpowers become evident. This study argues that, through AFRICOM, the American military-industrial complex operating in Africa wields America's extraordinary advantage in military power-projection capability and its long-term investments into regional military infrastructure to create and maintain a geopolitical gravity well of power, drawing in African countries through subtle yet powerful manipulations and incentive structures that render perceptions of legitimacy irrelevant. Furthermore, the US military-industrial complex finds itself drawn into a tug-of-war of continental proportions opposing an emerging Chinese

economic gravity well, established through the use of powerful financial influences and incentives such as the One Belt One Road policy and China's push to secure strategic resources. In addressing the question, it is prudent to draw on elements of John Mearsheimer's realism and Joseph Nye's liberalism, two opposing theories in mainstream IR, while recognizing their flaws and limitations, providing ultimately a more holistic approach to the subject matter.

Historically speaking, Africa has unwillingly served as a battleground for American interests vis-à-vis the Soviet Union, where the two countries waged a series of brutal proxy wars and precipitated coups in countries like Uganda and Ethiopia. Though the Cold War is over, America continues to operate in Africa, for reasons that are interesting to examine further. AFRICOM, or United States Africa Command, is an international subunit of the American Military, working to establish a US presence in Africa. Its role, according to President Bush, under whose administration it was established, is "peace and security to the people of Africa and promote our common goals of development, health, education, democracy, and economic growth in Africa" (AFRICOM 2007).

In his testimony to the U.S. congress, General Michael Langley, the AFRICOM chief, talked about 2 "enduring" U.S. forward operating military sites in Africa, and 12 other posture locations throughout Africa, which he termed as "minimal" and "low cost". Upon further investigation, including "contingency" and other locations excluded on technicality, one finds more than 26 bases in Africa. One of these launchpads for military initiatives, Air Base 201, costs to the tune of $250 million to build, and $20-30 million annually to maintain. Only the Pentagon could call Air Base 201, the largest "airman-built" project in Air Force history, a "low-cost" facility. (Turse 2023)

Both the extent of these bases and the secrecy surrounding them is striking. Why would the United States want or need such an archipelago of military infrastructure in Africa given global trends? The common narrative, promoted by respected NGOs such as the Red Cross, holds that war and violence are unacceptable, barbaric, and outdated forms of diplomacy that have no place in the world, much less in the toolbox of the "cradle of liberty", and that modern disputes can be holistically addressed without resorting to the use of military force. American politicians hardly discuss their country's presence in Africa, and even Jake Sullivan, America's national security advisor, fails to mention the presence of these bases in his article for Foreign Affairs magazine, titled "The Sources of American Power". Instead, he places heavy emphasis on America's cooperation with fellow democracies and the development of technologies, as is standard in liberalist perspectives like those of Joseph Nye, which emphasize the importance of cooperation among states, as well as the emergence of "soft power", a way of influencing countries through culture, diplomacy, and economics. So, how are these bases relevant to the American MIC (military-industrial complex) operating through AFRICOM, and their broader strategy in the region?

American author Charles W. Freeman, Jr. described power as "the capacity to direct the decisions and actions of others." Despite modern developments and initiatives striving for "world peace" by intergovernmental organizations like the UN, military force and hard power

are not outdated or ineffectual in the modern day in said capacity. According to a US Congressional Research Service study published in November 2010, Washington has dispatched anywhere between hundreds and several thousand combat troops, dozens of fighter planes, and warships to support client dictatorships or to unseat adversarial regimes in dozens of countries, almost on a yearly basis (Ploch 2010). To the leaders and the people of the African nations who happen to fall into the American sphere, the support of America means the difference between regime stability or collapse, life, or death. As discussed by James M. Cypher, the Emeritus Research Professor at the Universidad Autónoma de Zacatecas, Mexico, "Interventions have been facilitated through new processes and procedures, carefully constructed to create a sufficient degree of autonomy to permit the US state to 'project power' without broad societal resistance". Naturally, these countries pay careful heed to the wishes of Washington, ensuring American access to resources, secure trade routes like the Bab-el-Mandeb strait, and blank checks for America-based businesses to operate as they wish, exploiting both the environment and the people. Though Sullivan does not mention Africa, he lets the truth slip when discussing the US's dealings with other countries: "That is how we will seek to shape relations with them: so that on balance they have incentives to act in ways consistent with U.S. interests."

In this prevalence of force, the weakness of Joseph Nye's liberalist conceptions is exposed. In his 1990 article for Foreign Policy, Joseph Nye argued that "power is becoming less transferable, less coercive, and less tangible… Various trends today are making co-optive behavior and soft power resources relatively more important." (Nye, 1990) The use of hard power in a "soft" way and the competitive dynamics created by great power politics, as recognized by John Mearsheimer in his book, the Tragedy of Great Power Politics, overshadow and eclipse legitimacy as a ruling force in international relations. And indeed, great power politics plays a considerable role, as one of AFRICOM's objectives is to address the challenge to American hegemony on the world stage, and defeat its closest great power competitor: China.

Figure 2: A map of interests and alignments in Africa between the two major influencing superpowers. It is important to note the significance of geography - Countries located near the coast of the Indian Ocean feel the attractive pull of OBOR and the potential economic opportunities far more than countries in the Sahel, many of which host American military bases and cooperate with America.

The extent of American influence in Africa serves not only to align African countries with the United States, but also as part of a larger power competition that set the theme for events around the world and even the creation of AFRICOM itself. When AFRICOM was created in February 2007, the Pentagon claimed the necessity for a dedicated regional command grew out of the continent's rising strategic importance. However, as written by Stephanie Hanson of the Council of Foreign Relations that same year, "the command's creation was motivated by more specific concerns: China and oil. With Soviet influence gone and France's traditional presence much diminished, China has poured money into the continent in recent years." And indeed, In the nearby United Arab Emirates (UAE), China constructed several facilities at Khalifa Port, as well as an oil pipeline that stretches to the Port of Fujairah; in Oman, it is investing billions at the

emerging Duqm Port. While these investments offer near-term economic benefits to China, they may also lay the groundwork for the PLA to project power further into the African continent a fact AFRICOM planners are keenly aware of.

OBOR, or China's One Belt One Road policy, also exerts a major influence and is the primary component of China's economic gravitational pull. A trading initiative, this project has privileged China with high standings in many African and Asian countries. China's commercial engagement in developing areas in Africa has widened its sphere of influence to the eastern portion of the continent. To that end, China has made substantial efforts to win political and cultural prestige, including by providing political party training, doing favors for African leaders by building government buildings, and more. By comparison, American economic engagement in Africa is lackluster, nor is America able or willing to engage Africa in the same way China is. Thus, America works to compensate using its militaristic influence to retain the allegiance of countries. As in the Cold War, the realist theory on power dynamics between major countries and resources continue to be apt descriptors for the realities on the ground, a testament to the solidity of the realist theoretical foundation.

However, pure realism is not sufficient to address and understand the presence and scale of the military-industrial complex in Africa, and AFRICOM's operations. Though great powers do remain the primary actors in international relations, as is evident from the world-spanning influence of the competition between the United States and China, realism is inadequate in addressing the other major challenge to the United States and the world, and AFRICOM's role in combating it: terrorism. One of AFRICOM's major objectives is stabilizing and increasing the counterterrorism capabilities of US-friendly countries in Africa. Terrorism is not only a major cause for instability, but is often specifically directed against Western influence, due to a grudge against the longstanding historical dynamics of colonialism and oppression between the East and West.

As a theoretical foundation, in isolation, realism is not able to effectively address the spread and power of terrorist organizations because terrorism transcends territorial boundaries, throwing principles of sovereignty and territorial integrity into question. Indeed, America's realist approach to the emergence of terrorism has led to policies that are in hindsight considered to be mistakes, like the invasion of Iraq and forever-wars in Afghanistan, something Jake Sullivan recognized as a weakness and seeks to avoid in the future. Looking at AFRICOM reveals a crisis of theorization: rather than simple territorial claims and assertions of crude hard power in isolation, or idealistic and unsubstantiated claims about the international system, the advent of such varied phenomena as proxy wars, asymmetric warfare, the entanglement of the military with humanitarian agendas, economic development and the differing approaches diplomacy mean that any theory needs to be capable of grappling with diverse aims and diverse actors. Ironing out AFRICOM's approach to the modern challenge of terrorism while maintaining the US advantage over competitors like China and hostile countries like Iran, which utilize proxies and asymmetrical warfare, will undoubtedly be one of the primary tasks of AFRICOM in the first half of the 21st Century.

In conclusion, AFRICOM was created to reflect a changing international dynamic, one in which Africa is emerging as an increasingly relevant continent on the international stage. Thought modes of realism continue to guide the American strategy abroad, and the American military-industrial complex's strength continues to shape the modern state of affairs in the region. Examining AFRICOM's role in the broader China-US struggle, as well as its enduring relevance in asserting US strength, lends insight into the fascinating ways in which international dynamics and perceptions of power evolve over time.

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Science the experience, Science the social policy By Zikra Rahman

According to the Oxford dictionary, science is "knowledge about the structure and behavior of the natural and physical world, based on facts that you can prove, for example by experiments". However, in my experience, it is much more than that.

Inspiration can shapeshift into a hundred different forms, wear a million different faces and take an entire lifetime. Moreover, the inspiration for this essay came to me from several different sources. For one, my "eugenics and the dark side to science" unit in my seventh-grade biology class. Another is an essay written by MIT astrophysicist student Hillary Andales titled "The Hidden Bookshelf." As a child, Science was the millions of colors bursting through CBC and PBS Kids episodes. A world of exploration jumping from my television screen, lighting up the window to my backyard. Growing older, Science became a bunch of textbooks and grades, an infection of stress and perfection. However, it was also the cancer that killed my grandfather and the chemotherapy that saved my grandmother. A teenager now, I struggled to reclaim that initial childhood wonder that Science once meant to me. I no longer feel the adrenaline pumping through my eight-year-old fingers as I flipped through my "national geographic Oceanopedia". My relationship with Science is more or less like watching the light fade out of a childhood friend's eyes. This is partially because of how Science is taught but also because of how I experience Science. And to this day, I'm still not sure what Science means to me… But I do know it definitely means *something* to me. I am saying that Science, particularly biology, is less a theory and more a human experience.

In "The Hidden Bookshelf," Andales describes the betrayal she felt as she stumbled upon the millions of stories of Science being used as a political instrument, which were covered up and never addressed. Let's just say that Science was never the same for me after that. Like her, like American microbiologist Johnathan Beckwith, I realized the twin flames between politics and Science. In Beckwith's autobiography, he quotes:

"It was not until the early 1970s that I came across a book that opened my eyes to this history. I read a book review in Science entitled "A Tormented History. "… I borrowed the book from the Harvard Medical School library; fascinated by this hidden history, I read through it within a couple of days. I learned of the behavior of scientists during the genetic movement and how scientific ideas from genetics were converted into social policy. Reading Ludmerer's book and other writings on eugenics has had an enormous influence on me. Much of what I have done since as an activist within Science I attribute to my own recapture of this history." (Beckwith *Making genes, making waves a social activist in science*)

Ever since, I have been unable to help but see Science—the social policy, everywhere. Sitting in a classroom, Science these days feels less like a discovery and more like an institution… And like any other social institution, Science can be corrupted and politicized—a catalyst for power and discrimination. Moreover, I saw it the most during my study of living things. I may not have much experience with living or Science, but I confidently conclude that no other science is as rooted and interconnected with politics as biology. I recently learned of

social Darwinism, the belief that some people are evolutionarily better than others. Used to justify the mass persecution/murder of the holocaust, it truly is a disgusting and horrifying ideology. Millions of screams, cries and deaths, packaged and labeled "for the sake of science". Watching Gattaca in class, I wonder, sure, not everyone has the same abilities, skill sets or looks, but we all have emotions… Do feelings no longer matter? Is this the true nature of Science, according to humans?

It was mainly during our evolution unit that the connection between biology and politics kept muddling in my brain, solicited and not. We live in a sexist society; no surprise there. Women, in particular, live in a world revolving around the sun and the Eurocentric beauty standard. I, being South Asian, obviously do not fit into that standard whatsoever. And ironically, the place where I experience the most racism is within my community. Poking through the South Asian inferiority complex, white skin is seen as the ultimate form of beauty. To the point where South Asians developed a dialect where "fair" and "beautiful" are used interchangeably. The ideal for white skin has several origins; for one, it is a symbol of wealth as poor farmers would spend more time in the sun, becoming tanner than the rich lounging indoors. For another, British Colonizers left with our food, money and traditions, as well as a white supremacist culture in South Asia.

Sometimes, when it's everywhere, you start resenting your evolution, ancestry and who you are. Finding out about evolution was like finding out about someone(s) to blame for my predicament. Living in North America, sometimes, I resent my great-great-great grandchildren, who will inevitably evolve to be fairer than me. I know it's unfair, but I sometimes also resent my ancestors for not moving towards Northern India. If they had… would I have been fairer? Taller? Better? Sometimes I resent my mother for not giving me her skin tone. British colonization has not only psychologically shattered us but physiologically as well. During the Second World War, the British had a scarce food supply, so Winston Churchill started importing (stealing) rice from Bengal. This caused the second recorded worst famine and a title like "the Bengal famine," will never do justice to the millions killed and to my great grandparents, with their skin clung to their bones, begging for a single bite of fish. And unfortunately, this is not an isolated tragedy. British colonization caused over a hundred famines in South Asia, so our bodies had to adapt and evolve to the scarcity.

And I see the consequences of this every day. I see it every morning on my parents' breakfast plates. I see it in my grandmother's dinner recipes. I see it whenever my aunts and uncles complain about their recent weight gain. Sometimes, I joke that my family tree has two extra members: diabetes and cholesterol. But it's not only my family; around 14% of the Bangladesh population has diabetes, and it is the 8th country with the highest diabetes rate (NIH). However, in my experience, most of the Bengalis over thirty in the West I have known are diabetic/pre-diabetic. Like many Bengali children, both of my parents have diabetes, meaning I have around a 50% chance of developing it in the future. So, for the sake of my health, I never got to create a guilt-free, pleasurable experience with sugar. Instead, while my peers enjoy stuffing their faces with cookies, I see it for what it is for me: a guilty-poison. And now, as

if salt in a wound, many South Asians will get teased for their bodies, height, and everything else, good and bad, evolution handed them. It's its own form of generational trauma, being teased for my height when their ancestors stole my food… Not only that, but South Asians even get teased by their own kind for not exhibiting eurocentric features. When my great-grand-mother would give all the food to her little siblings, then pretend she'd eat later, what did you think would happen? That she'd reach 7 foot 3? Ironic in its own definition.

As seen, Science is anything but objective facts and truth. And unlike what school teaches me, Science is not strings of data in a textbook lining up to be graded. For my elementary school self, it was a universe of colors, cartoons and life bursting with being and existence. In middle school, it was what made me different, weird, and everything "wrong" with my body. Evolution has me carrying the consequences of a hundred-year-old politics in my body. Sometimes, I miss when Science was just going outside and observing that ladybug, losing myself in my magnifying glass. And I hate that, somewhere down the line, the world took that away from me. Now, I see that Science is politics and politics are justified by Science. Science is an institution, in how it is taught and applied. The monotony and institutionalization in how science is taught at school merits its own thesis, but alas.

There is no denying that Science is a beautiful thing. It has brought us to the moon, given us a roof over our heads, saved our lives so many times we aren't even aware, and given people careers, hopes, and dreams. But, on the flip side of the vaccines and spaceships, Science has been used for power, dominance and hurt. They say nothing hurts (or heals) like the truth. And Science is the closest we have to it. And nothing has ever caused as much pain as Science. Science is, in essence, a profoundly human experience.

Science is your life, experience, and heart that pumps your body. It is your connection with nature and the web of where you are and what you are, the evolution that brought you here. Science can make you love the world or hate it. There's Science in the melanin protecting her skin, and there's Science in the bleaching and corrosive properties of mercury cream. Science can make you love or hate yourself. And I guess that would make Science less of a political tool and more of a choice, right? And I guess learning about the closest thing we have to the truth and how to use it is so important. I agree the mechanisms of a gun are just words and theory on paper. But I also agree that your choices with Science can kill or resurrect a man. To quote Jurassic Park: "Just because you can, does not mean you should." Because Science and humans are essentially the same. Indistinguishable. Interconnected. Interdependent. Entitled.

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Novel Therapeutics Targeting Plasmacytoid Dendritic Cells for Systemic Lupus Erythematosus Treatment By Arjunn Sivanesan

Abstract

Systemic Lupus Erythematosus (SLE) is a chronic autoimmune disease in which the body's immune system becomes dysregulated, leading to progressive tissue damage. Various cell types, including plasmacytoid dendritic cells (pDCs), have been implicated in its pathogenesis. pDCs are a subset of dendritic cells specialized in secreting high levels of IFN-1, playing a crucial role in antiviral responses. Many currently utilized SLE therapies, which target other cell types, such as B-cells and T-cells, or are non-specifically immunosuppressive, have adverse effects, including various organ toxicities, and may lead to the development of resistance. Because physicians do not have a wide array of therapies to choose from, there is a need to identify novel strategies for targeting SLE. pDCs represent a promising new target for therapies against SLE due to their implication in SLE pathogenesis. These novel pDC-targeted therapies provide a much-needed alternative treatment option for SLE patients, offering hope for a better quality of life and the possibility of improved health outcomes for SLE patients. This review focuses on novel pDC cell therapies in trials or development that help treat and manage SLE.

Introduction:

Systemic Lupus Erythematosus:

Systemic Lupus Erythematosus (SLE) is a chronic, systemic autoimmune disorder that causes multisystem organ inflammation, affecting the kidneys, skin, and nervous system [44]. It is a variable disease that has many different presentations and symptoms. Those individuals that have an increased risk of developing SLE include people ages 15-45 of Native American, African American, Asian American, Hispanic, and Latino descent. Women also have a predisposition to developing SLE, as women are nine times as likely to be diagnosed with the disease as opposed to men [57]. SLE is also a major leading cause of death for women of ages 5-64, ranking 5th among African American and Hispanic women ages 15-24 and ranking in the top 20 leading causes of death for women of all demographics [58]. Currently, more than 1 million Americans suffer from SLE [3]. The causes of SLE remain unknown, though genetics, environmental factors, and unresolved inflammation may act as triggers [1]. Major symptoms that cause morbidity and mortality include inflammation of the kidneys, known as lupus nephritis, inflammation of the nervous system, causing memory deficiencies, headaches, stroke, and arteriosclerosis, which is a stiffening of the arteries that increases the risk of a heart attack [2]. Even though there are many existing therapies for SLE, many are nonspecific to the disease's underlying pathology and target inflammation systemically, leading to adverse effects such as an increased risk of infection. Additionally, they manage the disease's symptoms without treating the cause(s). Thus, there is a clinical need for more novel, targeted SLE therapies that better address the underlying mechanisms of the disease.

In SLE, a variety of cell types have been implicated in SLE development, indicative of the diversity of the disease. One cell-type widely implicated in SLE pathogenesis are B-cells, which are known to produce a wide range of autoantibodies [46, 47], a type of antibody, which are proteins that bind to substances to alert the immune system of their presence. These autoantibodies, important drivers of the disease, react to self-antigens such double-stranded DNA (dsDNA) and Smith antigens, which are part of a RNA protein complex that leads to mature mRNA production [46, 52]. Another cell-type implicated are T-cells, which are often found to be dysregulated in SLE, with hyperactivation, dysfunction due to metabolic pathway changes, and increased prevalence of pathogenic T-cell populations having been observed [45]. Additionally, plasmacytoid dendritic cells (pDCs), a subpopulation of dendritic cells, have also been implicated in SLE pathogenesis for their vast secretion of interferon-1 (IFN-1), a cytokine that promotes inflammation, leading to modulation of T-cell and B-cell responses [48]. Due to their outsized production of IFN-1, which causes systemic inflammation, and their role in regulating lymphocytes, a subpopulation of white blood cells, also known as leukocytes, consisting of T-cells, B-cells, and Natural Killer (NK) cells, pDCs present a promising new target for SLE therapeutics.

Current Treatments for SLE:

Glucocorticoids remain the mainstay of SLE treatment. Glucocorticoids help control SLE by inhibiting the production of pro-inflammatory cytokines while enhancing the secretion of anti-inflammatory molecules and regulating leukocyte function, proliferation, differentiation, and apoptosis, which is programmed cell death [14]. Though they remain one of the leading tools in controlling SLE, glucocorticoids have been associated with increased organ damage, as measured by the Systemic Lupus International Collaborating Clinics/American College of Rheumatology Damage Index (SDI), in patients, with a study finding organ damage in 42% of patients taking glucocorticoids compared to an incidence rate of 15% in patients not taking glucocorticoids [28]. Additionally, their usage has been associated with the development of hypertension, diabetes, ulcers, and increases in susceptibility to infection [23]. Moreover, despite their importance in treating SLE, resistance to glucocorticoids and non-corticosteroid immunosuppressants is rife [28]. Resistance appears in up to a third of SLE patients and manifests through incompatibility of glucocorticoid receptors to the administered glucocorticoid therapy, reducing the efficacy of glucocorticoids. Glucocorticoids also do not target pDC survival or activation, which allows pDCs to continue to secret large amounts of IFN-1 [53].

In addition to glucocorticoids, antimalarials such as hydroxychloroquine (HCQ) remain widely-used tools in treating SLE. Antimalarials help control SLE by interfering with the ligation of toll-like receptor 7 (TLR7), which senses RNA viruses and endogenous RNA, and toll-like receptor 9 (TLR9), which senses prokaryotic unmethylated CpG-rich and endogenous DNA, in pDCs and other antigen presenting cells (APCs), inhibiting TLR-initiated cell activation for pDCs and B-cells. Antimalarials also interfere with the processing of cellular debris within, which can inhibit MHC Class II autoantigen presentation [49]. Severe adverse effects that may

occur with the use of HCQ include retinal, cardiac, and kidney toxicity. All of these adverse effects are related to the dosage of HCQ and can usually be reversed. However, with the case of cardiac toxicity, the withdrawal of HCQ only improved the condition of 20-45% of patients from two studies conducted in 2018, and did not prevent the death of 15-45% of patients. Moreover, improval of retinal toxicity symptoms is only possible if HCQ is withdrawn early, preventing advanced progression of retinal damage that results in eventual blindness [50].

Beyond glucocorticoids and antimalarials, another class of SLE treating medications are non-corticosteroid immunosuppressants. These medications include mycophenolate mofetil (MMF), azathioprine (AZA), cyclophosphamide (CYC), cyclosporine A (CsA), tacrolimus, and voclosporin [29]. All of these medications have a mechanism of action that targets lymphocytes. Specifically, MMF inhibits T-cell and B-cell proliferation and antibody production, and has been associated with increases in bacterial and viral infections [15, 24]. AZA reduces the number of circulating lymphocytes and has been associated with bone-marrow suppression, hepatotoxicity, and renal damage [16, 25]. CYC reduces T-cell and B-cell proliferation and lymphoblast responses, and has been associated with increased infections and carcinogenic effects at higher dosages [17]. CsA inhibits T-cell proliferation and production of pro-inflammatory cytokines, but has been found to contribute to nephrotoxicity, which may significantly impact those suffering from lupus nephritis [18]. Voclosporin, a CsA analog, inhibits T-cell proliferation and differentiation, and has been found to contribute to increased infection, nephrotoxicity, and increased risk of lymphoma and malignancies of the skin [20]. Tacrolimus inhibits T-cells and B-cells via suppression of T-cell derived growth factors and has been found to contribute to nephrotoxicity [19, 26].

In recent years, however, the FDA has approved new therapies to treat SLE including voclosporin, belimumab, and anifrolumab, which were approved in 2021, 2020, and 2011, respectively [30]. Belimumab and anifrolumab represent the first targeted therapies used to treat SLE. Anifrolumab is a monoclonal antibody treatment that targets the IFN-1 receptor, preventing the transcription of genes that contribute to IFN-1 secretion [22]. Belimumab is also a biologic, targeting B-cell activation factor [21]. Belimumab and anifrolumab both present with their own risks of upper respiratory infections, bronchitis, arthralgia, and sinusitis [22, 27]. However, compared to non-targeted therapies, which are limited by toxicity and low efficacy [31], targeted therapies may offer more effective treatment without as many or as serious adverse effects. Additionally, the limited repertoire of therapeutic options for SLE treatment underscores the need for the development of new therapies. As researchers continue to develop new biologics and targeted therapies for SLE treatment, pDCs appear to be a potential target.

Plasmacytoid DC Biology and role in SLE Pathogenesis:
Plasmacytoid dendritic cells (pDCs) are a type of dendritic cell that play an important role in antiviral immune responses. These cells are highly specialized in the large-scale secretion of IFN-1 in response to the recognition of nucleic acids. This vast IFN-1 response is mediated by endosomal TLR7 and TLR9 [4]. Furthermore, IRF7, a transcription factor that is expressed at

higher levels in pDCs compared to other cell populations [5], is critical for the induction of IFN-α and IFN-□ genes, types of IFN-1, via the virus-activated MYD88-independent and the TLR-activated MYD88-dependent pathways [6]. pDCs secrete most of the IFN-1 detectable in the blood during a viral infection [4]. Though this secretion of IFN-1 by pDCs is initially low, protracted activation may result in prolonged IFN-1 secretion via a positive feedback mechanism [8]. These mechanisms, which allow for the increased secretion of IFN-1, also make pDCs susceptible to dysregulated, prolonged activation, leading to sustained and systemic inflammation.

SLE is a disease characterized by systemic inflammation caused by a loss of self-tolerance, meaning the body is no longer able to recognize self-tissues as non-threatening, resulting in the production of autoantibodies. This loss of self-tolerance is manifested via recognition of self-nucleic acids by endosomal cell receptors TLR7 and TLR9 [7]. Deletion of TLR7 in murine models genetically predisposed to SLE eliminated severe disease phenotypes, while the *Yaa*-mutation, a mutation correlated with a duplication of the TLR7 gene, exacerbated lupus-like symptoms in murine models [9, 10]. TLR7 and TLR9, as aforementioned, stimulate secretion of IFN-1 by pDCs [11], which also plays a significant role in SLE pathogenesis. Murine models that overexpress of IFN-α exhibit accelerated SLE disease progression [12]. Additionally, mice with a deletion of Tcf4, a gene specifically expressed in pDCs that regulates their development and whose deletion causes insufficient secretion of IFN, had few disease manifestations of SLE including decreased anti-DNA antibody production [7]. These animal studies point to pDCs playing a significant role in SLE development and pathogenesis. Another study, conducted by Jin et al., also ascertained that pDCs derived from SLE patients had an increased ability to stimulate T-cells. Additionally, these SLE-derived pDCs were also found unable to induce T-reg cells, which are a subtype of T-cells that are anti-inflammatory and oppose T-cell activation in response to the presence of apoptotic cell debris [51]. Based on these studies, pDCs appear to play an important role in the pathogenesis of SLE, particularly due to their secretion of IFN-1.

Therapies Targeting pDCs:

Activation of pDCs:

Currently, there are many different therapeutics exploring different methods targeting pDCs to treat SLE. An approach taken by some of these therapies is to target the activation of pDCs. Litifilimab is one such therapy. Litifilimab, also known as BIIB059, is a humanized IgG1 monoclonal antibody treatment that binds to blood dendritic cell antigen 2 (BDCA2), a receptor specific to pDCs [32]. The ligation of the BDCA2 receptor induces a B-cell receptor (BCR) like signaling pathway via transmembrane adaptor protein FcεRIγ [33]. This BCR-like signaling pathway was found to potently inhibit the production of IFNα, tumor necrotic factor α (TNFα), and interleukin-6 (IL-6) that was mediated via TLR pathways [34]. Litifilimab is currently undergoing multiple Phase 3 clinical trials and has completed Phase 2 clinical trials. The study concluded that Litifilimab at a dosage of 450 mg reduced the number of swollen and tender joints compared to the placebo group, with the reduction (±SE) from baseline in the Litifilimab

group being -15.0±1.2 swollen and tender joints compared to the -11.6±1.3 for the placebo group [35].

Another therapy that targets the activation of pDCs is Omalizumab. Similar to Litifilimab, Omalizumab is a humanized IgG1 monoclonal antibody that targets IgE, preventing its ligation of the FcεRI receptor [36]. Ligation of the FcεRI receptor by IgE immune complexes (IgE ICs) can cause a plethora of effects that contribute to the development of SLE. These include increased production of IFNα by pDCs, increased pDC mediated B-cell activation by immune complexes that contain double-stranded DNA-specific (dsDNA) IgE, and increased phagocytosis, or cellular engulfing of other substances, of immune complexes specific to self-nucleic acids, causing increased IFNα production via TLR7 and TLR9 [37].

Omalizumab underwent clinical trials in an attempt to assess the efficacy and safety of the therapy in SLE patients. Over the course of the trial, omalizumab was well tolerated by the participants with no adverse effects. After 16 and 32 weeks of omalizumab, there was improvement of disease activity as measured by the SLEDAI-2K score, which is a global index of SLE disease activity containing 24 items from 9 organ systems [59], but was not seen in any of the other measures of disease activity. This improvement in the SLEDAI-2K score, ~2, may not be clinically significant. However, Omalizumab was shown to decrease IFN gene signature in participants, particularly if they had a high baseline signature at enrollment [38]. However, this trial is limited by its small cohort size. A larger cohort is needed to more accurately depict potential adverse effects and assess the efficacy of omalizumab in treating SLE.

Besides therapies that are currently in clinical trials, there are other potential therapeutics that target pDCs. One candidate small molecule that is being studied is EGA, which is an endosomal trafficking inhibitor for both TLR7 and TLR9 [38, 39]. EGA, also known as 4-bromobenzaldehyde N-(2,6 dimethylphenyl) semicarbazone, was shown in a study conducted by Weist et al. to reduce trafficking of ligands to endosomes that activate TLR7 in human-derived SLE pDCs. The study established that EGA reduces secretion of IFN-α and TNF-α by pDCs. Additionally, another study conducted by Weist et al. found that EGA suppressed kinase activity related to endosome trafficking and cytokine expression. In pDCs treated with EGA, the activation of p65, a kinase involved in pro-inflammatory cytokine expression, was suppressed compared to non-treated pDCs. Moreover, STAT1 activation, which is responsible for downstream IFN-1 signaling, was inhibited by EGA [39]. EGA was also found to inhibit the trafficking of TLR9 agonists, similar to its inhibitory effect on the trafficking of TLR7 agonists. Both studies also confirmed that EGA was able to reduce the secretion of IFN-α by SLE pDCs, though it did not have an effect on secretion of TNF-α. EGA presents a promising, potential new targeted therapy against SLE by reducing IFN-1 secretion. Further studies are needed to assess the efficacy of EGA in murine or human models.

Numbers of pDCs:

Depletion of pDC numbers represents an alternative mechanism of targeting pDCs. One therapy utilizing this approach is Talacotuzumab, or CSL362. This therapy, which is a monoclonal antibody, works by targeting CD123, which is the α chain of the IL-3 receptor [40]

and is highly expressed on pDCs compared to other peripheral blood cell types. The Fc-region of CSL362, which is the part of the antibody that interacts with immune cells, is engineered to result in increased ligation of CD16 [42], a receptor on the surface of NK cells that is necessary for NK cell-mediated antibody-dependent cellular cytotoxicity [41]. NK cells are lymphocytes that specialize in destroying infected and cancerous cells. A study conducted by Monaghan et al. ascertained that CSL362 did indeed result in a depletion of SLE human-derived pDCs; at dosage above 0.0123 μg/mL, CSL362 resulted in a near total depletion of pDCs, along with significant reductions of myeloid dendritic cells and basophil populations. CSL362 was also found to decrease IFN-α production following stimulation of SLE pDCs by CpGc, SLE Ig + necrotic cell lysates (NCL), and SLE sera + NCL compared to non-CSL632 exposed pDCs. Treatment also reduced the expression of genes induced by TLR9 and SLE ICs [42]. Talacotuzumab appears to be a promising new potential therapy, and more research exploring its effects in vivo is necessary.

Another pDC-depleting therapy in development is Daxdilimab, or VIB7734. VIB7734 is a monoclonal antibody treatment that targets immunoglobulin-like transcript 7 (ILT7), a marker specifically expressed on the surface of pDCs. In clinical trials for cutaneous lupus, Daxdilimab was shown to rapidly deplete numbers of circulating and skin-resident pDCs. Daxdilimab was also shown to reduce IFN production in the skin and was generally well-tolerated, with similar rates of infection and adverse effects between the control and treatment groups [54]. Daxdilimab is also undergoing clinical trials to evaluate its efficacy in SLE, such as one concluding in 2023 that investigated the efficacy and safety of Daxdilimab in moderate to severely active SLE. The trial was unsuccessful at achieving its primary endpoint, which was the proportion of participants who achieved a British Isles Lupus Assessment Group 2004 Index-based combined lupus assessment (BICLA) response and reductions in their oral glucocorticoid dosage to below 7.5 mg over 48 weeks. However, the trial was able to see differences in some secondary endpoints such as the proportion of participants who saw reductions in their corticosteroid dosage and achieved a SLE Responder Index-4 (SRI-4) response [55, 56].

Conclusion:

Systemic Lupus Erythematosus is an autoimmune disorder characterized by multisystem organ inflammation. SLE is mainly treated with antimalarials, glucocorticoids, and non-corticosteroid immunosuppressants. These treatments have been associated with several adverse effects and are often ineffective at managing SLE in patients. Though many cell types have been implicated in its pathogenesis, pDCs, in particular, have been proposed as a significant mediator of inflammation in SLE via their substantial secretion of IFN in response to the detection of nucleic acids. Thus, pDCs represent a promising new target for the development of new therapeutics for SLE patients. Many therapies targeting pDCs are undergoing clinical trials, and results indicate that pDC-targeting therapies are generally well-tolerated in patients with few adverse effects. However, given the clinical need for new SLE therapeutics, it is imperative for researchers to elucidate the mechanisms behind SLE and potential methods of targeting the development and pathogenesis of the disease, ultimately giving hope to patients.

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Environmental Impact of Organic Agriculture By Shuyi Zhang

ABSTRACT

      Conventional agriculture poses significant environmental challenges, prompting interest in organic farming. Organic practices, including crop rotation and closed nutrient cycles, offer potential solutions. Despite debates, organic agriculture is practiced globally, covering 76 million hectares. This paper examines its impact on soil health, water management, and ecological benefits, highlighting its potential to mitigate environmental degradation. Criticisms and challenges, such as labor efficiency and economic considerations, are also addressed. Overall, organic farming presents a promising avenue for sustainable agriculture, with potential benefits for the environment and society.

      Keywords: agriculture, organic farming, sustainability, soil health, water management, ecological benefits, carbon-based farming

1. INTRODUCTION

      Agriculture gives developing supplies of food and different items, but it significantly supports greenhouse gases, biodiversity loss, and agrochemical and soil contamination. The loss of biodiversity, climate change, and the depletion of natural resources are pressuring society to alter the predominant farming practices. There are several alternative production techniques that offer advantages for the environment and society, such organic farming. Crop rotation, intercropping, and closed nutrient cycles are the mainstays of organic farming, which also ignores the use of synthetic fertilizers and pesticides. The goal of organic health is to maintain and improve human and environmental health. However, there has been global debate regarding the potential contribution of organic agriculture to sustainable development. Organic agriculture is proficient in 191 countries, and more than 76 million hectares of agricultural land are be able to organically by at least 3.7 million agrarians. Universal rummage sale of organic food and drink grasped almost 125 billion euros in 2021. As around 38% of Earth's property cover is occupied by agriculture, the more significant part of these ecological outcomes come from arable land, which contains approximately 12% of the land cover. Carbon-based Agriculture (OA) is wounded on 1% of the global farming land area, and its significance continues to develop. In particular, OA is seen by quite a few people as affecting the climate than regular farming since uses of solvent mineral composts and engineered herbicides and pesticides are denied. The International Federation of Organic Agriculture Movements (IFOAM) states that: "Organic farming is a manufacture system that endures the health of soils, ecosystems, and people."
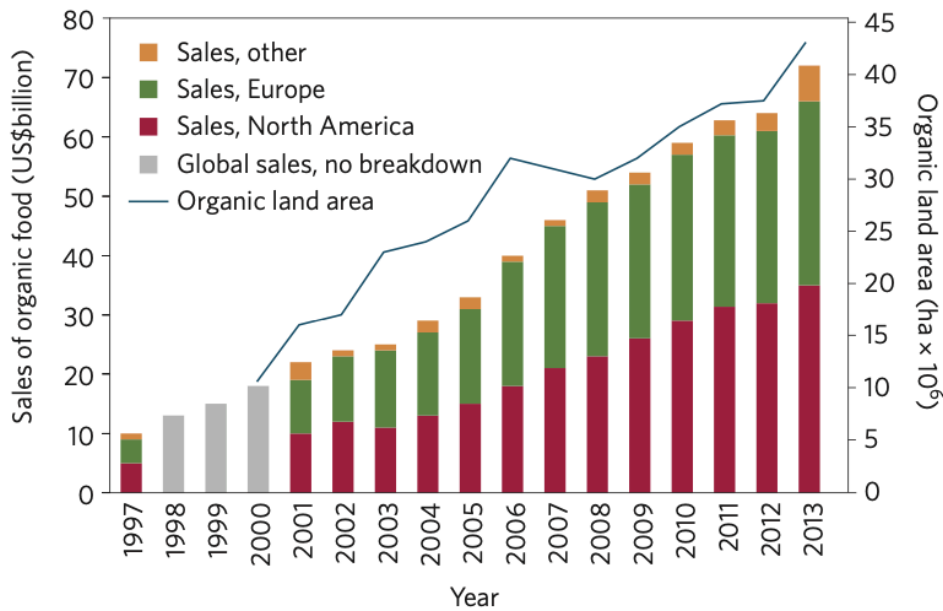
Figure 1: Annual global market for organic foods and land area of organic production

Organic agriculture, as certain by IFOAM, ought to be followed four guiding principles. Firstly, it must order the health of the land, plants, animals, humans, and the world as a whole. Secondly, it would be constructed on living environmental progressions and cycles, with an emphasis on increased soil organic matter, and the ability to work with, replicate, and support them. Thirdly, it should ensure equity in relations of the common environment and life opportunities through fair connections. Finally, it should be achieved with caution and responsibility to safeguard the well-being and well-being of present and future generations, as well as the environment.
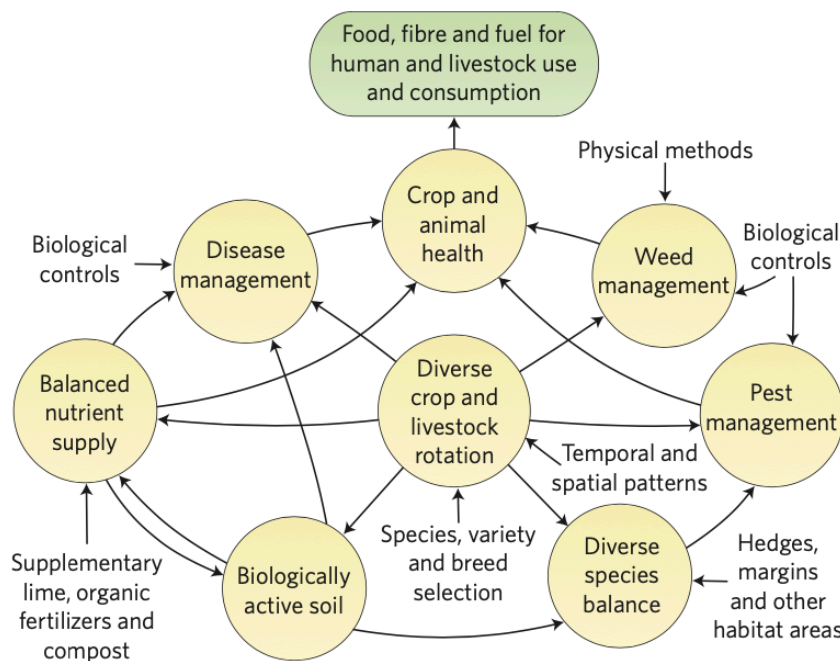
Figure 2: [Organic management practices](#)

2. DISCUSSION

Soil Health in Organic Agriculture

There is an urgent need to expand the information on the environmental effects of OA by conducting and evaluating long-term field trials in all major biomes and soils. Yields are around [19% lower under OA](#), and the associated lesser soil carbon (C) efforts, combined with tillage for weed control, contribute to lower profile soil organic carbon (SOC) stocks under OA. The consequences on soil inorganic carbon (SIC) stores are less well understood. Soils managed by OA, however, may release less carbon dioxide (CO2), nitrous oxide (N2O), and methane (CH4). Lush soils may have a higher CH4 uptake of [3.2 kg CO2 eq.](#) ha1 y1 under OA management. OA may also rally soil, air, and water excellence, but its possessions on biodiversity are equivocal. Food safety concerns and rising affluence will promote further growth in consumer demand for organic products. Even so, scientific interest in OA is less than a century old, and there is astonishing potential to mitigate its environmental implications, while OA-derived approaches can help to the sustainable strengthening of agricultural systems.

Water Resource Management in Organic Farming

The crop yield divided by the amount of water used determines water use efficiency. [Multiple ways](#) of further developing water use proficiency in organic agriculture have been proposed. These include evaporation through least culturing, mulching, utilizing more water-effective assortments, and actuating microclimatic changes to lessen crop water prerequisites. Sustainable agricultural practices can be feasible in further developing water use proficiency, specifically in developing agricultural nations impacted by water shortage. Organic Farming is possible in upgrading soil water content and further developing the effectiveness of water use.

Pimentel et al., (2005) revealed that through 1999, a year of thrilling drought (with total rainfall between April and August of [224 mm](#), associated to an average of 500 mm), the living animal system had meaningfully higher maize yield (1,511 kg/ ha) than either the biological pulse (412 kg/ha) or the conventional (1,100 kg per ha) systems.

For soybean, both organic systems outperformed the conventional system (Table 1).

Table 1: The Rodale Institute Farming System Trial, crops performance under drought condition, data after Pimentel et al. (2005)

Farming system	Yield (kg ha^{-1})	
	Corn	Soybean
Organic animal	1,511	1,400
Organic legume	412	1,800
Conventional	1,100	900

The fundamental cause for increased yield in organic crops is assumed to be the higher water-holding capacity of organically managed soils. When compared to conventional soils, organic soils catch and hold more water, up to 100% more in the crop root zone.

Organic Agriculture's Ecological Advantages

Soil biodiversity can benefit from a shift to organic soil management. One hectare of superior soil encompasses 1,300 kg of earthworms, 1,000 kg of arthropods, 3,000 kg of bacteria, 4,000 kg of fungi, and a variation of additional plants and animals. It should also be highlighted in this regard that SOM play an important role in enhancing soil biodiversity.

After reviewing several studies on soil biology, Hansen et al. (2001) discovered that biological farming is naturally linked with a suggestively complex level of biological activity, embodied by bacteria, fungi, springtails, mites, and earthworms, due to its versatile crop rotations, reduced nutrient applications, and pesticide ban. In a Swiss long-term experiment, soil ecological performance was considerably improved under biodynamic and organic management.

Contributions to the Sustainability of the Global Environment

It is a tremendous task to feed an emerging population that is predicted to reach 9 to 10 billion people by 2050 while also conserving the environment. Adopting truly sustainable agricultural techniques on a large scale is our best chance of overcoming this extraordinary task and assuring continuous food chains and ecological security.

According to a report published by the National Academy of Sciences in the United States, a farm can only be considered sustainable if it produces adequate amounts of high-quality food, improves the natural-resource base and environment, is financially viable, and contributes to the well-being of farmers and their communities. Hundreds of research studies comparing different features of organic and conventional farming systems have been published in the last two decades, as organic farming has grown in popularity. This section evaluates such comparison studies in these four areas of sustainability.
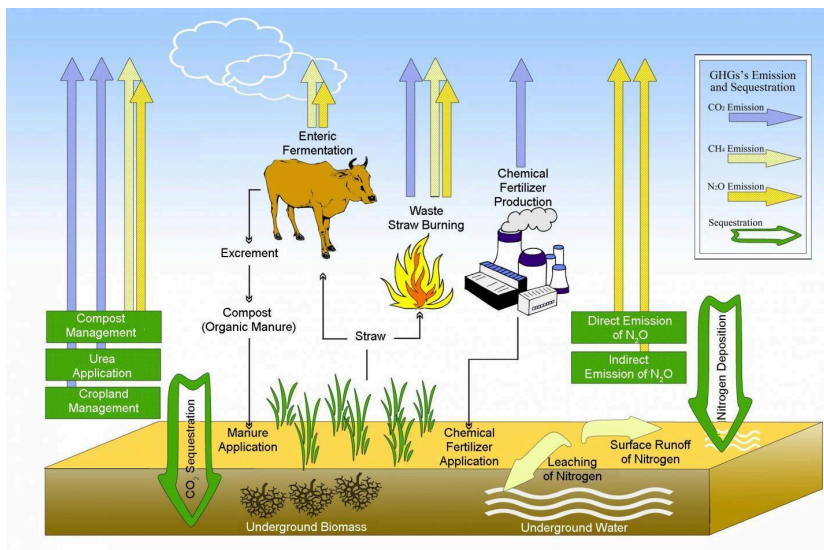
Figure 3: Carbon-based Farming can opposite the agriculture

Organic farming systems are supposed to be more environmentally friendly than conventional farming systems, according to reviews and meta-analyses. For instance, such collective studies have reliably indicated that organic farming systems have higher soil carbon levels, better soil quality, and less soil erosion than unoriginal systems. Besides, organic farms have higher plant diversity, higher faunal diversity (insects, soil fauna and microbes, birds), and typically higher habitat and landscape diversity. Furthermore, in a study spanning eight Western and Eastern European countries, insecticides and fungicides consistently had a negative impact on biodiversity, with pesticides lowering the biological control capability in farming systems.

Organic farms had reduced nitrate leakage, nitrous oxide releases, and ammonia emissions per unit of field area, then higher leakage and emissions per unit harvest, according to a meta-analysis of environmental quality metrics. Excessive use of nitrogen and phosphorus fertilizers has been linked to severe degradation of freshwater and marine ecosystems around the world, resulting in eutrophication of freshwater and the formation of hypoxic zones in coastal seas.
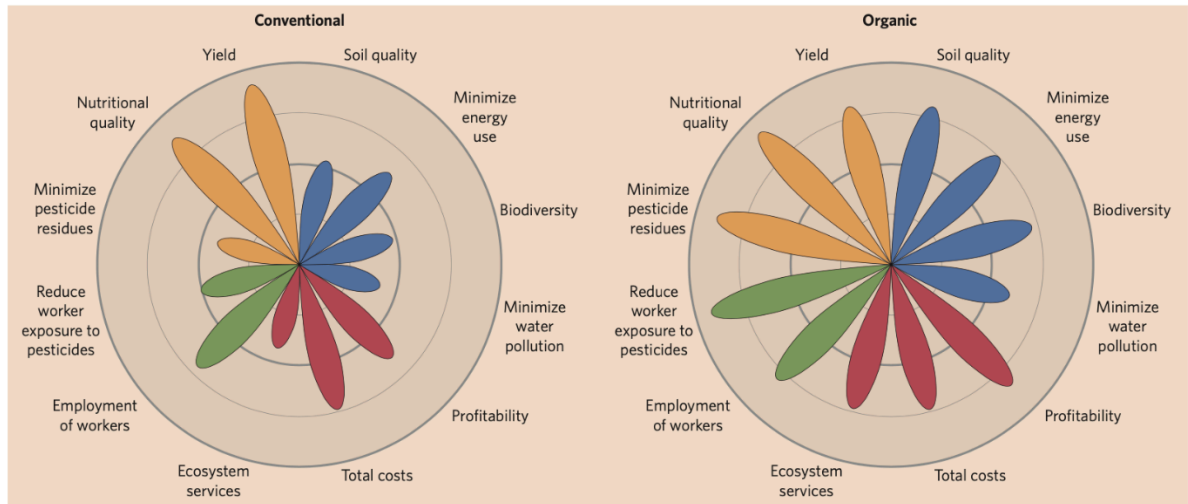
Figure 4: Assessment of biological farming virtual to conservative farming in the four major areas of sustainability

Criticisms and Challenges

Organic farming, according to some authors, is an ideology rather than a scientific approach to agriculture.

Labor efficiency is a significant criterion in determining the socioeconomic sustainability of farming companies. Organic farms, while more energy efficient, require more labor than conventional farms, ranging from 10% to 90%.

The economic benefits of agriculture management cannot be restricted to yield or commodity output or to farm investment and revenue alone. For example, when doing farming cost-benefit evaluations, concerns such as energy efficiency and GHG emissions, water supply preservation are typically not considered.

Barriers to sustainable agriculture

Powerful vested interests and existing policies

Lack of information and knowledge

Misconceptions and cultural biases

Weak infrastructure and other economic challenges

Production

Environment

Sustainable agriculture

Wellbeing

Economics

Financial instruments
• Increased farmer access to capital
• Elimination of crop subsidies and biofuel incentives
• Use of agro-environmental incentives
• Increased costs of scarce resources
• Targeted input subsidies for resource-poor farmers
• Investment in rural infrastructure

Legal instruments
• Measures to ensure open and competitive markets
• Reduction of commercial influence in government
• Development of national targets and trade policies for food and ecosystem security
• Enhanced security of land tenure

Knowledge-based instruments
• Public investment in agroecological research
• Farmer engagement in research and development
• Outreach to improve farmer knowledge and capacity
• Enhancement of women's educational and leadership opportunities
• Increased transparency throughout the food chain

Figure 5: Policy instruments for overwhelming obstacles to farmers adopting more ecological farming systems

3. CONCLUSION

Potential Future Trends of Organic Agriculture

A key element of sustainable agriculture is organic farming. Farmers still confront significant obstacles in spite of the potential advantages of biological farming, such as a lack of understanding and awareness of the methods and advantages of organic farming. A future with more organic food could be a very practical means of feeding the growing global population and ensuring stronger food security. It is said that using sustainable organic food production techniques can reduce climate change, maintain biodiversity, and yield nutrient-dense meals.

In order to prevent some diseases and pests from attacking organic farming and potentially lowering crop yields, special treatments are needed. Usually, this is accomplished by hiring skilled pest control professionals, who may be more expensive than using non-organic techniques.

Carbon-based farming appears to have a bright future ahead of it. In the near term, production may reduce yields, but generally, yields should remain or grow in the long run to feed the growing global population. In building a more secure, safe, and sustainable supply chain, the benefits appear to exceed the drawbacks, and they will only become better with time and more innovation.

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Ball Detection in Field Hockey Using the YOLOv5 Algorithm By Adhit Ranjan

Abstract

Accurately identifying the ball in field hockey videos is crucial for several purposes, such as player tracking, tactical analysis, and performance evaluation. This study introduces a detailed method that uses the YOLOv5 algorithm, which is well-known for its real-time object detection capabilities and accuracy, to detect the ball accurately. The proposed approach involves training the YOLOv5 model on a specialised dataset that includes annotated field hockey videos to enable precise ball identification and localization. The effectiveness of the proposed method is demonstrated through experimental evaluation, which utilises comprehensive metrics, including precision, recall, and mean Average Precision (mAP), showing high levels of accuracy and efficiency. By automating the ball detection process, this approach significantly reduces manual effort in field hockey video analysis and opens opportunities for advanced analytics, providing deeper insights into player behaviour, strategic patterns, and overall game dynamics. The outcomes of this study can significantly enhance the understanding of field hockey games, aid in strategic decision-making, and provide valuable insights for coaches, analysts, and players. The subsequent sections of the paper will discuss related work in the field, describe the methodology employed, present the experimental results and analysis, and conclude with a summary of the contributions and future directions of this research.

Introduction

Accurately detecting the ball in field hockey videos is a crucial task in the field of field hockey video analysis, which has several applications, such as player tracking, tactical analysis, and performance evaluation[1]. Automatically identifying and tracking the ball in field hockey videos provides essential insights into player behaviour, team strategies, and overall game dynamics[7]. The YOLOv5 algorithm is a state-of-the-art object detection framework that has demonstrated excellent performance in real-time object detection tasks. [8] This study aims to develop a method for accurate ball detection in field hockey videos by utilising the capabilities of YOLOv5. The research objectives include training the YOLOv5 model on a specialised dataset of annotated field hockey videos and evaluating the performance of the proposed method in terms of accuracy and efficiency in detecting and tracking the ball. The study's contributions include a novel application of the YOLOv5 algorithm in the context of field hockey video analysis and a validated methodology for accurate ball detection.

Background on ball detection in field hockey video analysis

Field hockey is a dynamic sport that involves intricate player movements and strategic gameplay. Analysing field hockey videos can provide valuable insights into team dynamics, player performance, and tactical patterns. One critical aspect of field hockey video analysis is the

accurate detection and tracking of the ball. The ball is the centrepiece of the game, and its position and movement play a crucial role in understanding the flow of the match. Accurately detecting and tracking the ball in field hockey videos provides analysts and coaches with a deeper understanding of player interactions, passing patterns, goal-scoring opportunities, defensive strategies, and overall game dynamics. However, manual ball detection in field hockey videos is a laborious and time-consuming task, limiting the scalability and efficiency of the analysis process. Therefore, automated ball detection methods are in high demand to streamline the video analysis workflow. Computer vision and deep learning techniques have made it possible to automate ball detection in field hockey videos, and the YOLOv5 algorithm is one such technique that has received attention for its real-time object detection capabilities and accuracy. By leveraging the YOLOv5 algorithm, we aim to provide a robust and accurate automated solution for ball detection in field hockey videos. The significance of accurate ball detection in field hockey video analysis lies in its potential to revolutionise the way the sport is analysed and understood. By automating the ball detection process, analysts can save time and effort, leading to larger-scale analyses and more comprehensive insights. Coaches can make data-driven decisions based on reliable ball tracking, leading to improved training strategies and game planning. Additionally, players can benefit from post-match analyses that provide detailed feedback on their performance and areas for improvement. In conclusion, accurate ball detection in field hockey video analysis is a crucial element for comprehensive match analysis, tactical evaluation, and player performance assessment.

Methodology

The methodology section describes the proposed approach for accurate ball detection in field hockey videos using the YOLOv5 algorithm. It outlines the steps involved in dataset preparation, model training, and the integration of tracking algorithms.

Background on YOLOv5

The YOLOv5 algorithm has emerged as a leading object detection framework, known for its exceptional accuracy, real-time processing capabilities, and overall resilience. YOLOv5 is an extension of the YOLO series, which stands for "You Only Look Once," emphasising its ability to perform object detection in a single pass through the neural network. YOLOv5 is based on a deep convolutional neural network architecture that uses convolutional layers, down sampling, and up sampling operations. YOLOv5 estimates bounding boxes and class probabilities for each individual grid cell by partitioning the input image into a grid. This approach enables YOLOv5 to efficiently detect multiple objects of different sizes and aspect ratios within an image. The relevance of YOLOv5 to ball detection in field hockey videos lies in its ability to accurately identify and localise objects, including small and dynamic objects like the ball. YOLOv5 has been trained on diverse datasets containing various object categories, making it capable of detecting objects with high precision and recall. To adapt YOLOv5 for ball detection in field hockey videos, a specialised dataset is prepared, consisting of annotated field hockey videos

where the ball's location is labelled. The model is trained on this dataset, allowing it to learn the visual characteristics of the ball, including its shape, colour, and motion patterns. One advantage of YOLOv5 for ball detection is its real-time performance. The algorithm can process video frames at a high frame rate, enabling near real-time ball detection in field hockey matches. This aspect is crucial for providing immediate feedback to coaches, players, and analysts during live or post-match scenarios. Additionally, YOLOv5 offers the flexibility to balance speed and accuracy through parameter settings, making it suitable for different computational resources and performance requirements. This adaptability allows researchers and practitioners to fine-tune the algorithm to achieve optimal ball detection results in the context of field hockey video analysis. The robustness of YOLOv5 in handling occlusions, varying lighting conditions, and complex backgrounds further enhances its relevance to ball detection in field hockey videos. It can effectively handle challenging scenarios often encountered in field hockey matches, ensuring accurate and reliable ball detection results.

Research Aim

The objective of this research is to develop a precise ball detection methodology using the YOLOv5 algorithm and make a significant contribution to the field of field hockey video analysis. The research aims to achieve this by creating a robust methodology for detecting the ball in field hockey videos, training the YOLOv5 model on a specialised annotated dataset, and evaluating its performance using standard metrics. The proposed method provides an automated and dependable solution for ball detection. This approach simplifies the video analysis workflow, allowing for scalable and comprehensive analysis of field hockey matches. The proposed method addresses the need for automated and reliable ball tracking and provides valuable insights for coaches, analysts, and players. The research outcomes contribute to advancements in computer vision and sports analytics, paving the way for further developments in automated object detection in sports.

Roboflow

Roboflow provides handpicked and preprocessed datasets for various computer vision tasks, such as object detection, image classification, and segmentation, making it easy to integrate into machine learning workflows[9]. To develop the proposed ball detection method using the YOLOv5 algorithm was combined with two distinct hockey ball datasets available on the Roboflow platform. These datasets comprise a diverse range of field hockey game images and annotations for the hockey ball, enabling us to train and evaluate our proposed ball detection methodology effectively.

Table 1 - Dataset details

Total Images	500
Classes	1

Unannotated	0
Training set	435 (87%)
Validation set	45 (9%)
Testing set	20 (4%)
Average image size	0.25 mp

Experimental Setup

To achieve accurate ball detection in field hockey videos using the YOLOv5 algorithm, the experimental setup involves various components. Firstly, a carefully curated dataset of field hockey videos is used, consisting of diverse matches, playing conditions, camera angles, and player movements. The dataset includes annotated ground truth bounding boxes for the ball and is split into training and validation subsets. The training set is used to train the YOLOv5 model with the annotated ball bounding boxes, while the validation set is used for hyperparameter tuning, model selection, and performance evaluation during training.

The YOLOv5 architecture is configured with specific numbers of parameters as per model configuration, including the number of anchor boxes, network depth, and other architectural choices. These configurations are determined based on empirical analysis and domain expertise to achieve optimal performance in ball detection. To leverage pre-existing knowledge, transfer learning is employed, and the YOLOv5 model is initialised with weights pretrained on large-scale image datasets such as COCO. Fine Tuning is then performed using the annotated field hockey dataset to adapt the model to ball detection in the specific context of field hockey videos.

The model is trained using the annotated dataset with the YOLOv5 annotation format, with the optimization process involving minimising the detection loss, such as the localization loss and the confidence loss, using gradient-based optimization algorithms like stochastic gradient descent (SGD) (lr=0.01) with parameter groups 97 weight(decay=0.0), 104 weight(decay=0.00046875), 103 bias. The learning rate, batch size, and other hyperparameters are tuned to achieve optimal performance. The performance of the proposed ball detection method is evaluated using standard accuracy metrics such as precision, recall, and F1 score, providing insights into the model's ability to accurately detect the ball in field hockey videos.

The software implementation utilises deep learning frameworks, specifically Ultralytics, for training the YOLOv5 model. Figure-1 in the paper shows the flow chart of the process to perform ball detection.

Evaluating the YOLOv5 Model

This section focuses on evaluating the performance of the YOLOv5 model for detecting balls in field hockey videos using precision, recall, and mean Average Precision (mAP) metrics.

These metrics provide valuable insights into the accuracy, recall, and localization precision of the model. Precision measures the accuracy of ball detection by calculating the ratio of correctly detected balls to the total number of detections, indicating how accurately the model identifies the ball. Recall measures the model's ability to detect all instances of the ball, regardless of false negatives. mAP is a popular evaluation metric used in object detection tasks, which measures the overall performance of a model by considering both precision and recall.

To compute mAP, the precision-recall curve is computed by varying a confidence threshold for object detection. The area under this curve is then averaged across all object classes to obtain the mean Average Precision. The precision, recall, and mAP metrics are analysed to.

Results

      By evaluating the ball detection performance using these metrics, we gain insights into the accuracy, recall, and localization precision of the YOLOv5 model. This analysis allows us to assess the model's ability to accurately identify and localise the ball in field hockey videos and make informed decisions regarding its performance and potential improvements.

Table 2 - At epoch 100, the performance of hockey ball detection was evaluated using different YOLOv5 models

Epochs	Pretrained YOLOv5 Model	Size/pixels	Parameters (millions)	Images	Instances	P	R	F1 Score	mAP (50)	mAP (50-95)
100	YOLOv5n	640	3.2	45	47	0.75	0.60	0.67	0.63	0.20
	YOLOv5s		11.2			0.73	0.56	0.64	0.61	0.20
	YOLOv5m		25.9			0.75	0.63	0.69	0.62	0.22
	YOLOv5l		43.7			0.73	0.52	0.61	0.55	0.19
	YOLOv5x		68.2			0.76	0.54	0.63	0.57	0.20

Table 3 - Precision Values for different YOLOv5 Models

Pretrained YOLOv5 Model	P
YOLOv5n	0.75
YOLOv5s	0.73
YOLOv5m	0.75

YOLOv5l	0.73
YOLOv5x	0.76

Table 2 presents the performance metrics of different YOLOv5 models for detecting hockey balls. The models are evaluated on a specific dataset consisting of 45 images with 47 ball instances, and the measured metrics include precision (P), recall (R), mAP at IoU 50 (mAP50), and mAP at IoU 50-95 (mAP50-95). The table illustrates the performance of different YOLOv5 models in terms of precision, recall, F1 score, mAP50, and mAP50-95. YOLOv5m outperforms the other models, exhibiting the highest precision (0.752) and recall (0.631).

Figure 2 presents the confusion matrix of the YOLOv5m model for ball detection, providing a detailed overview of the model's classification performance. Figure 3 showcases the graph of evaluation metrics as a function of the number of epochs, providing insights into the model's performance over time in terms of metrics such as precision, recall, and mAP.
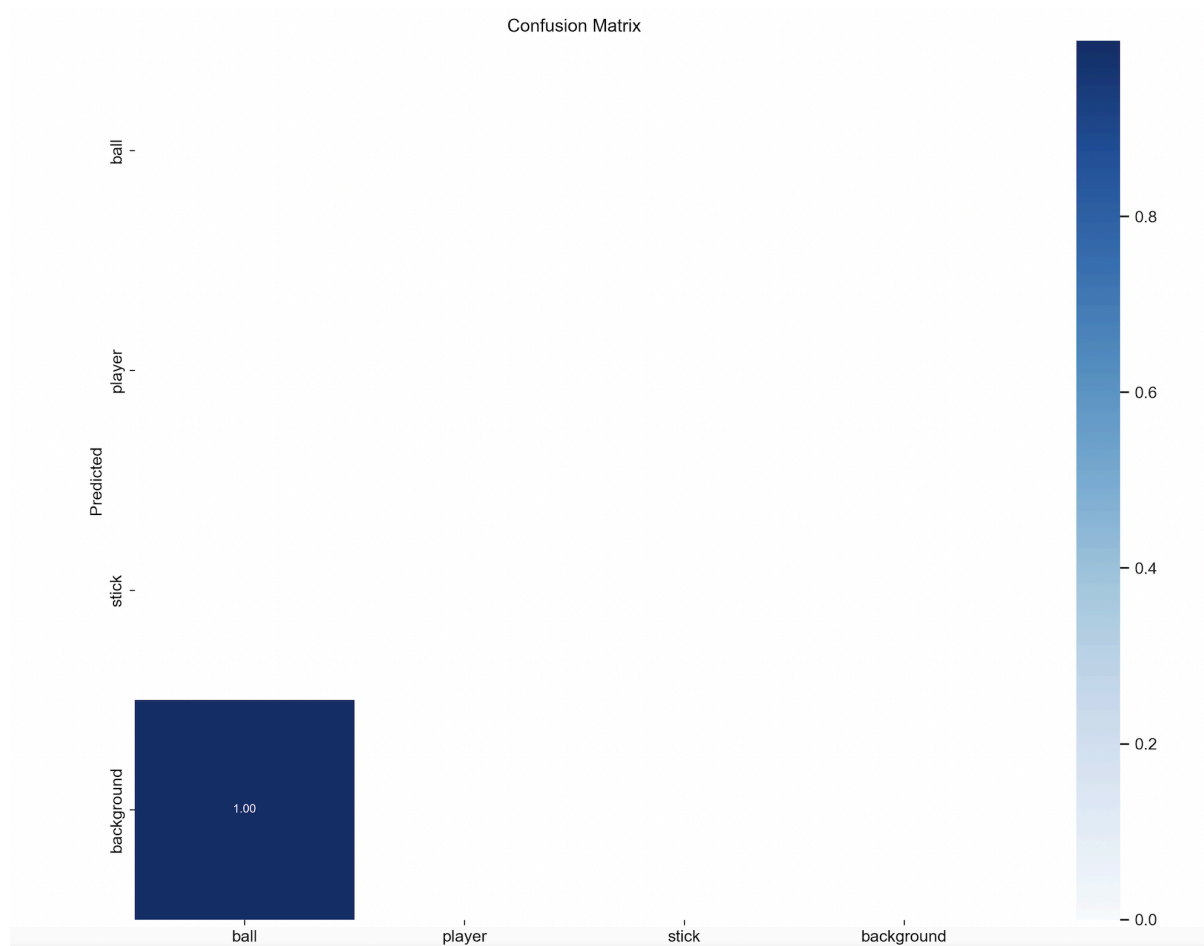

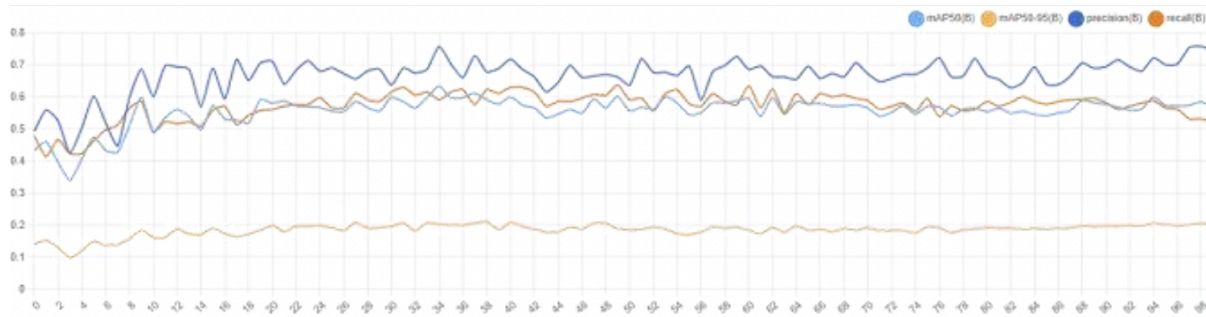Figure 2 Confusion matrix of YOLOv5m model for hockey ball detection

Figure 3 Evaluation metrics graphs of YOLOv5m model for hockey ball detection

Discussion

The application of the YOLOv5 algorithm for accurate ball detection in field hockey videos brings significant advancements to the field of field hockey video analysis. This technology enables precise detection of the ball's position, movement, and interactions with players, unlocking a wide range of applications and benefits. This research paper highlights the relevance of the YOLOv5 algorithm in achieving accurate detection results and provides a comprehensive overview of the methodology, including dataset acquisition and annotation, training the YOLOv5 model, and evaluating performance using appropriate metrics.

The literature review and related work section provide insights into existing ball detection techniques and object detection algorithms, emphasising the applicability and performance of the YOLOv5 algorithm in the field hockey context. The evaluation and results analysis demonstrate the effectiveness of our proposed method in accurately detecting balls in field hockey videos. Among the tested models, the YOLOv5m model exhibits the best performance, with higher precision, recall, F1 score, and mAP values. These results provide valuable insights for accurate ball detection in field hockey videos using YOLOv5.

Conclusion

Among the tested models, YOLOv5m demonstrates the best performance. It achieves the highest precision (0.752) and recall (0.631), resulting in a relatively higher F1 score (0.686). Additionally, YOLOv5m obtains a good mAP50 value of 0.623 and mAP50-95 value of 0.215. YOLOv5n and YOLOv5x exhibit comparable precision and recall values, with YOLOv5x having a slightly higher F1 score (0.632). However, YOLOv5n performs better in terms of mAP50 (0.626) compared to YOLOv5x (0.574). On the other hand, YOLOv5s and YOLOv5l models show lower precision, recall, and F1 score compared to the other models. They also have lower mAP50 and mAP50-95 values.

It is important to acknowledge certain limitations, such as occlusions, varying lighting conditions, and camera angles, which can still pose challenges to accurate ball detection. Future improvements could involve exploring advanced algorithms, incorporating multiple camera angles for enhanced accuracy, and optimising the training process for better performance.

The evaluation of the YOLOv5 models provides valuable insights into its capabilities and can guide future research and development in accurate ball detection methods for field hockey

videos. The results suggest that the model architecture and complexity play a crucial role in achieving higher accuracy and detection performance. Depending on the desired balance between precision, recall, and computational efficiency, different models may be preferred. Further optimization and fine-tuning of the models may lead to improved performance in ball detection tasks.

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Apr 29, Brad Dwyer, and Read 2021 6 Min. "Getting Started with Roboflow." Roboflow Blog, 29 Apr. 2021, blog.roboflow.com/getting-started-with-roboflow/.

Identifying Exoplanets by Using Artificial Intelligence By Maria Sawaya

Abstract

How can we find exoplanets in the universe using machine learning? Identifying exoplanets is a first step towards finding habitable planets and potentially intelligent life. To answer this question, I applied transit photometry and artificial intelligence to find patterns in the data that is otherwise hard to find using classical methods. We trained several models to identify patterns in the data to pre-select candidate planets for further exploration. For every model, some predictions weren't the same sometimes. Major conclusions in relation to this problem are that out of all the models that we used, the logistics regression model and the decision tree model were the most efficient, but none of them were perfect. For example, for the logistic regression we were able to achieve an accuracy score of 64.7%, and an F1 score of 2.68%; and for the decision tree we were able to achieve an accuracy score of 98.45% and an F1 score of 12.12%.

Introduction

What is an exoplanet? An exoplanet is a planet, that is outside the solar system, that orbits around a star. Identifying exoplanets is the start of finding habitable planets and eventually maybe intelligent life.

There are many ways to find exoplanets in the universe. The most effective way to date is the transmit photometry method, which consists of making direct observation on an exoplanet and its host star and measuring the change in its brightness. When a planet passes in front of her star, its brightness dims down slightly. The regular dim in brightness, indicates the planet orbiting and passing in front of the star every so often. Given the amount of data gathered by telescopes and the noise that the data typically carries, using machine learning provides a quicker and more accurate way of identifying potential exoplanet candidates. This pattern of dimming with regularity is what we hope our models pick up on. [(1)]

In my research, I used Python to analyze the data, worked with supervised learning and used a labeled dataset. I specifically used classification models. I tested out many classification models, such as logistic regression model, decision tree classifier and random forest classifier. In addition, I used numerical data in my research. I will be using a lot of numerical data, like to find the accuracy score, the precision score, the recall score and the F1-score of my models. To further analyze the models' mistakes, I will use a confusion matrix and a ROC curve display for each of my classification models. Lastly, I will be analyzing the flux data of a star after intervals. If I see a dim light at a certain area of the star after each interval, that means that there is an exoplanet present orbiting around the star. The labels of the given data for each star are either 1, meaning that there isn't an exoplanet, or 2, meaning that there is one.

Background

In recent years, the scientific community has made significant progress in identifying and qualifying exoplanets using available data provided by telescopes like Kepler or TESS. For example, a recent article published by NASA suggests that the agency already discovered 5599 exoplanets, the majority of which (4138) using the transit photometry method [(2)].

The use of machine learning to accelerate discovery and reduce errors has also become more common. For example, a recent study by the University of California at Berkeley describes how the team used machine learning to identify exoplanets with high degree of accuracy. The research team used both supervised and unsupervised learning to qualify their results (3).

These models have also been tested on different data sets. For example, a research team in Oxford applied its machine learning model on different datasets (Kepler and TESS) and found a similar level of accuracy in qualifying exoplanets (4).

1. Dataset
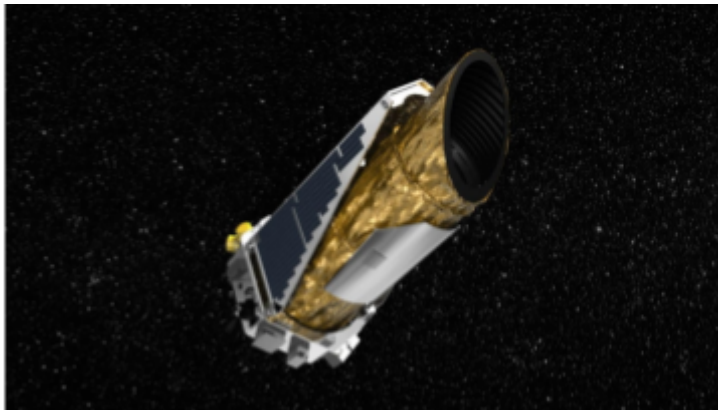
Picture of the Kepler Telescope

This process is very similar to the K2 mission. For 80 days, the K2 mission identified 100 square degrees. K2 is the second Kepler mission. The First Kepler mission, in 2013, ended because of the loss of the second reaction wheel. The K2 telescope is designed to continuously search for a part of our galaxy (Milky Way) for planets orbiting stars outside our solar system. This is done to be able to sample sight lines of certain parts of the Galaxy. The telescope uses the transit photometry method. It observes different stars to detect a slight dim in light that could potentially mean that there is the presence of exoplanets (5).

The data that I used comes from a paper on Kaggle called "Exoplanet Hunting in Deep Space" (6). With this data, I was able to identify 42 exoplanets out of about 3197 labels. This result isn't precise, but it was my first test.
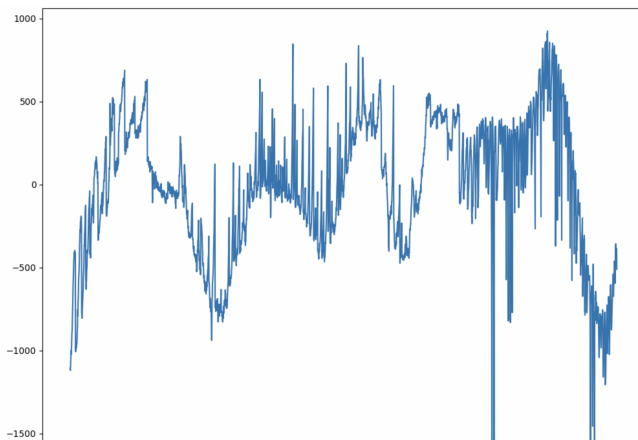

```
plt.figure(figsize=(12,10))
plt.plot(exo_data.iloc[4])
plt.xticks([])
plt.show()
```

This is an example of a chart that I created using one of the 42 stars with exoplanets that I briefly identified using the flux data. We can see that there is a dim light after intervals. Most of the intervals have a flux that is under zero, meaning that it is weak.

This flux data helped me throughout my research. I used this data for every test or program that I made. This data isn't very abundant, but I did have enough information to complete this project.

2. Methodology / Models

To solve my research problem, I used the flux data of 5657 stars and thoroughly analyzed it. I worked with supervised learning, meaning that I used labeled datasets, in this case a labeled flux dataset to answer my research question.

I used Google Colab with several python libraries. I imported libraries such as Pandas, Numpy and all the Sklearn modules (sklearn.metrics, sklearn.linear_model, sklearn.tree…).
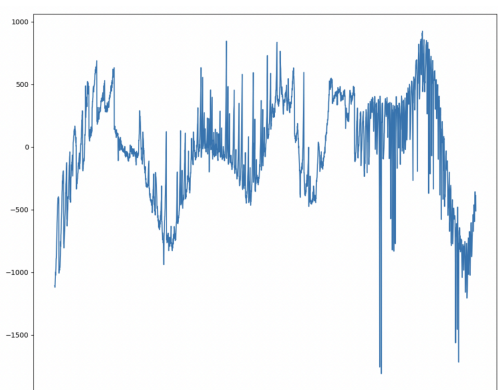
To start off my analysis, I looked at a few of these stars and inserted the flux data of each interval onto a line chart. Looking at this chart, I can briefly analyze the flux data and potentially say that the light of the star does dim at certain intervals. This way of analyzing the data is not very efficient.

A better way of observing the data is by using different models. I worked on a classification problem. I used various machine learning algorithms of classification :

- The logistic regression model: predicts an outcome of an observation. There are only two possible outcomes : true or false ; 0 or 1 ; yes or no. It finds the relationships and similarities between two data factors. It learns a weight for every input, and uses those to make a weighted sum, from which we calculate a probability after feeding it to a sigmoid function. Based on that probability, we get a classification.
- The decision tree: This model creates a tree of decisions based on the data. The latter is classified because of the branches of the decision tree. It narrows down the data according to the specific characteristics of each branch. Each branch focuses on a particular input (particular time point).
- The Random Forest Classifier: Incorporates the output of many decision trees to then reach a single result. It gives the input to these decision trees and it will see what each tree answered. The result will be based on the majority vote. Each decision tree takes a subset of the data.
- KNN (k-Nearest Neighbour classification): It uses proximity of the K-nearest neighbors to predict or to classify the data. K is the number of neighbors there is in the training data.

	FLUX.1	FLUX.2	FLUX.3	FLUX.4	FLUX.5	FLUX.6	FLUX.7	FLUX.8	FLUX.9	FLUX.10	...
LABEL											
2	93.85	83.81	20.10	-26.98	-39.56	-124.71	-135.18	-96.27	-79.89	-160.17	...
2	-38.88	-33.83	-58.54	-40.09	-79.31	-72.81	-86.55	-85.33	-83.97	-73.38	...
2	532.64	535.92	513.73	496.92	456.45	466.00	464.50	486.39	436.56	484.39	...
2	326.52	347.39	302.35	298.13	317.74	312.70	322.33	311.31	312.42	323.33	...
2	-1107.21	-1112.59	-1118.95	-1095.10	-1057.55	-1034.48	-998.34	-1022.71	-989.57	-970.88	...
...	...	...	...	...	...	...	...	...	...	...	...
1	374.46	326.06	319.87	338.23	251.54	209.84	186.35	167.46	135.45	107.28	...
1	-0.36	4.96	6.25	4.20	8.26	-9.53	-10.10	-4.54	-11.55	-10.48	...
1	-54.01	-44.13	-41.23	-42.82	-39.47	-24.88	-31.14	-24.71	-13.12	-14.78	...
1	91.36	85.60	48.81	48.69	70.05	22.30	11.63	37.86	28.27	-4.36	...
1	3071.19	2782.53	2608.69	2325.47	2089.37	1769.56	1421.09	1142.09	902.31	714.47	...

To split the data, I first imported the train_test_split function from sklearn.model_selection and then split the data into four parts : X_train, X_test, y_train and y_test. We first train the model to learn the data, and then we test it. That will make evaluation metrics (accuracy score , F1 score…) to be more accurate. We make the split so we can see how well the models would do on data they haven't seen, which gives us a better idea of how they're actually doing than if we tested them out on the data they were trained on. If we use the same dataset to train the model and to test the model, we will have a bias result. Without the train_test_split function, we wouldn't be able to tell if the end result is good or bad because our model would be biased to the dataset that we used to train.

To sum this up, splitting the data will let us see how well the models would do on data they haven't seen, which gives us a better idea of how they're actually doing than if we tested them out on the data they were trained on.

5. Results and discussion

I found the accuracy score, the precision score, the recall score and the F1 score of each of my models by using predictions:

	Logistic regression	Decision Tree	Random Forest	KNN
Accuracy score	64.97 %	98.45 %	99.30 %	99.30%
Precision score	1.37 %	10.00 %	00.0 %	0.00%
Recall score	69.23 %	15.38 %	0.00 %	0.00%
F1-score	2.68 %	12.12 %	0.00 %	0.00%

From what I observed, the logistic regression model is the most precise on the recall score, the decision tree and the Random forest classifier are more precise on the accuracy score. (KNN). The most efficient model would be logistic regression model, then the decision tree, and lastly the Random forest classifier.

For the precision score, the real score and the F1-score of the Random forest classifier and KNN, my model is guessing that there isn't an exoplanet for everything. All the scores are at 0.00% so it is unclear.

I think that the logistic regression model may have better predictions because of its purpose. It compares and contrasts better than the other metric. It learns the weight of every input, and then creates a weighted sum to calculate the probability, which is used for classification. For the decision tree classifier, the results are less favorable because this model is less stable. If you change one parameter in the data, it could lead to significant change in the decision tree, and it could return wrong information. The random forest classifier has the worst prediction performance because of the large number of trees and branches. It also takes a longer time to process. In addition, the result is based on the majority vote, which could potentially be less precise. In all the metrics, the accuracy score is not providing a complete picture of the models' performance. For example, in the random forest, the accuracy score is close to 100%, but performs poorly on the other metrics.

I also made a confusion matrix and a ROC curve for each of my models. A confusion matrix indicates whether my predictions are true positive, true negative, false positive and false negative. True positive means that the predictions are actually true. True negative tells you that the predictions are written as true but they aren't. False positive means that the predictions are actually false. Lastly, false negatives tell you that the predictions are written as false, but they are actually true. A ROC curve changes the probability cutoff for the positive vs. negative of the classification. To read a ROC curve, you have to understand that the closer the curve is to the upper left corner of the graph, the higher the accuracy of the test is.

Logistic regression model :

Confusion matrix
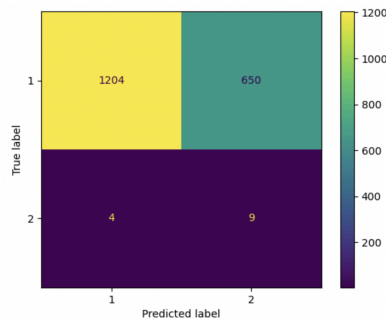
- True non-exoplanets (true negative) → 1204
- Fasle exoplanets (false positive) → 650
- True exoplanets (true positive) → 9
- False non-exoplanets (false negative) →4

Roc Curve
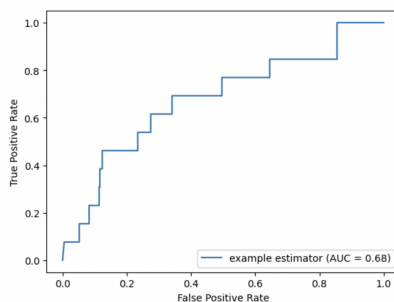
The ROC curve is leaning more to the true positive rate than the false positive rate. It could do better because the curve is

not at the top left corner as it is more at the diagonal of the graph. The model's deduction is decently accurate.

Decision tree classifier:

- True non-exoplanets (true negative) → 1836
- Fasle exoplanets (false positive) → 18
- True exoplanets (true positive) → 2
- False non-exoplanets (false negative) →11
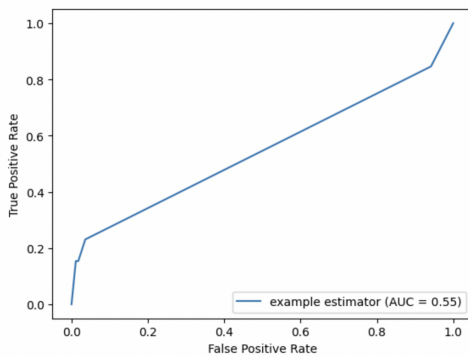
In this case, the ROC curve is leaning at the middle of the graph. It is at its diagonal. It could do better because the curve is at the false positive rate which is equivalent to 0.0. The model's prediction is not accurate.

Random Forest Classifier :
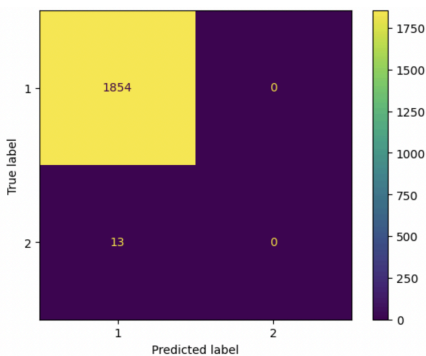
- True non-exoplanets (true negative) → 1854
- Fasle exoplanets (false positive) → 0
- True exoplanets (true positive) → 13
- False non-exoplanets (false negative) →0
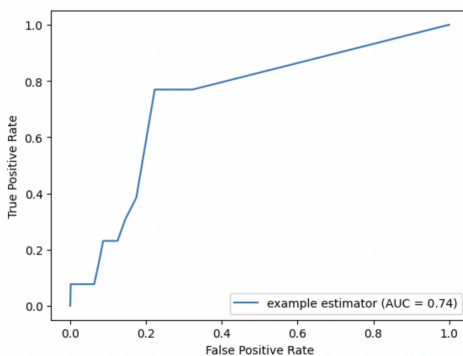
The ROC curve is leaning a lot more to the true positive rate than in the other models. This curve is the closest to the top left corner meaning that this model is closer to a true positive rate than a false positive rate. This shows us that this model's prediction is quite accurate.

KNN Model :
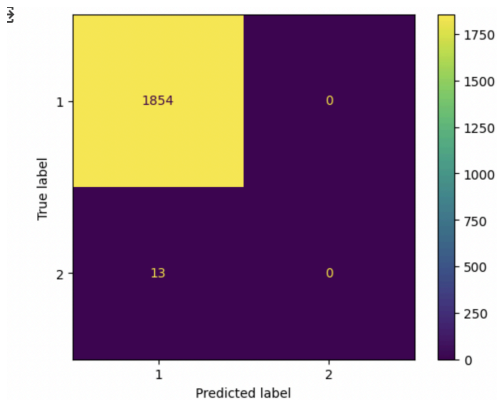
- True non-exoplanets (true negative) → 1854
- Fasle exoplanets (false positive) → 0
- True exoplanets (true positive) → 13
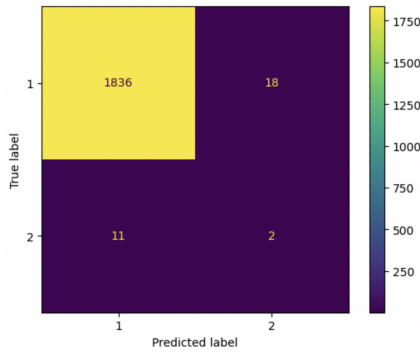- False non-exoplanets (false negative) →0
- These are the same results as for the Random forest classifier because they both learn to make a negative prediction for everything.
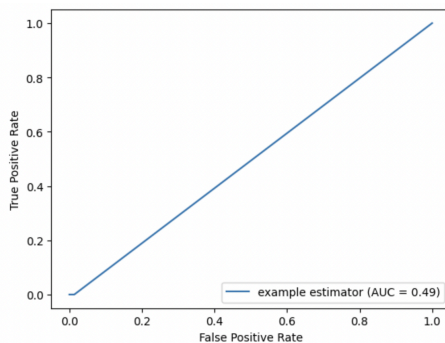
The ROC is literally on the diagonal of the graph. It means that the rate is close to 0.0 meaning that the curve is at a false positive rate. The model's prediction is inaccurate.

Each model gives a similar number for true non-exoplanets (from 1200-1850) but for the rest, the numbers tend to change. It is normal because the probability of actually identifying an exoplanet is very low. The other numbers are still really little compared to the true non-exoplanets, but you can see a change for every model. For example, the logistic regression model says that there are 650 false exoplanets, the Decision tree classifier says 18 , the Random forest classifier says 0 and KNN says. There are definitely different predictions.

Conclusions

Throughout my project, I answered my research question: How can we find exoplanets in the universe and how can we detect them using machine learning? There are many ways to identify exoplanets. The most effective way to date is the transmit photometry method, which consists of making direct observation on an exoplanet and its host star and measuring the change in its brightness.

In my research, we used Python to analyze the data, worked with supervised learning and used a labeled dataset. We specifically used classification models such as logistic regression, decision tree classifier. In addition, we used numerical and image data. We found the accuracy score, the precision score, the recall score and the F1-score of my models and then, to further analyze the models' mistakes, we used a confusion matrix and a Roc curve display. These suggested that my findings were not accurate enough (for example returning 650 false positives

in the logistic regression) and that further improvements are needed to improve the accuracy of my models.

One obvious improvement area is the dataset used in our research. The amount of data used is insufficient and needs to be expanded in the future in order to get more accurate results.

In our future work, we would expand the dataset and use hyperparameters to refine the accuracy of our models and pick the one that can help best identify exoplanets. For example, max depth would be a good hyperparameter to use.

Works Cited

References

Use ASME style for References. Refer to the Wiki for instructions.

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Prion Immunotherapies: Recent Advances in the Field By Aravind Sivanesan

Abstract

        Prion diseases, otherwise known as Transmissible Spongiform Encephalopathies (TSEs), are a class of neurodegenerative diseases caused by misfolded proteins called prions. Prions are largely only expressed in the brain, and when they become misfolded can cause diseases, such as Creutzfeld-Jakob, Fatal Familial Insomnia, Gerstmann-Sträussler-Scheinker, Kuru, and others. Prion diseases are extremely difficult if not impossible to treat due to their molecular characteristics. Prions misfold into structures that becomes β sheet rich rather than α-helix rich, making it difficult for cellular proteases to destroy them. This causes aggregates to form, leading to the neurodegenerative diseases mentioned previously. Although there are limited, if any, therapeutics available to address prion diseases, potential immunotherapies have become a topic of interest in therapy against prions. This review will cover how prions cause pathology, the body of research surrounding prion immunotherapies and discuss some of the limitations that face prion research.

Introduction

        Cellular Prion Protein (PrP^C) is a 253 amino acid, highly conserved glycoprotein with a structured C-terminus and a disordered N-terminus, mainly expressed in the spinal cord and brain of adult humans [2, 12, 18]. PrP^C is also expressed at some level in the neuroendocrine system, the peripheral nervous system, as well as in lymphocytes of the skin, gut and bronchus associated lymphoid tissue [16]. PrP^C is a product of the *PRNP* gene expressed from chromosome 20 [1,3]. In humans, *PRNP* is expressed in the skin; glands such as the pancreas, adrenal, and salivary glands; brain; lungs; and other organs [17]. The function of PrP^C is not clearly known, but there is evidence that it is involved in many biological processes. PrP^C has also been shown to be involved with cellular signaling, as well as play a regulatory effect on protein kinase A, allowing for proper synaptic development [1, 38]. However, research has also shown that PrP^C has a cytoprotective effect in yeast, mice, and mammalian cells [2]. PrP^C also becomes pathogenic when it misfolds into the PrP^{SC} prion isoform. The main structural difference between PrP^C and PrP^{SC} is the change from an α-helix dominated structure in PrP^C to a β-pleated sheet dominated structure in PrP^{SC} [4]. Unlike PrP^C, the β-pleated sheet rich PrP^{SC} is protease resistant and is unable to undergo hydrolysis of peptide bonds which leads to the development of aggregations in affected tissue [5]. . Combining this with the fact that PrP^{SC} has the ability to induce the misfolding of PrP^C to PrP^{SC} results in protein aggregations and eventually prion diseases, otherwise known as transmissible spongiform encephalopathies (TSEs) [51].

        One key area of interest regarding prion pathology is the path that prions take to infect the central nervous system (CNS). Acquired prion diseases are transmitted via ingestion of food contaminated with PrP^{SC} [26, 27]. The mechanism that allows for prions to enter the body through the intestinal epithelium is not fully known, but there are certain cells that are believed

to be responsible that can transfer prions through the intestinal lumen [27-29, 39]. Afterwards, dendritic cells, mainly follicular dendritic cells (FDCs), transport, amplify, and replicate prions [27, 28, 29]. From there, prions next begin to accumulate in lymphoreticular tissue as well as in the enteric nervous system [28]. The location of where prions accumulate in the lymphoreticular system depends on the host, and accumulation in the spleen has been seen in variant CJD in humans, scrapie and bovine spongiform encephalopathy (BSE) in sheep, and scrapie in mice [28]. From here, prions invade the CNS via the vagus nerve or via the sympathetic nervous system to the spinal cord [27-29]. The prion's vast use of the immune system as a vector for pathology to the nervous system is of key interest in prion diseases such as variant CJD.

TSEs include a wide range of prion diseases such as Creutzfeldt-Jakob Disease (CJD), Gerstmann-Sträussler-Scheinker disease (GSS), Fatal Familial Insomnia (FFI). These diseases and many others may present differently in a clinical perspective, but some can be traced to mutations in the *PRNP* gene [6]. Many different therapies have been investigated to find a cure to prion diseases, but none have yielded a treatment. As there is a lack of current prion therapies, prion immunotherapies have become one of the most promising emerging therapies to combat prion diseases. This literature review will cover the recent advances in the prion immunotherapy field.

Prion Diseases:

Creutzfeldt-Jakob Disease (CJD) is the most common prion disease in humans and is caused by the transformation of PrP^C into PrP^{SC} within the cerebral cortex (Figure 1) [9]. There are multiple types of CJD, including sporadic CJD (sCJD), acquired CJD (aCJD), and inherited or genetic CJD (gCJD), all of which are fatal [9-11]. sCJD is the most common form of human prion disease, comprising approximately 85% of cases [10, 11]. attempts to find an effective treatment so far have been unsuccessful [9, 10]. sCJD has an illness duration of 4-5 months, and presents similarly to rapidly developing dementia, with symptoms including psychiatric symptoms such as memory loss, agitation, ataxia, etc. It also presents with myoclonus and involuntary jerks [10, 11]. Compared to sCJD, vCJD has a longer duration of illness at 13-14 months [54]. CJD is diagnosed using the WHO's diagnostic criteria, which includes usage of EEG results, CSF testing, and clinical examination. However, nowadays, genetic testing and more sophisticated tests can assist with diagnosis of CJD. 14-3-3 protein tests, t-tau tests, EEGs, and brain MRIs are used in conjunction with each other, with brain MRIs being most diagnostically accurate at 97% [10].

Gerstmann-Sträussler-Scheinker Syndrome (GSS) is another, less common prion disease. GSS affects mainly the white matter of the cerebellum and cerebral hemispheres (Figure 1) [31]. GSS is associated with mutations in the first α-helix domain of PrP^C at codons 102, 105, and 117; a mutation at codon 145 in the carboxyl-terminal end of the 2nd helical domain causes a premature stop codon and therefore a shortened PrP^C protein; two other mutations, at codon 198 and 217 in the third and fourth helical domains respectively, are associated with the PrP^C amyloid build up [6]. Not unexpectedly, clinical symptoms vary between the different mutations that

cause GSS [52]. GSS is also an autosomal dominantly inherited disorder [31, 32]. GSS onset occurs at 49.5±4.51 years of age [32]. The mean duration of illness during GSS is 5-6 years [31]. Clinical symptoms include combinations of cerebellar dysfunction, including unsteady gait, limb ataxia, tremors, nystagmus, and many more [31].

Fatal Familial Insomnia (FFI) is another less common prion disease. FFI is caused by a mutation at codon 178 in which aspartic acid is switched to asparagine, along with the maintenance of methionine at codon 129 [6, 13]. FFI is an autosomal dominantly inherited trait [13]. FFI mainly affects the thalamus, but has been shown to also involve the cerebral cortex, cerebellum, and other brian structures (Figure 1) [13]. FFI, like the other prion diseases, is universally fatal and also has a mean illness duration of 18 months [13]. FFI has been clinically described to have 4 stages of disease progression. The first stage, which lasts for 3-6 months, involves the beginning and subsequent worsening of insomnia, as well as associated psychiatric symptoms such as depression and panic attacks. Lucid, or vivid dreaming has also been reported in this stage. The second stage, which lasts at least 5 months, involves worsening insomnia, psychiatric symptoms, and sympathetic nervous system hyperactivity with subsequent autonomic dysfunction. The third stage, which lasts around 3 months, involves total insomnia and a complete disruption of the sleep-wake cycle. The fourth stage, which lasts up to 6 months, is dominated by rapid cognitive decline and dementia caused by lack of sleep, loss of voluntary motor function and speech ability, and ends in coma and death [13, 24]. As with the other prion diseases, FFI currently has no cure, but possible treatments are being researched.
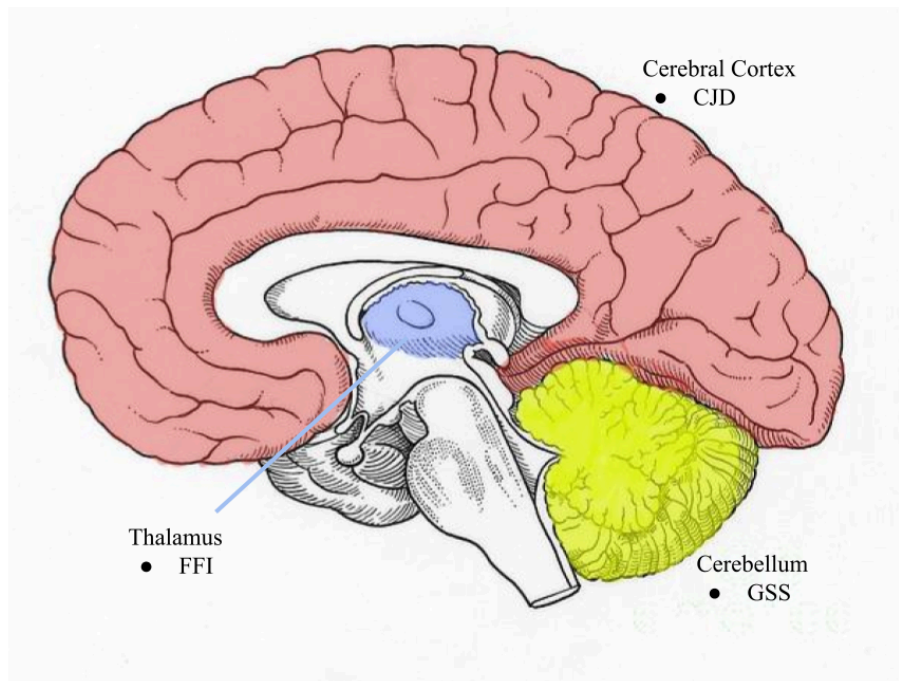
Figure 1. Location of PrP^{SC} expression in different TSEs.

History of Prion Therapies:

Due to prions having a novel method of infection, they are a topic of interest in therapeutics. In the early 2000s, quinacrine was suggested as a potential pharmacotherapy for prion diseases after Korth et al. 2001 proposed its efficacy as an antiprion drug [14]. Between 2005-2009, the University of California: San Francisco performed a study to determine the effectiveness of quinacrine at treating sCJD [21]. It was soon determined that quinacrine did not have a statistically significant impact on the survival of sCJD or CJD patients [20, 21]. A study in 2003 by Barret et al. examined the molecular effects of quinacrine on PrP and found that it bound to the PrP peptide, but did nothing to reverse the protease resistance of PrP^{res} (PrP^{SC}) or reverse the accumulation of PrP^{res} aggregates. Barret et al. conducted a further in-vivo study of mice to determine if quinacrine prevented the accumulation of PrP^{SC} in the lymphoreticular system, and found that there was no curative effect by quinacrine on prion accumulation. Quinacrine has been shown to have anti-prion effects in-vitro, but no positive in-vivo effect has been observed [46]. There is even evidence that quinacrine treatment seems to create drug-resistant prions, which further supports the position that quinacrine should be considered an outdated prion treatment [46].

Besides quinacrine, chlorpromazine was another potential pharmacotherapy suggested for treating prion diseases. Chlorpromazine was a promising pharmacotherapy because of its ability to pass the blood-brain barrier and it was shown to inhibit PrP^{SC} formation [30, 46]. However, it was soon found that chlorpromazine had no effect on prion accumulation in vivo or in vitro. [23, 30]. It was further found that the use of chlorpromazine, as well as quinacrine, could lead to hepatic impairment and jaundice in treated patients, without any clinical improvement in symptoms [50]. The lack of pharmacological success in finding a treatment to prion diseases led to researchers attempting to find novel methods to find a cure, which coincided with the sudden growth of immunologic treatments, led to research on prion immunotherapies.

Active Immunotherapy:

Prion immunotherapies have been studied since the mid 2000s, but the immunologic methods have not remained constant. In prion immunotherapy experiments since 2021, active immunotherapies to combat prion diseases have focused on using different vectors to overcome prion self-tolerance against PrP^{SC} in the immune system. One of the novel methods of active immunotherapy has been the novel use of hamster polyomavirus (HaPyV) capsid derived virus-like particles (VLPs) as a route to avoid self-tolerance in active immunization has recently been explored [15]. The effect of mouse PrP$_{128-164}$ inserted into the viral protein HaPyV-VP1 led to the incubation period for prion disease being 240.4±13.6 days versus the control incubation of 201.6±4.5 days, or an 18% increase in incubation time (Table 1) [15]. However, the full length of mouse PrP inserted into the viral protein HaPyV-VP2 actually led to an 8 day decrease in survival time [15]. This shows that there is a nuance to using virus-like particles as a vector to

cause immunity, and further research to determine the mechanisms that cause the change in survival time between the different viral protein and PrP combinations to find the best combination of virus-like particles and prion protein should be conducted. Another group overcame self-tolerance for PrP by using inactive *Trypnasoma Brucei* modified to have a prion and variable surface glycoprotein (VSG), or PrP-VSG, coat to elicit an immune response. In this experiment, mice inoculated with *T. Brucei* with the PrP-VSG coat were able to specifically recognize PrP[SC], while control mice in the experiment were unable to [20]. PrP-Tryp mice were injected with PrP-Tryp 3 times over 45 days, and were then challenged intraperitoneally with prions 30 days after the injection protocol was finished. The PrP-Tryp mice had an increased survival time of 236.9±3.56 days vs. the survival time of control mice, which was 214.9±2.37 days (Table 1) [20]. Triller et al. further explained that the Prp-Tryp mice could be further divided into 2 groups, of which the shorter survival times were 229±1.70 days and the longer survival times were 246.3±5.13 days [20]. While these two experiments of utilizing viral and parasitic vectors to overcome immunity only led to an 18% and 10% increase in survival time respectively, these both represent large strides in the attempt to overcome self-tolerance of PrP using other vectors. Perhaps more importantly, none of the mice injected with PrP-Tryp showed any reactions to the immunization, showing that the method is safe. This method, while not producing outstanding results, warrants further research in mouse models to find more effective immunogenic agents and vectors.

Another method of active immunotherapies that has been explored is mimicry of the prion protein's structure to elicit an immune response. These experiments have used proteins that contain similar epitopes to prions, but are different enough that they elicit an immune response. Different mimicry proteins have been used in different mouse models, with varying degrees of success. The prion-like domain of the modified fungal protein HET-s was used as an immunogenic agent to elicit an immune response in human transgenic TgP101L model mice [19]. TgP101L is a specific model of mouse that has GSS [19]. The choice to use modified HET-s was due to HET-s' molecular structure that contains several β-pleated sheets, which is similar to that of PrP[SC]. Mice not immunized with modified HET-s developed symptoms at approximately 177±17 days while mice immunized with modified HET-s developed symptoms after 448±39 days (Table 1) [19]. With an over 250% increase in survival time in a transgenic mouse that models GSS, the use of modified HET-s as an immunogenic agent to create protection against prions should be heavily studied in the future. Another group studied the use of Succinylarginine Dihydrolase (SADH) from *E. Coli*. SADH, similarly to PrP[SC], has a β-pleated sheet dominated structure. Active immunization with SADH from *E. Coli* led to an increase in survival time of 31 days, up to 329±15 days from 298±28 days in non-immunized mice, representing an increase of 10.4% [35]. Both of these studies show promise, as they increase survival time by >250% and 10% respectively. Since the 2022 study of HET-s showed such an increase in survival time in human GSS transgenic mice, this should be seen as a breakthrough in using mimicry in immunization and further research on similar proteins that

present similar epitopes should be further researched as potential immunogenic agents to actively immunize against prion diseases.

Another major active immunotherapy strategy is using recombinant PrP to create an immune response. Using recombinant PrP is based on the possibility that an immune response will be created by recombinant PrP and be able to attack PrP^{SC}. The use of recombinant monomeric PrP$_{23-231}$ with CpG adjuvant to elicit an active immune response was studied in elk transgenic TgElk mice [33]. After 4 boosters of subcutaneous immunization and intraperitoneal prion inoculation with CWD, mice immunized with recombinant monomeric PrP$_{23-231}$ with CpG adjuvant survived 183.6±8.8 days, while mice only immunized with CpG adjuvant survived 114.8±10.0 days [33]. This is a promising result for agricultural departments across North America, in which there is a CWD epidemic amongst cervid populations [49]. Another study looked into the effect that mouse PrP expressed via Salmonella typhimurium LVR01 had on the progression of prion disease in CD-1 mice [37]. All CD-1 mice were mucosally vaccinated with mouse PrP expressed via *S. typhimurium* LVR01 and then inoculated with scrapie orally. After immunization and before prion administration, mice were divided into sections based on their levels of mucosal IgA and systemic IgG response [37]. The control group of mice and the low IgA and IgG mice group had a median survival of 194 days [37]. However, all 14 mice in the high IgA and IgG group of mice after immunization survived 400 days with no clinical symptoms (Table 1) [37]. This increased survival time of 400 days without clinical symptoms demonstrated a major finding in the prion active immunization field, and while it was found in 2008, the study should be followed up with more studies to reinforce the efficacy of PrP expressed via a *S. typhimurium* vector. Potential human trials should also be looked at as an option once the safety of such a method is established through further research .

Table 1. Active Immunotherapies

Year of Study	Immunogenic Agent	Immunization Method	Mouse Model	Prion Administer Method	Result
2008	PrP expressed via a *S. typhimurium* vector [37]	Oral	CD-1	Oral	No clinical symptoms 400 days post-prion administration
2011	Recombinant Succinylarginine Dihydrolase from *E. Coli* [35]	Intraperitoneally	BALB/c	Intraperitoneally	31 day increase in mean survival time
2018	Recombinant monomeric PrP_{23-231} with CpG adjuvant [33]	Subcutaneous	TgElk	Intraperitoneally	60% increase in incubation time
2021	HaPyV-VP1 inserted with mouse $PrP_{128-164}$[15]	Intraperitoneally	C57BL/6	Intraperitoneally	40 day increase in incubation time
	HaPyV-VP2 inserted with full length mouse PrP sequence [15]	Intraperitoneally	C57BL/6	Intraperitoneally	8 day decrease in survival time
2022	Prion Domain of modified HET-s protein[19]	N/A	TgP101L	N/A	277 day or >250% increase in survival time
	Inactive, modified *T. Brucei* with a	Intraperitoneally	BALB/c	Intraperitoneally	22 day increase in survival time

	PrP-VSG coat [20]				

Passive Immunotherapy:

      Passive immunotherapies are the other immunotherapies that are being studied to potentially treat prion diseases. The goal of passive immunotherapies is to deliver antibodies to those currently affected by the disease. One study utilized the use of pAb W3, an antibody that attacks laminin receptors for PrP^C and PrP^{SC} and prevents PrP^{SC} propagation, to prolong survival time in C57BL/6 wild-type mice. Mice were injected intraperitoneally with prions 1 week after pAb W3 administration, and the study found that immunized mice had a combined incubation and survival time of 202.2 ± 18.4 days, while non-immunized mice had an incubation and survival time of 187.8±10.6 days. pAb W3 also led to a 1.8x increase in survival time after clinical symptoms had been detected in mice, from 17.5±7.2 days in control mice to 31.4±16 days in immunized mice [42]. While this study led to a 13.9 day increase in mean survival time (Table 2), the difference in survival time was not significant between the control group and the group immunized with pAb W3. However, results indicate that it led to a significant decrease of 66% in PrP^{SC} levels without affecting PrP^C levels. These results are not also statistically significant, but with further research on pAb W3 it would be possible to determine if it has a significant impact on survival time after clinical symptoms appear. The mechanism of attacking other receptors that PrP^{SC} uses to propagate is a promising idea, and while pAb W3 may not be the best target, its methodology is sound. Another group studied the effect of antibody BAR236, an antibody that inhibits PrP^{SC} replication by identifying an unknown PrP epitope, on prion disease treatment and incubation in C57BL/6 wild-type mice. The control group had an incubation period before symptoms of 248.3±6.7 days while the group immunized with BAR236 had an incubation of 361.2±37.8 days [41]. This constituted a 45.5% increase (Table 2), and since this increase is significant, BAR236 should be further studied to identify its molecular mechanisms in delaying prion pathogenesis and its effect on survival after symptoms occur.

      Another group studied mAb 31C6 in Jcl:ICR mice models. mAb 31C6 is a potential passive immunotherapy because it is an anti-PrP antibody that specifically recognizes amino acids 143-149 along murine PrP [36]. After administration of mAb 31C6, scrapie Chandler prion strain was injected intracerebrally. 7 out of 12 of the mice given had an increased survival time of 165±5.4 days versus a negative control mAb survival time of 153.3±4.3 days. However, 5 out of 12 of the mice given mAb 31C6 had no increase in survival time, and the research team discovered through immunofluorescence that this was due to the mAb not being as well absorbed and widespread in the 5 mice compared to the 7 mice who survived longer [36]. The results suggest that mAb 31C6 can slow disease progression when administered intravenously [36]. While the results are statistically significant, the increase is modest at 12 days. Even then, five out of the 12 mice did not have an increase in survival time. This, combined with mAb 6D11's poor absorption into the brains of these 5 mice should mean that mAb 31C6 does not hold as

much promise in the future as other potential passive immunotherapies. However, mAb 6D11's effect on PrP^{SC} in N2A/22L cells was studied, and the results were promising. N2A/22L cells were treated with 10 μg/mL of 6D11 mAb, and the research group found that the amount of PrP^{SC} was reduced by 28.3% ± 11.1%, 53.7% ± 5.1%, and 90.8% ± 3.1% after 6, 12, and 24 hours respectively. After 48 hours, PrP^{SC} was undetectable in the lysate of the N2A/22L cells (Table 2) [34]. While this study was conducted *in vitro* and not *in vivo*, it shows a promising reduction of PrP^{SC} levels in these N2A/22L cells. Therefore, it is worth conducting larger studies to see if mAb 6D11 truly does hold promise in helping to combat prion disease.

Intravenous immunoglobulin, or IVIG, was also looked at as a potential passive immunotherapy due to it having anti-PrP autoantibodies [40]. IVIG was administered to the GSS transgenic PrP-A116V mouse model. This mouse model was genetically modified to express human prion protein with a GSS-causing mutation at the 116th codon. Mice were euthanized when they reached the terminal clinical stage of GSS, and the mean age until death was studied. Mice immunized with IVIG survived 191±12.3 days while control mice survived 179±18.2 days. While this difference isn't statistically significant, the mice immunized with IVIG had a mean age of disease onset of 130.2±7.6 days, while non-immunized mice had a mean age of onset of 116.9±5.1 days (Table 2) [40]. This data shows that while IVIG increased the survival time of PrP-A116V mice without statistical significance, it increased the age of disease onset significantly. While the results of this IVIG study are encouraging, figuring out the mechanism that IVIG utilizes to increase incubation time and studying and isolating the specific anti-prion autoantibodies in IVIG should be the next steps done in order to narrow down potential antibodies to use in passive prion immunotherapies.

Perhaps, the greatest breakthrough in prion immunotherapy to this date is due to a group at University College London Hospital Clinical Research Facility recently conducting the first in-human prion treatment program in 2022. This group used the humanized anti-PrP^C mAb, PRN100, to treat 6 human patients with CJD in the UK. Patient 1's MRC Prion Disease Rating Scale score, which is a scale used to determine the severity of prion disease symptoms, stabilized once the PRN100 cerebrospinal fluid (CSF) target concentration of 50nM was reached. Patient 2 also had relatively stable MRC scale scores once the target concentration of 50nM was reached before they passed away from pneumonia. Patient 3 had a very severe course of disease, their MRC score rapidly decreased before the target concentration in CSF was reached. Patient 4 had a sharp decrease in MRC scale scores during their first 6 doses of PRN100, but the decrease leveled off and the PRN100 concentration in patient 4's CSF during this time was 50nM. Patient 5, like patient 3, had a very severe course of disease and passed before the target concentration was reached. Patient 6's MRC scale scores also decreased while on treatment, and treatment was halted when the supply of drug was out [48]. While the number of patients, 6, means that a conclusion on whether or not PRN100 changed the course of CJD, CSF studies showed that PRN100 was able to diffuse into the brain safely at the target concentration of 50nM in CSF. The lack of neurotoxicity (Table 2) and the promising permeability of the blood-brain barrier that

PRN100 has means that there should be further research done in larger groups of CJD patients to try and determine if it affects prion diseases.

Table 2. Passive Immunotherapies

Year of Study	Antibody Type	Prion Administer Method	Model	Results
2007	Anti-laminin receptor pAb W3 [42]	Intraperitoneally	C57BL/6	13.9 day increase in mean survival time
2010	BAR236 [41]	Intraperitoneally	C57BL/6	45.5% increase in incubation time
2013	mAb 31C6 [36]	Intracerebrally	Jcl:ICR Mice	PrP^{SC} accumulation was slowed, no significant change in survival time
2019	IVIG with Anti-PrP autoantibodies [40]		GSS-Tg (PrP-A116V) Mice	11.4% increase in incubation time vs. non-immunized mice
2019	mAb 6D11[34]	N/A	N2A/22L Cells	PrP^{SC} was undetectable in N2A/22L lysate after 48 hours
2022	PRN100 [48]	N/A	Humans with CJD	No neurotoxic effects, MRC prion disease rating scale scores stabilized

Conclusion:

Prion immunotherapies are of the utmost importance to refine as they are the current frontier of prion therapeutics research, and because prion diseases are universally fatal with no treatment. Recent studies into immunogen-mimicry to elicit an active immune response against PrP^{SC} have revealed promising strategies, such as HET-s, that can be further studied in the future. Passive immunotherapies, such as mAb 6D11 and BAR236, have also shown promise in reducing the presence of PrP^{SC} and increasing incubation time before symptoms. However, it is hard to understate the monumental milestone that PRN100, the first clinical trial of a prion immunotherapy in humans, represents in the quest to cure prion diseases. PRN100's lack of neurotoxicity when reaching therapeutic levels in the brain leads to it warranting further clinical trials in humans, as it also showed some therapeutic value during its clinical trial [48]. It is vital that PRN100's trials in humans be expanded to larger samples of those suffering from CJD to get definitive answers about PRN100's effectiveness. However, both active and passive immunization have their own weaknesses and side effects that must also be kept in mind when discussing them as potential therapeutics. Passive immunotherapies have been found to be non-effective closer to the onset of symptoms of prion diseases [47]. On the other hand, active immunization to treat prion disease has resulted in autoimmune-meningoencephalitis, and other severe side effects [44, 45].

When analyzing all of these trials, it is important to consider that all of these experiments were lab controlled, and not realistic to how human prion disease occurs and could be treated. In all of the experiments, mice were given treatment shortly after prion inoculation, and well before the onset of clinical symptoms. In humans, that will not be the case due to a lack of early diagnostic tools for prion disease. In humans, prion diseases are recognized after clinical symptoms appear, and more research into therapeutics modeling these situations must be conducted unless early prion diagnostic tools can be developed.

Looking past prion diseases, cracking the treatment for prion diseases also holds importance because other neurological disorders, such as Alzheimer's, have proteins that are prion-like [43]. To effectively combat prion diseases and other prion-like diseases, it is imperative that scientists focus research on finding new immunogenic agents and antibodies that are effective in mice, and eventually translate these into human clinical trials and treatments.

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What is the correlation between academic performance and access to computers at school?
By José Mestres Vitón

Abstract

  As a result of inequality and lack of resources, only a few students can access computers to enhance their academic journey. In this paper, I investigate the relationship between access to computer and academic results. Using data from Programme for International Student Assessment (PISA) 2018, which is a standardised test which is used to compare 15 year old students, I also study how the effect of computers varies depending on gender. I find that students are benefited from the use of computers and a higher socio economic background, and that computers affect males at higher rates. I also find that women outperform males in maths and science scores while failing to do so in reading.

Introduction

  Computers are crucial in today's society, thus it is crucial to understand its importance and role, if it exists, in education and student's development.

  Technologies develop extremely quickly and it is often hard for society and even experts to understand their implications and consequences on various aspects of the real world. Knowing and understanding these, especially in an area such as education, could provide incentives for authorities to take action and make use of them to enhance the experience for students.

  Not only this, but as I mentioned, education is a crucial area for all societies and so understanding how these function and special factors such as what benefits them is crucial for society as a whole to ensure these are developed as much as possible.

  Apart from the features mentioned, because this paper will also tackle the different effects depending on the gender, it could potentially develop a base for experts to continue to work on personalising education depending on specific characteristics.

  Academic performance is not an easy subject to study however. Even though test scores are a pretty effective way to measure how students perform there are a lot of aspects and features I would not be taking into account. How would participation in class be measured through test scores? It is not possible and hence this value is not entirely accurate or easy to calculate.

Literature Review
 1. Theoretical framework
1.1 academic performance

  According to Oxford's Language Dictionary academia refers to "the environment or community concerned with the pursuit of research, education, and scholarship" and performance is "the action or process of performing a task or function". So it is fair to say that academic performance is a measure of how well the actions of research, education and scholarship are done. There are many indicators of academic performance, the most popular being test grades and scores.

It has been proved that there are many factors that affect academic performance. One of these is intelligence. Intelligence quotient (IQ) scores, which measure the position of an individual with respect to others his age in mental abilities, are positively correlated to school scores (Mahalanobis et al., 1936). Moreover, it was also established that a higher socio-economic status was positively correlated with a higher academic performance (Sirin, 2005). It was also found that confidence before taking a test was positively correlated with the score achieved in it (Smith, 2002). Lastly, Shafaghi (2023) suggests that motivation, although most importantly attitude, also contributes to a better performance in tests.

1.2 access to computers

As society grows more and more dependent on Information and Communications Technology (ICT), education in all age levels does so as well. Not only is it necessary for young individuals to acquire skills to use computers, but they need computers to acquire certain skills and achieve certain levels of academic performance and development. According to the Federal Reserve Bank of Atlanta, 92% of all jobs require digital skills, something which can't be acquired without the possession of a computer.

In addition, many skills (both digital and non-digital) require the use of computers. So much so that it has been found that access to technology and specifically ones that can be used in an educative way rather than solely for entertainment was positively correlated with increased reading and mathematical skills in young toddlers (Espinosa et al., 2006).

2. Prior empirical studies on effect of access to computers on academic performance

As it may be clear from previous references, many researchers have attempted to find the correlation between access to computers and academic performance. It has been found that use of ICT for both entertainment and educational purposes can bring about negative effects on academic performance, but if used solely for learning, then it improves it (Park et al., 2020).

3. Contribution to literature

With this paper, I seek to address many gaps in current literature. First of all, it explores cross-national trends in the effect of access to technology on test scores in Latin America. By analysing between Latin American countries using the PISA dataset, I could come up with the effects different variables have for each one, and compare among them. This paper also provides the different effect computer access has on test scores depending on the gender.

Methodology
Data
Overview of data

The original dataset was downloaded from the Programme for International Student Assessment (PISA) 2018 database, an international exam which takes place every 3 years. It is

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run by the Organization for Economic Co-operation and Development (OECD) and has the objective of measuring education as well as seeing what skills can be improved in the younger generations. The students that take these exams (in this case students in 2018) are 15 years of age. The subjects assessed are mathematics, science and reading.

Given the primary focus on Latin American countries, my sample consists only of Latin American countries that participated in PISA 2018. Because of this, 75,622 students remained. After removing the null values from the dataset, I get that there are 40,663 students.

In order to gain a better understanding of the variables analysed, I have provided summary statistics with the main values for each column. The sample size, mean, standard deviation, minimum value and maximum value were calculated and portrayed below in the form of a table.

	N	Mean	St. Dev.	Min	Max
Math Score	40663	398.611026	85.328168	64.3070	797.6250
Science Score	40663	414.427878	87.451638	95.5710	747.4990
Reading Score	40663	424.022722	94.209368	108.4750	770.0280
Gender	40663	1.484937	0.499779	1.0000	2.0000
Country	40663	320.301896	245.226150	76.0000	858.0000
Internet Connection	40663	1.360008	0.747248	1.0000	3.0000
International Grade	40663	9.751986	0.855501	7.0000	12.0000
Index of Social, Cultural and Economic Status	40663	-0.894745	1.240905	-6.1238	3.3014
Availability of Computers At School	40663	1.836928	0.856218	1.0000	3.0000

Table 1: Summary Statistics of Dataset

Dependent variables

In this regression model and research paper in general, the dependent variables are the test scores: maths scores, science scores and reading scores. I measured the impact of independent and control variables on them.

These test scores are measured through plausible values. However, as Aparicio et al., 2021 suggested, using one of ten plausible values may not affect basic inference from regression analysis. Thus, I use the first plausible value from each subject for my analysis.
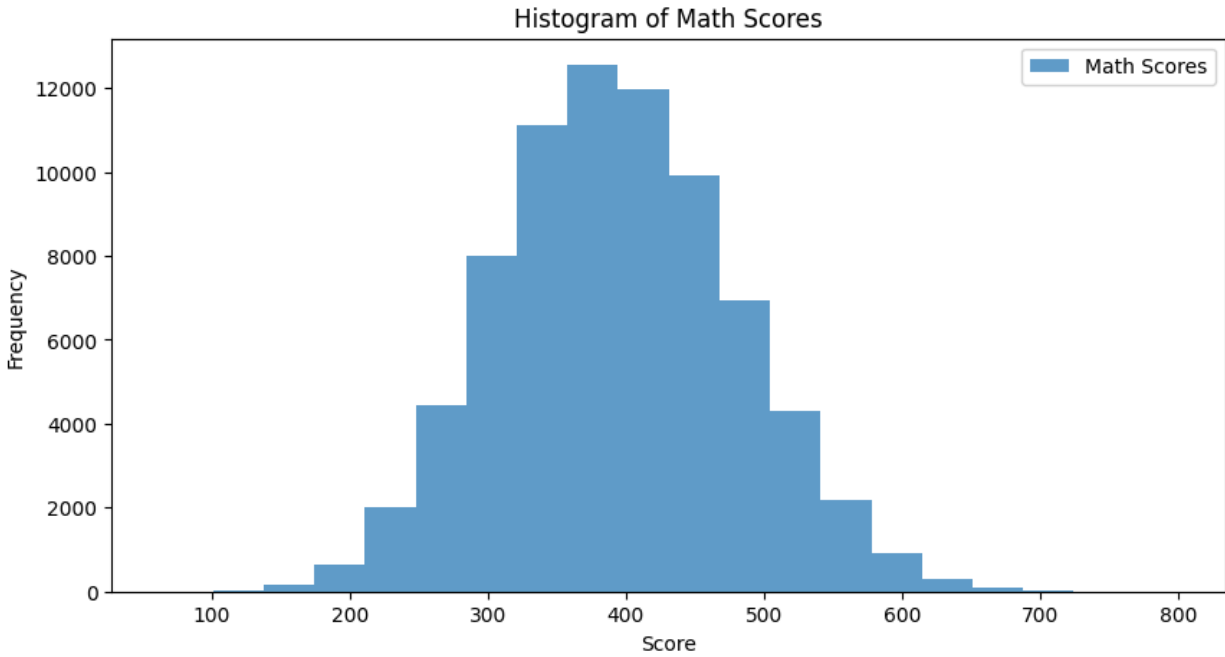
Figure 1 (a): Histogram of Maths Scores

As evident in the histogram above, maths scores exhibit an empirical normal distribution, with scores ranging from 100 to near 800 and most concentrated within 300 and 500. The modal score in this dataset seems to be 350.
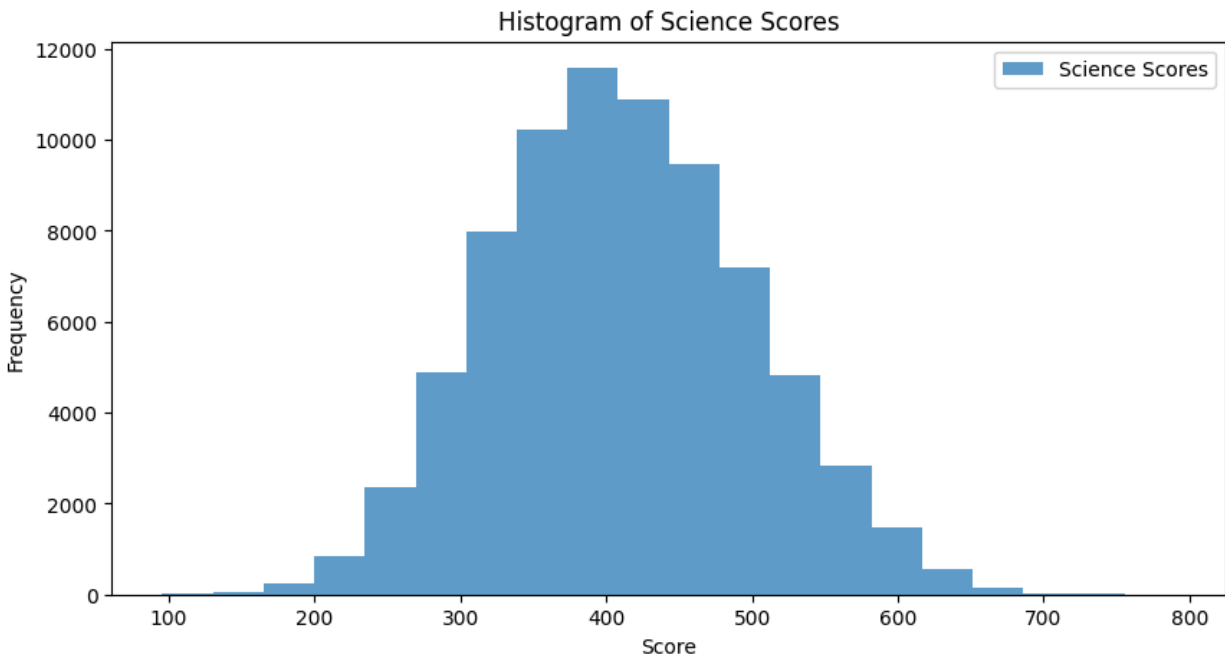
Figure 1 (b): Histogram of Science Scores

As it can be seen, the histogram of science scores is slightly positively skewed. Also, the modal score is in the range between 400 and 450 with the values ranging from 100 to slightly more than 750.

Histogram of Reading Scores
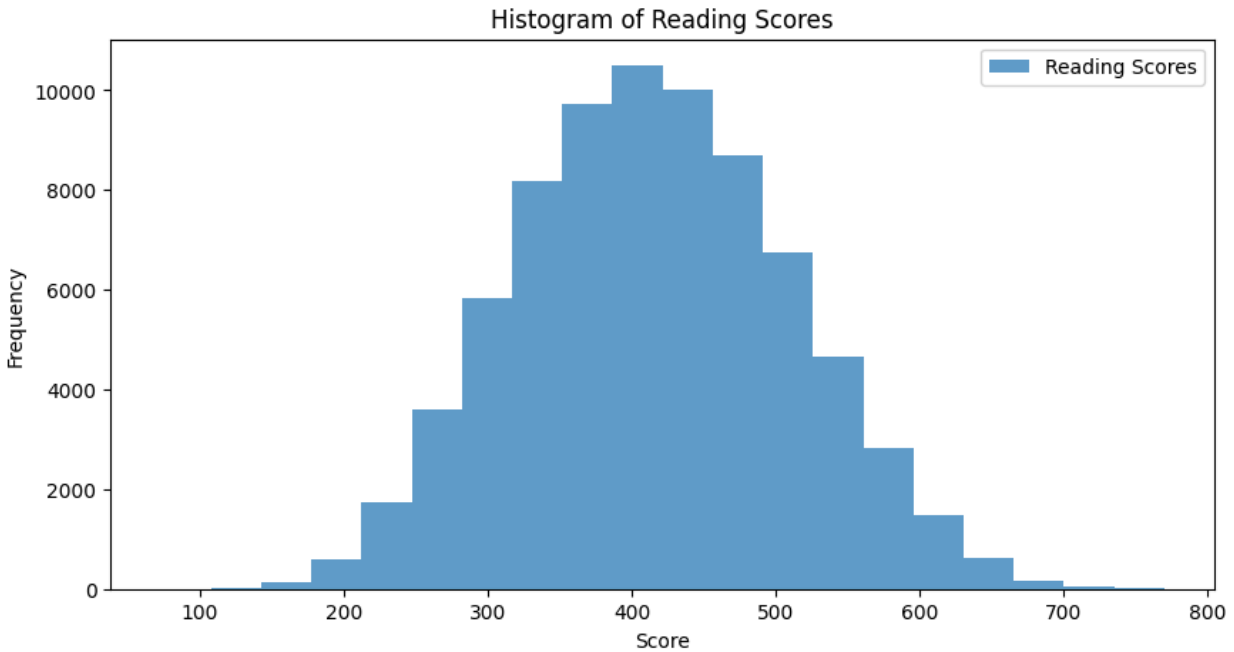
Figure 1 (c): Histogram of Reading Scores

Lastly, for the histogram of reading scores, I can see that the scores are arranged in the form of normal distribution. With no outliers clearly visible, the modal score is approximately 400, which it appears is very similar to the mean of the dataset.

Modelling Strategy

$Score = α + β_1·Gender + β_2·Computer + β_3·Socio-economic\ background + β_4.Internet\ con$

Where $Π$ is the vector of country fixed effects indicator variables

Score is the dependent variable and represents how well a certain student did in a certain academic subject. α (alpha) is the intercept, or the constant that represents the average baseline score when all independent variables are zero. Moving on, gender, with its own parameter ($β_1$) which shows the change of the dependent variable on a one-unit change, measures how gender affects student scores and has two options: male and female. Computer refers to access to computers at school and options vary from having it and using it, to not even having a computer to use. Socio-economic background is an index that measures the status of a student. Lastly, $Π$ is

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the vector of the country fixed effects indicator variable, which means it captures time-invariant country-specific trends that are not taken into account in the model but that affect the scores.

Results

Discussion

Maths scores

To begin with, looking at the coefficient from gender (which is 9.9359) I can see that female students, on average, score 9.9359 points higher than male students in maths, all other variables held constant. I can also see how this result is statistically significant because the p-value is equal to 0.000, which means it is fair to say that in the Pisa 2018 test, female students did better, on average, than male ones. This is also consistent with previous findings which stated that even though more males choose science, technology, engineering and mathematics (STEM) as their careers, girls tended to do better on these subjects, on average (Lagisz et al, 2018).

Moving on, if I look at the coefficient of availability of computers at school, which is equal to -3.9648, due to the fact that the options closest to 1 refer to an availability and use of computers while value closest to 3, a non-existent availability of computers, I can see that an increase in availability means an increase in scores, all other variables held constant. This relationship is also significant (p-value close to 0.000), indicating a consistent pattern across the sample.

Moreover, with the coefficient of the index of social, cultural and economical status being equal to 22.7762, the results indicate that students from higher socio-economic backgrounds perform significantly better in maths. This is one of the most impactful coefficients in the model (also with a p-value close to 0.000), highlighting the strong influence of socio-economic status on maths scores. This result, as well as the results for science scores and reading scores (which will be analysed below) are consistent current literature (Munir et al, 2023).

Finally, I can also see with a p-value of 0 and a coefficient of 3.0860, that males perform better in maths with computers in maths tests. In other words, computers have a greater effect on men than on women in maths tests.

Science scores

Moving on to science scores, through the running of the regression model, I could also observe some insightful results. While girls, on average, still get better science scores, the difference is smaller than in the case of maths scores. On average this difference is equal to 3.0770. This value is also statistically significant with its p-value equal to 0.000.

In addition to this, the intercept of availability of computers at school being equal to -4.1496, and taking into account that the lower the value, the higher the availability, I can see that an increase in availability per unit causes an increase in the points scored of 4.1496 points. It is also important to note that it is greater than that of maths scores and may be due to the fact that science performance depends more on specialised softwares or the internet as a whole than maths does. This value is also statistically significant with its p-value equal to 0.000.

Lastly, with the intercept of the social, cultural and economic index being equal to 24.1424 and the p-value to 0.000 (which means it is statistically significant), an increase in the social, cultural and economic status, will cause a significant increase in science scores. I should note that it is the greatest in terms of the science scores, without mentioning it is also greater than the coefficient which arises from maths scores. This could be attributable to the fact that science scores, as I said, depend highly on many programmes and may require a greater dedication or investment from behalf of the student's parents.

Not only this, but I can see that computers affect genders differently. In the case of science scores, seen by a coefficient equal to 3.1627 and a p-value equal to 0, I can state that males are benefitted more in this subject relative to females.

Reading scores

Lastly, with reading scores, I have also obtained some interesting and informing results. Unlike in science and maths scores, where girls, on average did better than boys, in reading scores boys did better (on average 18.9314 points above girls). This value is statistically significant with its p-value near 0.

Along with the coefficient estimate for gender I have the estimates for the impact of the availability of computers. As in the other subjects, higher access to computers is directly correlated with an increase in performance. This can be seen clearly with the coefficient equal to -3.6485 (recalling that the lower the value, the higher the score in this section). It is also vital to observe that it is the lowest of them all. This could be because reading does not need an extensive amount of computers and software and can be taught effectively with fewer computers than maths and science. This value, as all above, with a p-value equal to 0.000, is statistically significant.

Finally, with the coefficient estimate equal to 24.6443, I can see that an increase in the spectrum of social, cultural and economical status is correlated with an increase in reading scores. Not only is this value statistically significant (its p-value is equal to 0.000), but it is the highest of all of the regressions I ran. A higher status makes a bigger effect on reading scores than that of mathematics or even science, which could be due to the fact that higher status is correlated with a higher exposure to reading through books. These results are consistent with previous findings that stated that lower status was correlated with less reading ability and found that the most likely reason was not the poverty itself, but everything it entailed in the child's surrounding (Chandler, 1966).

As with the other subjects, in reading scores, the use of computers benefited males more than females, shown by the coefficient equal to 3.8821 and p-value to 0.000. Given the fact that in all of these subjects males have performed better with computers, teachers may need to focus more on teaching female students to exploit technological resources.

Robustness Checks

In order to validate this regression model, I will test it against the assumptions: constant variance assumption and normality assumption. To begin with, by plotting the fitted values (the predicted values obtained when the observed data points are put into the model) in the horizontal axis and the standardised residuals (which are the differences between the observed values and the fitted values) I have proved the existence of constant variance.

As displayed below, maths scores satisfy this assumption because the points are spreaded in the shape of random scatter and the spread is, although not entirely, roughly the same throughout the red line. This without mentioning that there appears not to be any presence of heteroscedasticity.
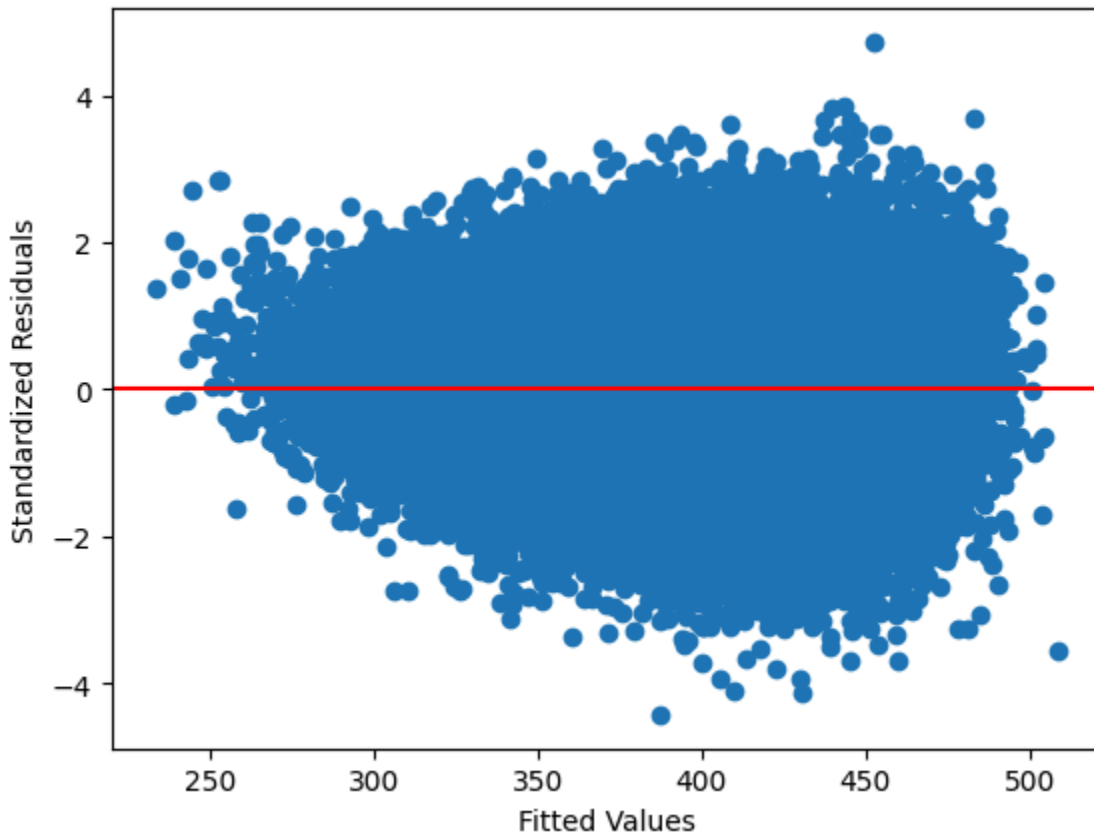
Figure 2 (a): Graph Comparing Fitted Values Against Standardised Residuals For Maths Scores

Moving on, I can see that the science scores satisfy the constant variance assumptions because there is also no clear pattern or shape (purely random scatter), the spread is roughly even throughout the graph, and there is no clear funnel shape. This can be seen below.
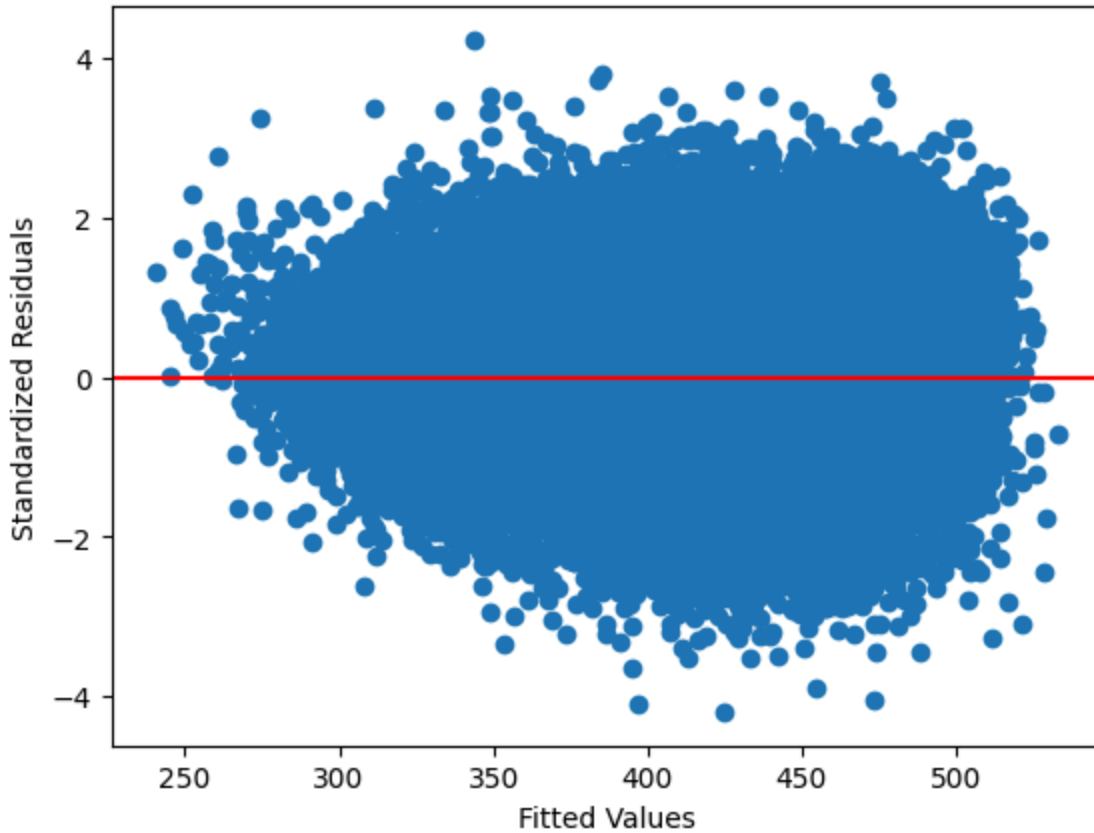
Figure 2 (b): Graph Comparing Fitted Values Against Standardised Residuals For Science Scores

Lastly, I can also see that reading scores' results are also trust-worthy because they meet this same assumption. As with both the other scores, there is no clear pattern, there is an even spread throughout the plot and there is no presence of a funnel shape.
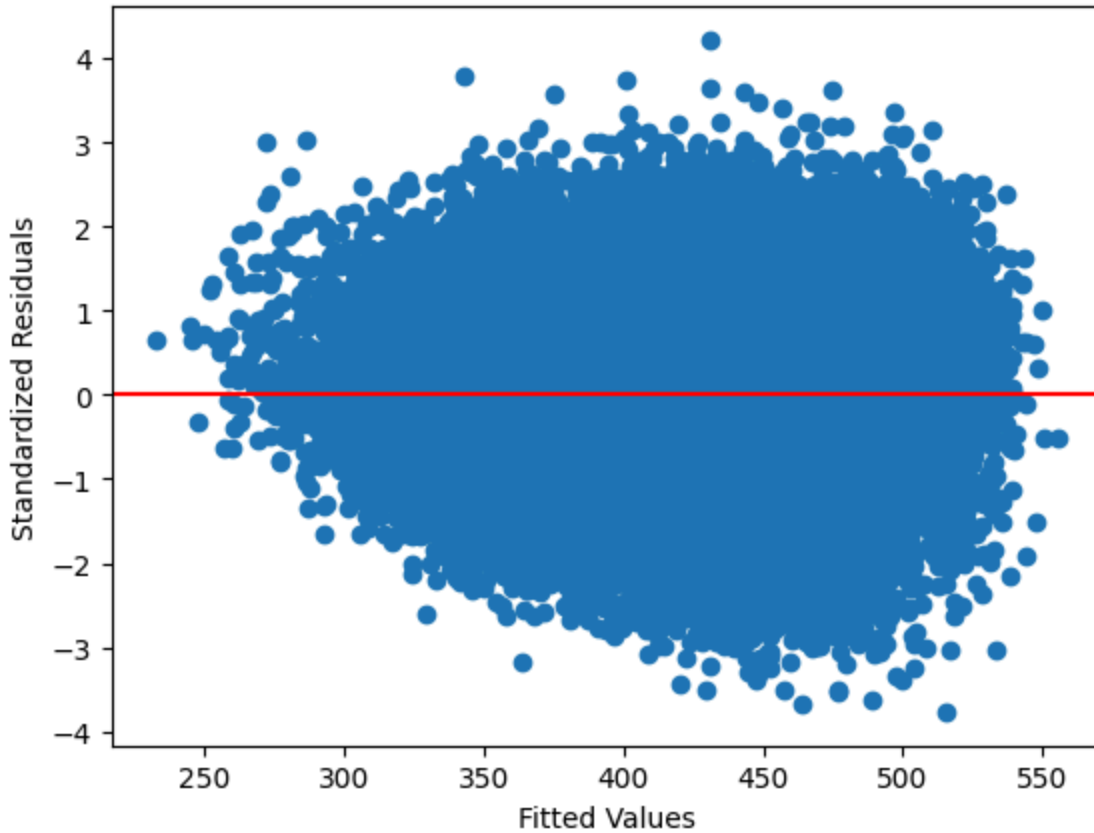
Figure 2 (c): Graph Comparing Fitted Values Against Standardised Residuals For Reading Scores

       This is not, however, the only assumption the data set has to pass in order for the model's results to be trust-worthy. I also want to show that this data is distributed normally. First of all, the data from maths scores is relatively normally distributed as seen by the shape of the graph.

This shows that the results obtained by the model analysing maths scores is trust-worthy.
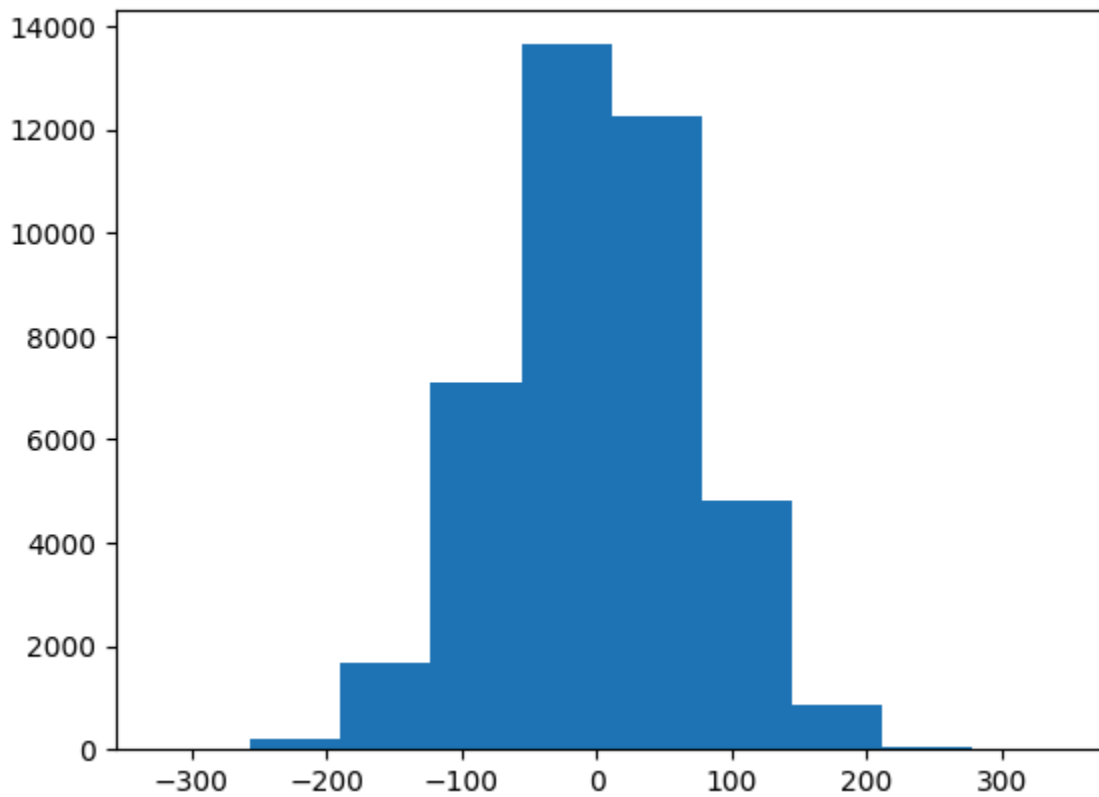
Figure 3 (a): Graph Showing Normal Distribution Of Residuals (Maths Scores)

Furthermore, similar characteristics can also be seen in science scores. With this shape even clearer, it is a matter of fact that the data from this set is likely to yield results that can be trusted. This graph is shown below.
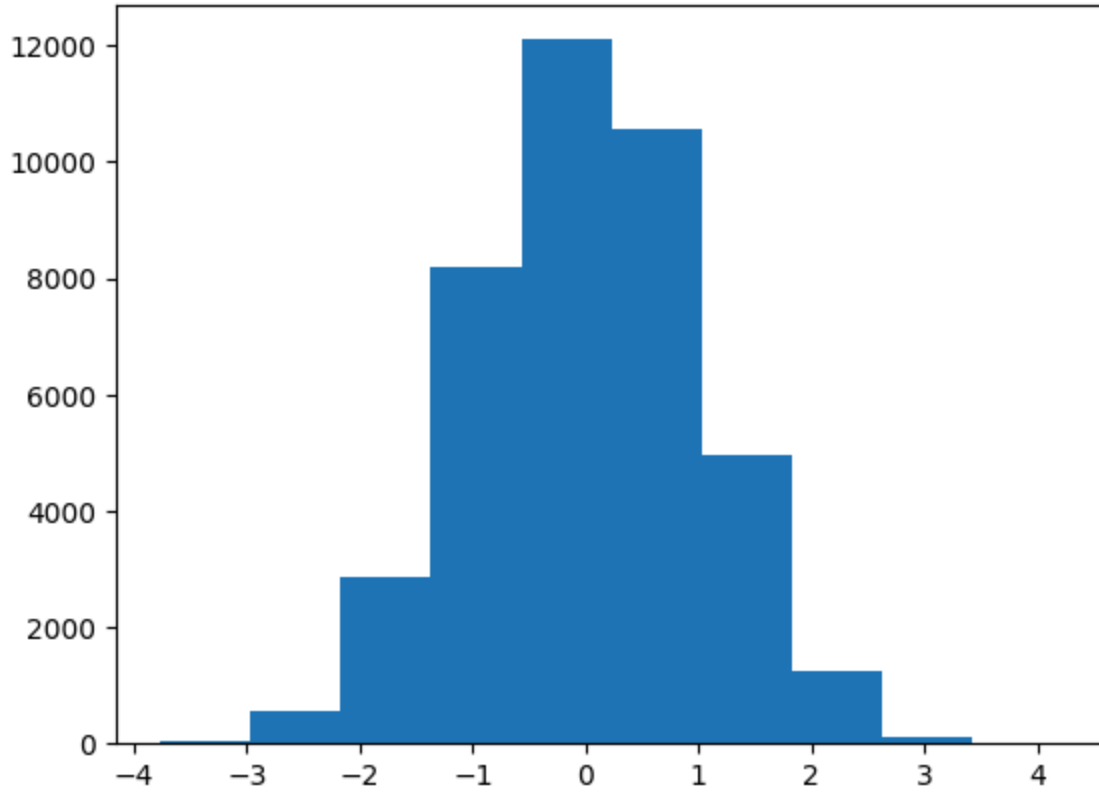
Figure 3 (b): Graph Showing Normal Distribution Of Residuals (Science Scores)

Finally, in the case of the reading scores, the results show pretty much the same. With the overall tendency of the graph nearly normally distributed, it can be stated that this sample of the dataset has results with the model that can be trusted.
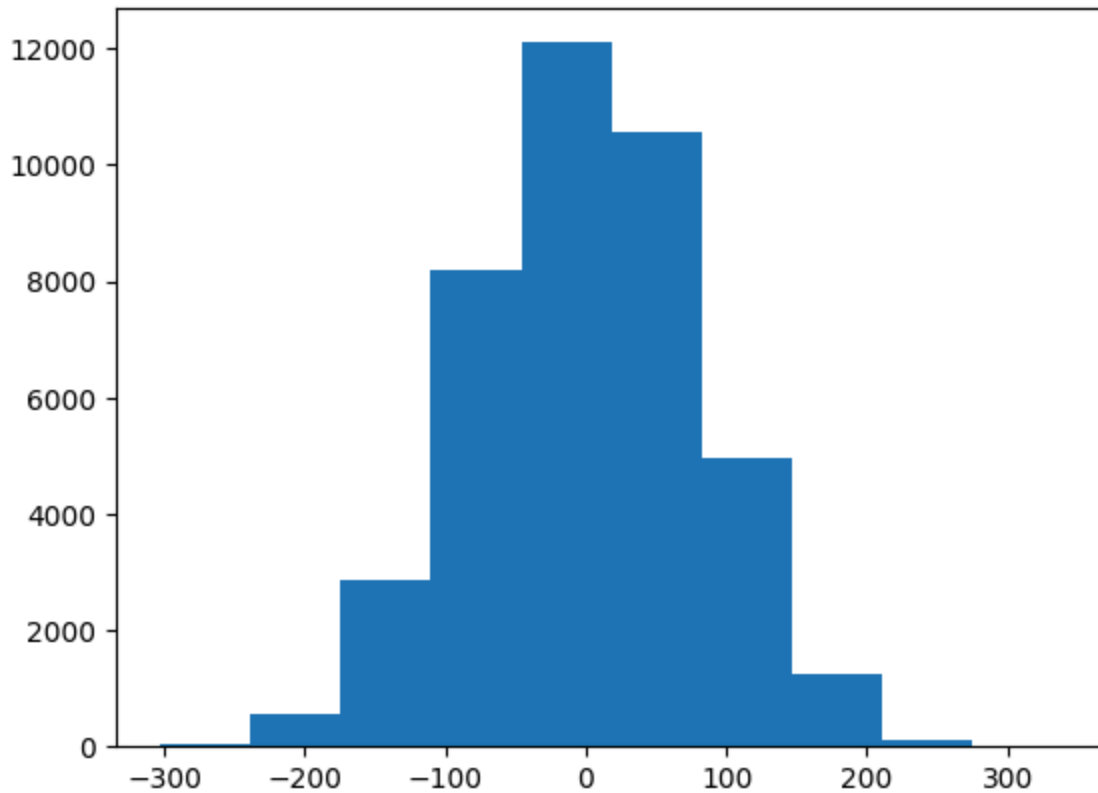
Figure 3 (c): Graph Showing Normal Distribution Of Residuals (Reading Scores)

Conclusion

As previously mentioned, the research question was "What is the correlation between academic performance and access to computers at school?". Interested in finding how computers at school affected how well students did, this research began.

It was found that females, on average, do better than males on these academic subjects. Educational institutions could take this into account to try and improve male reception of concepts (without harming those of females). The strongest indicator of someone's academic success is his or her socio-economic background was noted, affecting the most in reading scores which could be as a result of greater exposure to books and learning opportunities. It was also found, absent in current literature, that computers favour males more than females all things equal: when both genders have a computer to prepare for academic subjects, the male will most likely perform best (this was the case with all subjects).

Key findings aside, the research study has had its limitations. First of all, I have omitted many variables like teacher quality or parental involvement and also have missing data. Thus I may not have a complete description of the individuals. It is also hard to assess the best form of measuring performance. Whether it is test scores, class participation, projects or peer assessments I do not know and thus this leads to a problem related to construct validity. Secondly there is also a problem of construct validity.

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A Better Homeless Solution? A Study of Lifemoves Project in Silicon Valley By Jared Chua

Executive Summary:

Homelessness is a growing problem in California. Despite California spending over $17 billion in 2022 to combat this issue, homelessness is still on the rise (Watt). Apart from alleviating human suffering, addressing homelessness is important as it reduces the tax dollars spent on associated support and social services. The main driver for homelessness in California is high housing costs and the lack of affordable housing. There is not enough housing being created to support the constant inflow of people coming to California for jobs ("Bay Area Homelessness"). Current approaches in addressing homelessness, which primarily focus on providing temporary shelter, are not enough.

California should invest more resources in transitional housing programs such as LifeMoves to better address the homelessness crisis. LifeMoves, a non-profit organization based in Silicon Valley, works to address the root causes of homelessness by providing not only transitional housing but also supportive services for clients to achieve self-sufficiency, so as to help them find and maintain permanent housing. In addition to the direct benefits to the individuals, this also betters the community as a whole by reducing homelessness and associated costs to the government and society. These cost savings can then be redirected to other areas for overall quality of life improvements.

Problem frame:

Having a home offers people a sense of security and stability. Shelter is one of the basic necessities in life. It is important for people, especially children, to have a place to return to every day. A home serves as a form of protection and also a place where one finds comfort and creates memories.

Homelessness is a pressing problem in California, affecting not only the individuals who lack stable housing, but also the society as a whole. Homelessness is linked to many societal issues including increased crime, drug use, and human rights violations. The San Francisco Bay Area, in particular, has a significant homeless population that needs urgent attention and solutions.

Quantify/Qualify the Problem:

About 38,000 people could be homeless on any given night in the San Francisco Bay Area in 2023, which is a 35% increase from 2019 (Krivkovich). From 2017 to 2020, the Bay Area's homeless population without access to basic shelter (street homeless) increased from 67% to 73% of all homeless people in the area("Bay Area Homelessness"). The pandemic also had a significant impact on the increasing homelessness crisis due to the economic burden it placed on many individuals (Tobias). Homelessness is especially prevalent in California; as of 2020, California makes up 30% of all homelessness in the United States (Paluch and Herrera).

As of 2019, non-Hispanic/non-Latino White people made up the largest portion of homeless individuals in the Bay Area at 34% ("Who is Homeless…"). They are followed by African American/Black people with 22% of all homeless people and then the Hispanic/Latino group with 21% as the three biggest groups, making up 77% of the homeless in the area ("Who is Homeless…"). African American/Black individuals have the largest proportion of their population experiencing homelessness; for example, although they make up only 5% of San Francisco's population, they represent 37% of the homeless people ("Racial Equity…").

The 2020 Annual Homeless Assessment Report reported that 41 in every 10,000 people in California were experiencing homelessness ("The 2020 Annual…"). Further impacting the homeless population, California lacks an adequate shelter system compared to other states. Seventy percent of California's homeless population live in vehicles, tents, or public spaces as they do not have access to a shelter system, while only 5% of New York state's homeless population does not have access to a shelter system ("Homelessness in California").

Homeless people often run into difficulties when trying to secure employment. Reasons such as no permanent address, lack of business clothing, no reliable transportation, or disabilities make it difficult for homeless people to acquire jobs (Crowe). Even so, 40% of the homeless population living outside of a shelter in fact had formal employment (X). These unhoused individuals have trouble finding shelter due to high costs of living and unaffordable housing.

Crime also intersects with the homeless community, with the homeless population engaging in 40 times higher rates of violent crimes and 27 times higher rates of nonviolent crimes compared to an individual with permanent housing (Admin). For individuals with a criminal record, difficulty can arise when these individuals seek both employment and housing, making them more susceptible to homelessness. Furthermore, people who are homeless are also significantly more likely to be victims of crimes, being 27 times more likely to be subject to attempted murder ("County of Santa…").

Diagnose the Problem:

The main issue that causes many people to be homeless in the Bay Area is the lack of affordable housing. From 2011 to 2017, there were 531,400 new jobs created in the Bay Area but only 123,801 new housing units ("Bay Area Homeless"). This results in a ratio of 4.3 jobs for every unit of housing, significantly higher than the 1.5 ratio recommended by the U.S. Environmental Protection Agency ("Bay Area Homeless"). When there are significantly more jobs than units of housing, demand for housing will skyrocket since the workers want housing relatively near their jobs.

This constant demand for housing is what makes housing in California one of the most expensive states in the country ("Bay Area Homeless"). From 2012 to 2017, the number of affordable rental units in the Bay Area declined by 24% ("Bay Area Homeless"). At the same time, 5,000 units of affordable housing were lost for those earning less than 30% of the median income due to increased pricing ("Bay Area Homeless"). In California, home values in the metro area more than tripled between 2000 to 2021 ("Homelessness in California"). The median rent

for a two-bedroom apartment in the Bay Area is more than double the national average [Bay Area: $3000, National Avg: $1200] ("Homelessness in California"). In more than two-thirds of zip codes in California, families are spending more than 30 percent of their income on rent ("Homelessness in California"). These people are considered, by federal standards, "rent burdened" people.

Further, since 1991, California has been falling short in housing supply ("Homelessness in California"). For example, San Francisco created 38,000 new jobs from 2016 to 2019, but only created 4,500 new housing units ("Homelessness in California"). California ranks 49th in U.S. states for housing units per capita ("Homelessness in California").

Rationalize Government (or Nonprofit) Intervention:

Government/nonprofit intervention is a rational approach to help solve many societal issues that arise from homelessness. Housing assistance provided by the government and nonprofits will lower crime rates because people who are homeless are significantly more likely to commit and be victims of crimes (Admin).

Outside intervention can help prevent "overcriminalization" among unhoused individuals. Homeless people are oftentimes blamed for crime despite making up a small percentage of overall crime rates (Vankin). This leads to "overcriminalization," making the unhoused more likely to be incarcerated (Vankin). This overcriminalization is also a result of homeless people being accused of "homeless status offenses" such as loitering, vagrancy, and trespassing, which are illegal acts that are difficult to avoid for people with nowhere to go (Vankin). This not only uses up unnecessary space in prisons, but also once incarcerated, homelessness upon release is much more likely, contributing to the cycle (Vankin).

Homelessness also negatively affects the availability of health resources and the use of tax dollars. In 2012, the secretary of the U.S. Housing and Urban Development Department (HUD), Shaun Donovan, stated that, "...between shelters and emergency rooms and jails, it costs the federal government about $40,000 a year for a homeless person to be on the streets" ("Community Impact…").

Individuals who are homeless also experience a number of consequences besides being unable to sustain a secure lifestyle. Homelessness exposes people to many health risks and limits access to healthcare ("Q&A: Understanding…"). There is also psychological trauma linked to being unhoused that may induce mental health problems for some and worsen existing problems for others ("Q&A: Understanding…"). Having a safe home can not only reduce stress, but also puts children at less risk of violence (Høvring).

Policy Objective:

People without permanent housing will have more access to transitional housing systems.

Current state:

Mountain View is a city in the Santa Clara County of the Bay Area region in California. Mountain View currently has two programs aimed at helping reduce homelessness: Project Homekey and CrestView Hotel. LifeMoves' Mountain View location is funded by the state's "Project Homekey." This interim housing community houses 88 individuals and 12 families (approximately 124 people) at a time ("The 2020 Annual…"). The CrestView Hotel has 67 residential units for individuals and families without stable housing ("County of Santa…"). By providing extremely affordable housing to those previously homeless, Mountain View hopes to quickly get community members off the streets and give them a fresh start ("County of Santa…").

Mountain View also endorsed a 2020-2025 community plan to end homelessness in Santa Clara County. This plan utilizes three strategies to address the growing homelessness crisis: Addressing the root causes of homelessness through policy change, expanding homelessness prevention and housing programs, and improving the quality of life for unsheltered individuals. Some of the goals outlined in the plan are to house 20,000 people through supportive housing, achieve a 30% reduction in the annual inflow of homeless people, double the amount of temporary housing/shelter capacity, expand the homelessness prevention system to serve 2,500 people annually, and address the racial inequalities present in unhoused people ("Community Plan to").

As of their 2022 year-end report, they have made progress in following the guidelines. Of the 20,000 people they aimed to house, 9,645 people have been housed. They currently have reduced the annual inflow of homeless people, or the number of new homeless people, by 27% (goal was 30%); however, the percentage went down from 2021 to 2022. The supportive housing capacity went up by 15% from 2020, although their goal was to double the number. Of the 2,500 people they hoped to serve through the homelessness prevention system per year, they are currently at 2,161 (40% increase from 2020). The report did not mention progress regarding their racial inequality goal ("2022 year-end…").

While promising, this is not enough to solve the ever-worsening homelessness crisis. From 2018-2022, California spent $17.5 billion trying to address homelessness (Watt). In theory, this large amount of money could have paid the rent for each unhoused individual during the same timeframe, but the homeless population rose instead (Watt). Despite all their efforts, the community plan to end homelessness still acknowledged a ratio of 1.7 households becoming homeless for every household who finds shelter ("2022 year-end…"). The fact that the homeless population is still growing in the area even with these efforts emphasizes the ineffectiveness of current methods of addressing homelessness. There needs to be a different approach to addressing homelessness as the current approach is not meeting the current need.

New policy idea:

Building new LifeMoves locations around Santa Clara County can help address the needs of the homeless population in a more effective manner. LifeMoves' transitional housing system is not only successful in getting people off the streets, but also at making sure that those people

are moved into stable housing and do not become homeless again. LifeMoves has a multitude of staff, each playing their own role in supporting their clients.

The most prevalent roles at the organization are residential services coordinators, case managers, family coordinators, therapists, nurses, and associate program directors. LifeMoves uses three resident service coordinators per site (26 official sites as of Oct. 2023) rather than security personnel because this approach is more effective and is more trauma-informed. Resident service coordinators are trained to assess the impact of trauma when interacting with residents and are less intimidating to the clients.

LifeMoves' case managers work with each individual/family who comes in for help to get them back on track. These case managers work to help the clients better manage their money and acquire jobs, along with supporting them to meet other needs as well. Since no case is the same, they work with each person/family individually depending on their specific needs.

Therapists are there to help those who need it, as experiencing homelessness can be a traumatizing experience for anyone. Supporting people in this way ensures that they will be able to live a stable lifestyle once they leave LifeMoves. The nurses are there to provide medical care, which supports the clients financially since they do not have to go to the hospital and pay hospital bills for any medical issues they may have.

However, these services come with a heavy cost to LifeMoves. Some government officials and citizens expressed concerns regarding LifeMoves' operating costs, as LifeMoves' services make them more expensive than other homeless shelter services. Yet, LifeMoves staff believe that these costs are necessary because they enable the people to permanently stay in stable housing and not return into homelessness.

This not only has a positive social impact on the community but also a positive financial benefit on society over time. There are many costs related to unsheltered individuals such as healthcare, social, and judicial costs that come from instances such as homeless people visiting the emergency room, 911 calls placed on homeless people, and incarceration of individuals who are homeless ("Home Not Found…Home").

By providing the services that LifeMoves does, the costs on associated support and social services are minimized. This means that the tax money that residents pay can either be reduced or used in other areas to further improve the quality of life instead of addressing homelessness, often in a less effective manner. By enabling the government to spend tax dollars in different areas, it makes the money that people pay more effective to address community needs, while the homeless population is still accessing support.

The defining factor that sets LifeMoves apart from other homelessness support systems is the services that they provide. Although it appears that Santa Clara County is making progress towards its goals to reduce homelessness in the area, they do not address the concern of whether those in homeless shelters will remain off the streets in the long term.

LifeMoves' program is the more effective method of helping unhoused people find stable housing. LifeMoves' Mountain View location serves 124 people at a time and clients are anticipated to stay about 90-120 days, meaning they serve 350+ clients over a year ("Mountain

View, CA"). 86% of families and 67% of all clients who ever worked with LifeMoves were able to find and stay in stable housing ("Mountain View, CA"). The homeless population in Mountain View has significantly decreased since LifeMoves opened. LifeMoves' Mountain View location was opened in the spring of 2021, and using Santa Clara County's Point In Time counts, LifeMoves made a noticeable difference in the number of homeless people in Mountain View. From 2017-2019, Mountain View's homeless population grew by 46% [416 to 606] but it decreased by 43% from 2019-2022 [606 to 346] ("Home - Office…(2019)"; "Home - Office…(2022)").

On the other hand, a city currently without a LifeMoves location, such as Santa Clara, has a continuously worsening homeless issue. Santa Clara had their homeless population grow by 20% [272 to 326] from 2017 to 2019, and then grow by another 35% [326 to 440] from 2019 to 2022 ("Home - Office…(2019)"; "Home - Office…(2022)"). LifeMoves received a lot of resistance when they proposed a new location in Santa Clara due to local residents not wanting there to be a homeless shelter nearby for safety reasons, as well as their high operating expenses. Yet, it is evident that what LifeMoves does will not only help address homelessness effectively but will also help save on the tax dollars that the local residents pay. The analysis shows it is likely that the costs of providing homeless shelter services is easily outweighed by the benefits that the newly employed people bring to the economy.

Policy Effectiveness in Reducing Government Costs Long-Term

➔ **Analysis method one: Effectiveness**

In 2015, Santa Clara County collaborated with Economic Roundtable, a nonprofit research organization specializing in analyzing economic, social, and environmental conditions, to publish a study analyzing the cost of homelessness in Santa Clara County called: "Home Not Found."[21]

The study found that Santa Clara County spent more than $3 billion on homelessness services between 2007 to 2012, $520 million of which came from the Santa Clara County community ("Home Not…Sheet"). The two biggest expenses were health care services, which made up 63% of the costs ($1.9 billion), and the justice system, amounting to 26.2% of the costs ($786 million).

The research showed that the average homeless person costs the government $62,473 annually, but that it only costs about $19,767 to place the same individual in a housing program, generating an annual cost saving of $42,706 by housing the homeless ("Home Not…Sheet").

It was also found that 5% of homeless people (2,800 people) make up 47% of all public costs. This group is categorized as the "persistently homeless," costing an average of $83,000 per person annually ("Home Not…Sheet"). Although this study was conducted over 10 years ago, it still provides good insight on the topic as the general idea still holds true. The amount of funding

and costs are most likely different today than it was in 2012, but placing individuals who are street homeless in housing can still reduce costs to the government.

LifeMoves costs more than the average homeless shelter organization, but they are more likely to help those who are homeless not to become homeless again ("Annual Report 2020-2021"). This not only saves money by reducing the inflow of people who are homeless on the streets but also can help address the "persistently homeless" group mentioned in the study. LifeMoves addresses the root causes of an individual's homelessness, such as substance use disorder or the inability to acquire a job, and works with the client in order to return them to a lifestyle where they can maintain living in permanent housing.

The National Institutes of Health (NIH) also supports this argument with sources stating significant reduction in healthcare costs and utilization. They described the taxpayer money being reduced by 59% in healthcare costs, 61% in emergency department costs, and the general number of inpatient hospitalizations decreasing by 77% annually if homeless individuals are provided with supportive housing ("The business case…"). Another article from NIH states that from evidence gathered in studies, the median intervention cost for any given homeless person in the U.S. is $16,479, while the median benefit (savings) would be $18,247 ("Permanent Supportive Housing…). This further supports the claim of an economic benefit by supporting the homeless with housing, not just in the Bay Area, but also in a national context.

➔ **Analysis method two: Efficiency**

According to Santa Clara's 2022 Point In Time count, only 12% of homeless people in the area are employed. Of the unemployed individuals, only 41% are looking for work, while the rest are either unable to work or no longer looking for employment.

The Point In Time count indicated that there were 10,028 homeless individuals in Santa Clara County, meaning that there are about 3,618 people who are unemployed but looking for jobs ("Home - Office…(2022)"). However, the U.S. only considers individuals who have been actively looking for jobs in the past 4 weeks as "unemployed," so there are likely more individuals who are actually interested in employment (DeSilver).

LifeMoves in total served 7,231 unhoused individuals in 2020 throughout all locations ("Annual Report 2020-2021"). From their 2020 financial report, LifeMoves totaled $34.98 million in expenses (FY21). They also reported that 72% of their expenses came from their interim housing system, with the other portion being spent on homeless prevention, outreach, wellness, and education, etc (FY21). This means that they spend about $4,836.90 per client ($3,482.58 if only taking into account interim housing system costs).

Assuming that the Mountain View location will serve 350 people each year, that means they will spend $1.69 million annually on clients ("Mountain View, CA"). LifeMoves reports that 69% of all clients returned to stable housing, including an 89% rate for families. Excluding the family rate, 242 of the clients served will be returned to stable housing ("Mountain View, CA"). Since they also reported 1 of every 5 clients are children, we can assume that 194 people

who returned to stable housing are able to work ("Annual Report 2020-2021"). The current minimum wage in Mountain View is $18.15 per hour ("Mountain View, CA…"). If we assume that the people returned to stable housing will earn at least minimum wage and work a typical 40 hour per week job as well as 260 work days in a year, they will collectively make $7.32 million in annual income (Wang).

This benefits the community because it introduces more money into the economy when these people have more money to spend which in turn helps the economy grow. It also reduces tax dollars that the government previously had spent on helping the unhoused, and increases the taxpayer base..

Political Feasibility:

LifeMoves recently proposed opening another interim housing program location in Santa Clara. However, they received much resistance from the community as there were many people who did not want homeless shelters in their community. This is a problem faced by many proposed homeless shelters with people being supportive of homeless shelters until they are proposed in their own neighborhood.

This could be because of many different concerns such as safety and crime in their neighborhood or people not wanting what they perceive as negative influences on their children. Some Santa Clara residents had reservations about this project due to the lack of background checks and screening of those anticipated to move in (DeSilver). As a result of this, LifeMoves faced challenges when trying to get their proposal approved in Santa Clara and was barely able to get it passed. They initially planned on 120 individual units, but pressure from the community resulted in a change to just 30 family units (DeSilver).

There are also some government officials who are averse to the high costs of running the LifeMoves program. They believe that the same results could be achieved without having to spend the same amount of funding for all the services that LifeMoves provides its clients. This also creates difficulty for LifeMoves to open new sites because there are some officials who are against their model.

Despite all this, we still see that there are people who are supportive of the homeless shelters and advocate for the LifeMoves model. This paper aims to show that there are a number of under-recognized benefits of providing shelter for homeless people in communities that go beyond supporting individuals in need. This may serve as evidence to many people to be more accepting of these kinds of housing shelter systems and make it easier for these to be approved.

Conclusion:

In summary, the LifeMoves model has been shown to be more effective in addressing the homelessness crisis. LifeMoves' approach of providing not only shelter but also addressing the root problems of homelessness through various support services has been very successful in helping unhoused individuals find and maintain permanent housing. While the costs of running

such a program may be higher than other homeless shelter services, the long-term benefits make it a worthwhile investment. LifeMoves' approach not only benefits the unhoused individuals but also has a positive impact on the economy by saving tax dollars and introducing more cash flow.

This model could be adopted in other places around the United States with homelessness. Major cities in the United States, not only in the Bay Area, have high rates of homelessness (Cassaday). Although reasons for homelessness could be different throughout the country, addressing the same root problems can help address homelessness. Investing in these kinds of programs will help alleviate the suffering and build the economies of cities around America.

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Dietary behavior and suicidal risk among adolescents: Focusing on skipping breakfast, caffeinated beverages, and late-night snacks By Kihyun Hong

Abstract

Youth suicide is globally at an increasing rate, especially in South Korea, where excessive academic passion creates a highly competitive system for students. Although there were several policies from the South Korean government over the years, none of them effectively remedied the social issue. To help solve the problem, this study identifies and analyzes the relationship between adolescents' dietary behavior –skipping breakfast, caffeinated beverages, and late-night snacks– and suicidal risks, including suicidal ideation, planning, and attempts. This study was conducted using the related questions from the 18th Youth Health Behavior Survey, and the data was analyzed using SPSS.

Skipping breakfast, drinking caffeinated beverages, and eating late-night snacks all showed a positive relationship with suicidal ideation, planning, and attempts. Late-night snacks showed the highest correlation, followed by caffeinated beverages and skipping breakfast. One commonality was for all three categories, most suicidal ideation stops at the thought of suicide, but progresses to a suicide plan and is followed through with a very high rate of suicide attempts. This finding can be integrated into South Korean education by prioritizing foods with the highest suicide association rate in education and setting regulations on unlimited consumption that leads to unhealthy dietary patterns.

Introduction

Adolescence is the phase of life where adolescents undergo rapid physical, rational, and psychosocial growth. This phase of life significantly affects how they feel, think, make decisions, and interact with the world, which becomes a building stone to be an adult(WHO "Adolescent Health" report, 2024). Although this phase of life should be a healthy stage of life, there is significant death in the youth years, which is mostly preventable or treatable. Adolescent suicide, an act of injuring oneself to die, is a serious ongoing global issue. According to the Centers for Disease Control (CDC), the youth suicide rate in the US, aged 10 to 24 had increased by over 62% from 2007 to 2021(Curtin, Garnett, 2023). Also, the World Health Organization (WHO) confirmed suicide is the fourth leading cause of death among 15-29-year-olds. Hence, many countries are working to mitigate increasing youth suicide.

South Korea is particularly vulnerable to adolescent mental health problems. Korea has the highest depression experience rate with an average of 13.2 people among 100 who answered they experienced a depressing event that affected their daily lives over two weeks(Soontae, 2020). South Korea also has one of the lowest happiness index in the world. In the 2020 World Happiness Report by the Sustainable Development Solutions Network (Soontae, 2020), South Korea was ranked 61st, marking 5.872 out of 10. It has been a steady decrease since 2017. As these statistics prove, South Korean youth's leading cause of death is suicide, surpassing cancer and safety incidents; South Korea is ranked first place in suicide mortality rate among OECD

major countries with an average rate of 22.6 suicides among 100,000 population(Statistics Korea Office, 2022). Although South Korea executed several policies on the issue beginning in 2004, a much more effective solution seems to be needed for South Korean adolescents.

There are several causes of Adolscent's suicides: family stresses and conflict, mental health problems (e.g. depression), diagnosed psychiatric disorders, and more(Smischney, Chrisler, Villarruel, 2014). Among these risk factors, dietary patterns also play a role. WHO states Adolescents establish patterns of dietary behavior that last until the rest of their lives, and wrongly structured diet patterns may lead to common mental diseases such as depression and further suicide(WHO, 2024). Several preceding research proved that there is a significant positive correlation between youth's unhealthy eating habits - skipping breakfasts, drinking sports drinks, and fruit and vegetable intake - and suicidal thoughts as well as attempts(Michael, et al. 2020; Bryant, 2018). Despite this significance, researchers regarding this field are very trivial in South Korea although the study has the potential to remedy the high suicide rate in South Korea (Seul Ki Park et. al, 2020, Hyo-Eun Park et. al, 2016). This research will examine the positive relationship between adolescent's dietary behavior and suicidal risks, especially focusing on skipping breakfast, caffeinated beverages, and late-night snacks.

Background

<Adolescent Suicide>

WHO states suicide is the fourth leading cause of death among 15-29-year-olds(WHO, 2024).. Although the global suicide rate has decreased over the last few decades, the adolescent suicide rate has seen a steady increase. For example, the suicide rates in males aged 15-19 rose between 1979 and 1996 In 21 of the 30 countries in the World Health Organization (WHO) European region(Daunta, Qi, Guo-Xin, 2005). Particularly, South Korea has an extremely high rate of adolescent suicide, marking the top place in suicide mortality rate among OECD major countries(Statistics Korea Office, 2022).

Adolescent suicide became prevalent in South Korea and has been rising since the 1990s. According to OECD, the Organization for Economic Co-operation and Development, the suicide rate in Korea increased by 200% from 1990 to 2015. In 2010, the rate of suicide among adolescents was 5.2 per 100,000 people. However, the rate had increased to 5.9 in 2019 and 7.1 in 2021(OECD Data, 2023). The suicide rate of male and female teenagers is similar, meaning suicide is not a problem for a specific sex.

To remedy the problem, the South Korean government has enacted numerous policies to prevent suicide. Roh Moo-hyun government implemented the first 5-year basic plan for suicide prevention, and the Lee Myung-back government executed 2nd comprehensive suicide prevention policy to mainly lower the suicide rate per 100,000 people(Jeonghwan, 2013). Also, the South Korean government gradually increased the mental health screening conducted at elementary, middle, and high schools from 245 places to 450 places in 2009, and to every school in 2010(Jeonghwan, 2013).

Adolescent suicide in Korea began with the country's economic rise in the 20th century. The exponential growth resulted in intensified socioeconomic competition and increased academic pressures for the rising generations. According to a 2014 New York Times analysis article about the level of education and income inequality in the United States, Korea marked the second country for passion for education among OECD countries(Porter, 2014). The mental suffering during school days originally resulted from the Wilhelminismus era's wrongly structured education in Germany(Mischler, 2000). In the early 20th century, education focused on making adolescents good citizens of the state, rather than developing their personal character. As a result, youths were expected to conform to the system and had to manage an overwhelming academic workload. This repeated mechanical learning leads to young people committing suicide with their youth getting suppressed. With this social atmosphere, much German literature and pop culture adhered to the suicide problem. Representatively, there are *Unterm Rad(Beneath the Wheel, 1906)* by Hermann Hesse and *Freund Hein(Friend Hein, 1902)* by Emil Strauß which criticized the school and education system and had huge popularity (Kim, 2014). Likewise, many Korean literature and pop culture also accused the problem of suicide. Representatively, there is a movie called "Happiness Does Not Come In Grades" from 1989 that explicitly shows how academic pressure ruins school days and causes suicide. Recently, many media have raised suicide awareness and emphasized its danger. In conclusion, suicide, which originated in Germany, is a serious social problem in South Korea.

< Dietary behavior and suicide>

Adolescents' dietary behavior has a positive correlation with suicidal thoughts and attempts. WHO states Adolescents establish patterns of dietary behavior that last until the rest of their lives, and wrongly structured diet patterns may lead to common mental diseases such as depression and further suicide(WHO, 2024). Particularly, adolescents are often marked by a change in food consumption patterns, including skipping breakfasts, frequent snacks, and eating unhealthy food, which makes them vulnerable to establishing a healthy dietary pattern. There is similar evidence that links adolescent's diet quality with mental health. Cross-sectional studies from the UK and Austria reported a positive relationship between higher intake of unhealthy foods and mental health symptoms among 10 to 14-year-olds(Jacka, et al.). It is important to note that an unhealthy mental state can often lead to suicide.

Caffeine beverages are one of the most common features that easily lead adolescents to have an unbalanced diet, comprehensively causing mental diseases that cause suicide. Adolescent suicide has several different features from adult suicide. They choose suicide not because of mental illness like adults but as a way to escape from difficulties and stresses in life, for adolescents, who are prone to impulsive attempts, consuming large amounts of caffeine beverages affects their thoughts and attempts of suicide through arousal effects and withdrawal symptoms(Ahn, et al., 2016; Mash et al., 2014).

Late-night snacks are one of the main causes of disrupting adolescents' diets, especially in South Korea. Due to South Korea's excessive study load and competitive education system,

Korean teenagers spend a lot of time at academies, resulting in a late home arrival. In South Korea, many adolescents return home from school late at night, increasing the environmental opportunities for late-night snacking, with the prevalence of late-night snacking at least three times a week reaching 24.9 percent for boys and 22.2 percent for girls (KDCA, 2022). Such academic burden and pressure causes teenagers to occasionally skip meals and replace them with instant foods, such as cheap breads and chips. These academic stresses lead to highly savory meals mainly with spicy, sweet, and salty tastes, and irregular meal times such as late-night snacks, and instant foods(Lee, et al., 2007). In particular, Korean teenagers have a strong addiction to mukbang content and impulsively imitate it by attempting binge eating, and this unbalanced nutritional intake that haphazardly follows Internet content can eventually lead to physical and mental disorders(Yoo, et al., 2021; Kim, et al., 2023)

Like Caffeine beverages and late-night snacks, skipping breakfast also hurts our mental health. There was a systematic review and meta-analysis of observational studies regarding the relationship between breakfast consumption and mental health. The study searched and analyzed all related papers through comprehensive international databases, concluding that there is a positive relationship between skipping breakfast and mental diseases, including depression, stress, and psychological distress in all groups, especially anxiety in adolescence(Zahedi et al., 2020). Breakfast is also associated with late-night snacking: late-night snacking leads to late sleep, poor sleep quality due to digestion, leading to oversleeping, and a lower desire to eat at night (Cho et al, 2014).

In conclusion, unbalanced diet patterns in teenagers, including caffeine beverages, late-night snacks, and skipping breakfast, all had a positive relationship with mental diseases that can highly lead to suicide.

Hypothesis

Through the studies and preceding research stated above, there is a positive relationship between unhealthy diet for adolescents, including skipping breakfast, late-night snacks, and caffeinated beverages, and suicidal risks accompanied by suicidal risks. Therefore, it is possible to infer that the unbalanced nutrition intake of South Korean adolescents will negatively affect their mental health, possibly leading to suicide.

First hypothesis: Caffeinated beverages have a positive relationship with South Korean adolescents' suicidal risk (ideation, plan, attempt).
Second hypothesis: Late-night snacks have a positive relationship with South Korean adolescents' suicidal risk (ideation, plan, attempt).
Third hypothesis: Skipping breakfasts has a positive relationship with South Korean adolescents' suicidal risk (ideation, plan, attempt).

Method
<Research Data>

This study utilized data from the 18th Youth Health Behavior Survey, which is conducted annually by the Korea Disease Control and Prevention Agency. The Korea Disease Control and Prevention Agency is an agency under the Ministry of Health and Welfare of the Republic of Korea and is the central administrative agency in charge of infectious diseases such as quarantine and epidemic prevention, and investigations, tests, and research on various diseases. The Youth Health Behavior Survey is an officially approved national statistic that is conducted annually by the National Health Promotion Act to identify the current health behavior of Korean adolescents to calculate health indicators necessary for planning and evaluating youth health promotion projects.

Beginning in 2005, The Youth Health Behavior Survey started its survey. The 18th survey, conducted in 2022, involved 51,850 students from 7th grade to 12th grade in 800 middle and high schools nationwide. The survey consisted of 88 questions in 16 categories, including smoking, alcohol, diet, mental health, obesity and weight control, personal hygiene, atopy, asthma, and internet addiction. The results of the survey are publicly available on the Korean Centers for Disease Control and Prevention website and can be used for research(https://www.kdca.go.kr/yhs/home.jsp).

Measure
<Dietary behavior>
This study analyzed questions related to skipping breakfast, caffeinated beverages, and late-night snacks from the "diet" section of the survey. For skipping breakfast, the study used "How many days did you skip breakfast in the last 7 days?"; for caffeinated beverages, the question is: "How often did you drink high-caffeine beverages in the last 7 days?"; and the late-night snacks question is: "How often did you eat late-night snacks in the last 7 days?".

The answers had a scale from 1 to 8 where participants had to choose one. 1 means they do not eat/drink the questioned activity (skipping breakfast, drinking beverages, eating late-night snacks). 2 means they eat/drink the questioned activity once a week. 3 means they eat/drink the questioned activity twice a week. 4 means they eat/drink the questioned activity three times a week. 5 means they eat/drink the questioned activity four times a week. 6 means they eat/drink the questioned activity five times a week. 7 means they eat/drink the questioned activity six times a week. 8 means they eat/drink the questioned activity seven times a week.

<Suicidal risk>
The suicidal risk was analyzed through the questions related to suicidal ideation, suicidal planning, and suicidal attempts in the "mental health" section of the survey. The question used for suicidal ideation was "In the past 12 months, have you had serious thoughts of suicide?"; the suicidal planning question was "In the past 12 months, have you made specific plans to commit suicide?" and the suicidal execution question is: "In the past 12 months, have you attempted suicide?". The participants had to answer yes or no to the questions stated above.

<Statistical analysis>

        This study aims to determine whether unhealthy dietary behaviors such as skipping breakfast, caffeinated beverages, and late-night snacks are associated with suicidal risk. Therefore, for this study, dietary behaviors and suicidal risk were analyzed using crosstabs. This study was conducted using SPPS, a comprehensive system for data analysis. SPSS includes several software programs for data entry, management, statistical analysis, and presentation. SPSS combines complex data and file administration with statistical analysis and reporting tasks. SPSS can produce tabular reports, charts and maps of distributions and trends, descriptive statistics, and sophisticated statistical analyses(Varghese, et al., 2023). To analyze the questions, crosstabs were used to determine the proportion of suicide risk by frequency of dieting behavior.

Result -Overall Results

<Demographics>

Table 1. General Characteristics of the study subjects

Table 1 shows the general characteristics of the study subjects. Of the total 51,850 participants, 26,397(50.9%) were male and 25,435(49.1%) were female. By school, 28,015 (54.0%) were middle school students, 19,279(37.2%) were in academic high school, and 4,113(7.9%) were in vocational high school. By self-rated academic achievement, 6,935(13.4%) rated themselves as "Very High,"13,116(25.3%) as "High", 15,484(29.9%) as "Middle," 11,380(21.9%) as "low", an

Characteristics	Total (n=51,850/100.0%)	Suicidal Ideation (n=7,350/14.2%)	Suicidal Plan (n=2,327/4.5%)	Suicidal Attempt (n=1,393/2.7%)
Gender: n(%)				
Male	26,397(50.9)	2,808(38.2)	962(41.3)	525(37.7)
Fermale	25,453(49.1)	4,542(61.8)	1,365(58.7)	868(62.3)
School, n(%)				
Middle school	28,015(54.0)	4,237(57.6)	1,344(57.8)	839(60.2)
Academic high school	19,279(37.2)	2,476(33.7)	752(32.3)	405(29.1)
Vocational high school	4,113(7.9)	588(8.7)	218(9.9)	144(10.3)
Self-rated academic achievement, n(%)				
Very high	6,935(13.4)	911(12.4)	316(13.6)	163(11.7)
High	13,116(25.3)	1,718(23.4)	514(22.1)	264(19.0)
Middle	15,484(29.9)	1,889(25.7)	595(25.6)	348(25.0)
Low	11,380(21.9)	1,787(24.3)	504(21.7)	356(25.6)
Very low	4,933(9.5)	1,045(14.2)	398(17.1)	262(18.8)
Socioeconomic status, n(%)				
Very high	5,984(11.5)	798(10.9)	308(13.2)	198(14.2)
High	15,904(30.7)	1,983(27.0)	625(26.9)	346(24.8)
Middle	24,143(46.6)	3,194(43.5)	908(39.0)	550(39.5)
Low	4,807(9.3)	1,055(14.4)	343(14.7)	187(13.4)
Very low	1,009(1.9)	320(4.4)	143(6.1)	112(8.0)
Living area, n(%)				
Metropolis	25,589(49.4)	3,614(49.2)	1,124(48.3)	657(47.2)
Cities	23,227(44.8)	3,361(45.7)	1,080(46.4)	661(47.5)
Rural	3,034(5.9)	375(5.1)	123(5.3)	75(5.4)

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4,993(9.5%) as "Very Low."

Of the total 51,850 teenagers, 7,350(14.2%) experienced suicidal ideation, 2,327(4.5%) experienced suicidal plans, and 1,393(2.7%) experienced suicidal attempt. When broken down by gender, suicidal plans were experienced by 2,808(38.2%) males and 4,542(61.8%) females. Among those who experienced suicidal plans, 962(41.3%) were males and 1,365(58.7%) were females, and among participants who attempted suicide, 525(37.7%) were males and 868(62.3%) were females. For other details, refer to Table 1.

<Caffeinated Beverages and Adolescent's Suicidal Risk>
    The number(%) who answered "Yes" to the question about suicidal risk(ideation, plan, attempt) by frequency of drinking caffeinated beverages is shown in Table 2. Among 26,876 participants who answered they do not drink caffeinated beverages, 3,093(11.5%) had suicidal ideation, 887(3.3%) had suicidal planning, and 447(1.8%) attempted suicide. Among 13,717 participants who answered they drink caffeinated beverages 1 to 2 times a week, 1,964(14.3%) experienced suicidal ideation, 607(4.4%) experienced suicidal planning, and 358(2.6%)

attempted suicide. Among 6,175 participants who answered they drink caffeinated beverages 3 to 4 times a week, 1,116(18.1%) experienced suicidal ideation, 351(5.7%) experienced suicidal plans, and 246(4.0%) attempted suicide. Among 2,146 participants who answered they drink caffeinated beverages 5 to 6 times a week, 480(22.4%) experienced suicidal ideation, 195(9.1%) experienced suicidal plans, and 101(4.7%) attempted suicide. Among 1,725 participants who answered they drink caffeinated beverages 1 time a day, 336(19.5%) experienced suicidal ideation, 113(6.6%) experienced suicidal plans, and 71(4.1%) attempted suicide. Among 720 participants who answered they drink caffeinated beverages 2 times a day, 190(26.4%) experienced suicidal ideation, 77(10.7%) experienced suicidal plans, and 58(8.1%) attempted suicide. Among 491 participants who answered they drink caffeinated beverages 3 times or more a week, 171(34.8%) experienced suicidal ideation, 97(19.8%) experienced suicidal plans, and 82(16.7%) attempted suicide.

Table 2. Relationship Between Drinking Caffeinated Beverages and Adolescents' Suicidal Risk

	none (n=26,876)	1–2 times / week (n=13,717)	3–4 times / week (n=6,175)	5–6 times / week (n=2,146)	1 time / day (n=1,725)	2 times / day (n=720)	3 times / day or more (n=491)	Total (n=51,850)
Ideation	3,093(11.5%)	1,964(14.3%)	1,116(18.1%)	480(22.4%)	336(19.5%)	190(26.4%)	171(34.8%)	7,350(14.2%)
Plan	887(3.3%)	607(4.4%)	351(5.7%)	195(9.1%)	113(6.6%)	77(10.7%)	97(19.8%)	2,327(4.5%)
Attempt	477(1.8%)	358(2.6%)	246(4.0%)	101(4.7%)	71(4.1%)	58(8.1%)	82(16.7%)	1,393(2.7%)

Fig. 1 shows the change in suicidal risk to caffeinated beverages drinking frequency from Table 2.

Fig. 1 Changes in Suicidal Risk Depending on Drinking Caffeinated Beverages Frequency

Changes in Suicidal Risk Depending on Drinking Caffeinated Beverages Frequency
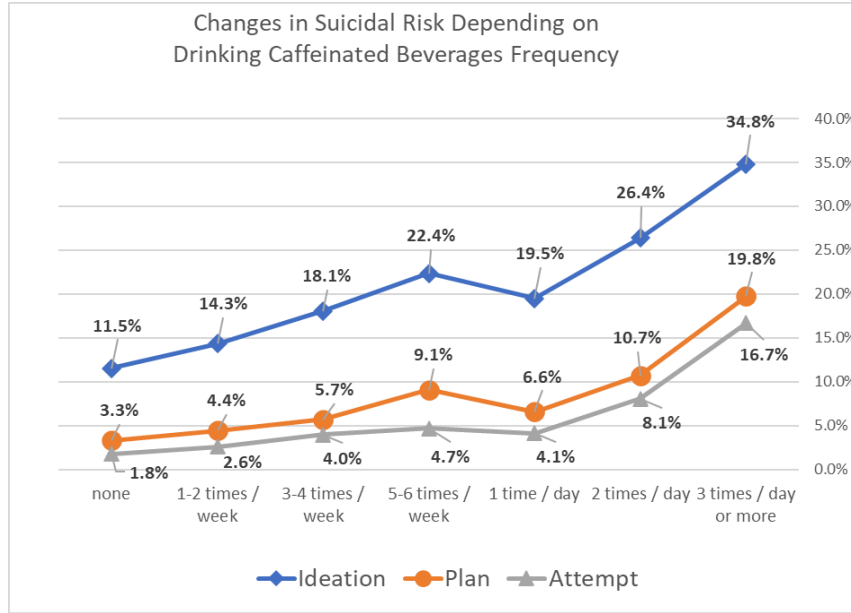
Assuming 100%(1.0) as the number of participants who answered "Yes" on 7 drinking caffeinated beverages frequency groups in Table 2, this study analyzed the ratio of suicidal plans to attempt. In the 1-2 times/week caffeinated beverage group, 31% planned and 18% attempted suicide. In the 3-4 times/week caffeinated beverage group, 31% planned and 22% attempted. In the 5-6 times/week caffeinated beverage group, 41% planned and 21 attempted. In 1 time/day caffeinated beverage group, 34% planned and 21 attempted. In the 2 times/day caffeinated beverage group, 40% planned and 31% attempted. In 3 times/day or more, 57% planned and 48% attempted.

The visualization of this ratio of plans and attempts for suicidal ideation is shown in Fig. 2.

Fig. 2 Ratio of plans and attempts for suicidal ideations in Drinking Caffeinated Beverages Frequency

Ratio of Plan and Attempt for Suicidal Ideation in Drinking Caffeinated Beverages Frequency (%)
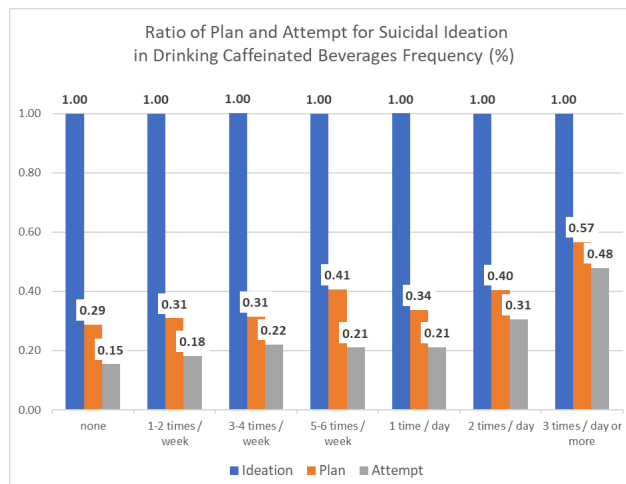
<Late-Night Snacks and Adolescents' Suicidal Risk>
The number(%) who answered "Yes" to the question of suicide risk(ideation, plan, attempt) by frequency of eating late-night snacks are shown in Table 3. Of the 20,962 people who said they never eat a late-night snack, 2,764 (13.2%) ideated, 833 (4.0%) planned, and 489 (2.3%) attempted suicide. Of the 9,984 people who reported eating a late-night snack 1 time/week, 1,321 (13.2%) ideated, 421 (4.2%) planned, and 251 (2.5%) attempted suicide. Of the 8,979 people who reported eating a late-night snack 2 times/week, 1,242 (13.8%) ideated, 399 (4.4%) planned, and 227 (2.5%) attempted suicide. Of the 5,793 people who reported eating a late-night snack 3 times/week, 938 (16.2%) ideated, 291 (5.0%) planned, and 172 (3.0%) attempted suicide. Of the 2,698 people who reported eating a late-night snack 4 times/week, 431 (16.0%) ideated, 134 (5.0%) planned, and 85 (3.2%) attempted suicide. Of the 1,732 people who reported eating a late-night snack 5 times/week, 289 (16.2%) ideated, 291 (5.0%) planned, and 55 (3.2%) attempted suicide. Of the 644 people who reported eating a late-night snack 6 times/week, 124 (19.3%) ideated, 44 (6.8%) planned, and 29 (4.5%) attempted suicide. Of the 1,058 people who reported eating a late-night snack 7 times/week, 241 (22.8%) ideated, 111 (10.5%) planned, and 85 (8.0%) attempted suicide.

Table 3. Relationship Between Eating Late-Night Snacks and Adolescents' Suicidal Risk

	none (n=20,962)	1 time / week (n=9,984)	2 times / week (n=8,979)	3 times / week (n=5,793)	4 times / week (n=2,698)	5 times / week (n=1,732)	6 times / week (644)	7 times / week (1,058)	Total (n=51,850)
Ideation	2,764(13.2%)	1,321(13.2%)	1,242(13.8%)	938(16.2%)	431(16.0%)	289(16.7%)	124(19.3%)	241(22.8%)	7,350(14.2%)
Plan	833(4.0%)	421(4.2%)	399(4.4%)	291(5.0%)	134(5.0%)	94(5.4%)	44(6.8%)	111(10.5%)	2,327(4.5%)
Attempt	489(2.3%)	251(2.5%)	227(2.5%)	172(3.0%)	85(3.2%)	55(3.2%)	29(4.5%)	85(8.0%)	1,393(2.7%)

The following Fig.3 is the visualization of the change in suicidal risk as a function of eating late-night snacks frequency shown in Table 3.

Fig. 3 Changes in Suicidal Risk Depending on Eating Late-Night Snack Frequency

Changes in Suicidal Risk Depending on Eating Late-Night Snack Frequency
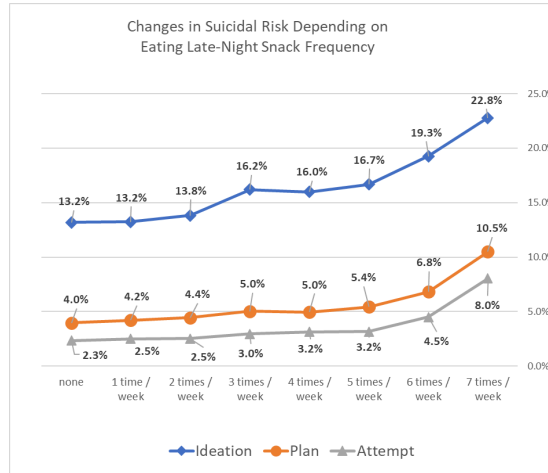
Assuming 100%(1.0) as the number of participants who answered "Yes" on eight eating late-night snacks frequency groups in Table 3, this study analyzed the ratio of suicidal plans to attempt. In the group who answered they do not eat late-night snacks, 30% of those who reported having thoughts of suicide had suicidal planning and 18% attempted suicide. In the 1 time/week late-night snack group, 32% had suicidal planning and 19% attempted suicide. In the 2 times/week late-night snack group, 32% had suicidal planning and 18% attempted suicide. In the 3 times/week late-night snack group, 31% had suicidal planning and 18% attempted suicide. In the 4 times/week late-night snack group, 31% had suicidal planning and 20% attempted suicide. In the 5 times/week late-night snack group, 33% had suicidal planning and 19% attempted suicide. In the 6 times/week late-night snack group, 35% had suicidal planning and 23% attempted suicide. In the 7 times/week late-night snack group, 46% had suicidal planning and 35% attempted suicide.

The visualization of this ratio of plans and attempts for suicidal ideation is shown in Fig. 4.

Fig. 4 Ratio of plans and attempts for suicidal thoughts in Eating Late-Night Snack Frequency

Ratio of Plan and Attempt for Suicidal Ideation in Eating Late-Night Snack Frequency (%)

<Skipping Breakfast and Adolescents' Suicidal Risk>
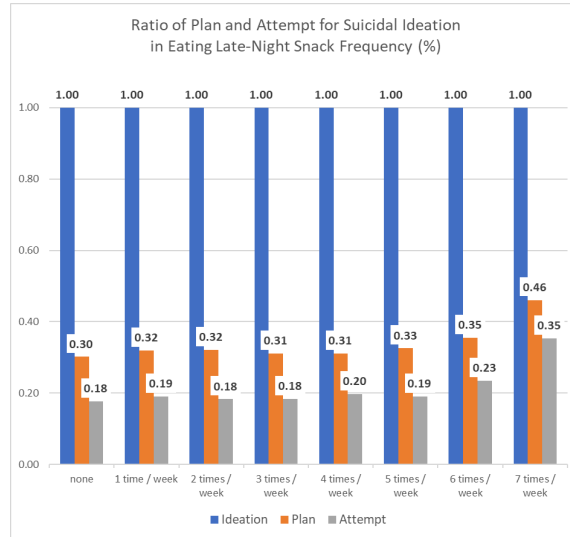
The number(%) who answered "Yes" to the question of suicidal risk(ideation, plan, attempt) by frequency of eating breakfast is shown in Table 4. Among 11,533 participants who answered they do not eat breakfast, 1,840(16.0%) had suicidal ideation, 593(5.1%) had suicidal planning, and 402(3.5%) attempted suicide. Among 3,995 participants who answered they eat breakfast 1 time a week, 627(15.7%) had suicidal ideation, 196(4.9)% had suicidal planning, and 130(3.3%) attempted suicide. Among 4,838 participants who answered they eat breakfast 2 times a week, 764(15.8%) had suicidal ideation, 244(5.0)% had suicidal planning, and 151(3.1%) attempted suicide. Among 4,205 participants who answered they eat breakfast 3 times a week, 638(15.2%) had suicidal ideation, 216(5.1)% had suicidal planning, and 125(3.0%) attempted suicide. Among 3,467 participants who answered they eat breakfast 4 times a week, 543(15.7%) had suicidal ideation, 174(5.0)% had suicidal planning, and 91(2.6%) attempted suicide. Among 6,446 participants who answered they eat breakfast 5 times a week, 856(13.3%) had suicidal ideation, 281(4.4)% had suicidal planning, and 158(2.5%) attempted suicide. Among 3,517 participants who answered they eat breakfast 6 times a week,417(13.4%) had suicidal ideation, 133(3.8)% had suicidal planning, and 73(2.1%) attempted suicide. Among 13,843 participants who answered they eat breakfast 7 times a week, 1,609(11.6%) had suicidal ideation, 488(3.5)% had suicidal planning, and 262(1.9%) attempted suicide.

Table 4. Relationship Between Eating Breakfast and Adolescent's Suicidal Risk

	none (n=11,533)	1 time / week (n=3,995)	2 times / week (n=4,838)	3 times / week (n=4,205)	4 times / week (n=3,467)	5 times / week (n=6,446)	6 times / week (n=3,517))	7 times / week (n=13,843)	Total (n=51,844)
Ideation	1,840(16.0%)	627(15.7%)	764(15.8%)	638(15.2%)	543(15.7%)	856(13.3%)	471(13.4%)	1,609(11.6%)	7,348(14.2%)
Plan	593(5.1%)	196(4.9%)	244(5.0%)	216(5.1%)	174(5.0%)	281(4.4%)	133(3.8%)	488(3.5%)	2,325(4.5%)
Attempt	402(3.5%)	130(3.3%)	151(3.1%)	125(3.0%)	91(2.6%)	158(2.5%)	73(2.1%)	262(1.9%)	1,392(2.7%)

The following Fig.5 is the visualization of the change in suicidal risk as a function of eating breakfast frequency shown in Table 4.

Fig. 5 Changes in Suicidal Risk Depending on Eating Breakfast Frequency
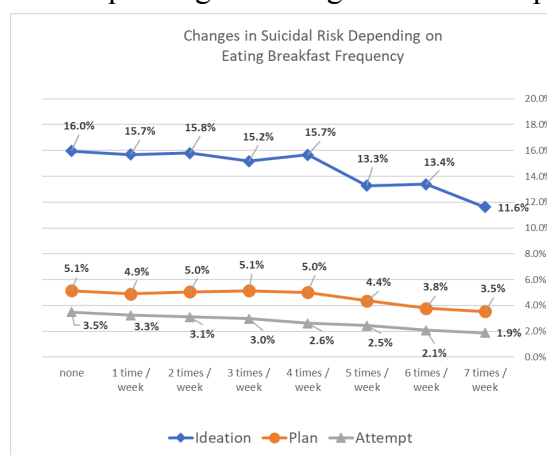
Assuming 100%(1.0) as the number of participants who answered "Yes" on eight eating breakfast frequency groups in Table 4, this study analyzed the ratio of suicidal plans to attempt. In the group who answered they do not eat breakfast, 32% of those who reported having thoughts of suicide had suicidal planning and 22% attempted suicide. In the 1 time/week eating breakfast group, 31% had suicidal planning and 21% attempted suicide. In the 2 times/week eating breakfast group, 32% had suicidal planning and 20% attempted suicide. In the 3 times/week eating breakfast group, 34% had suicidal planning and 20% attempted suicide. In the 4 times/week eating breakfast group, 32% had suicidal planning and 17% attempted suicide. In the 5 times/week eating breakfast group, 33% had suicidal planning and 18% attempted suicide. In the 6 times/week eating breakfast group, 28% had suicidal planning and 15% attempted suicide. In the 7 times/week eating breakfast group, 30% had suicidal planning and 16% attempted suicide.

The visualization of this ratio of plans and attempts for suicidal ideation is shown in Fig. 6.

Fig. 6 Ratio of plans and attempts for suicidal thoughts in Eating Breakfast Frequency

Ratio of Plan and Attempt for Suicidal Ideation in Eating Breakfast Frequency (%)
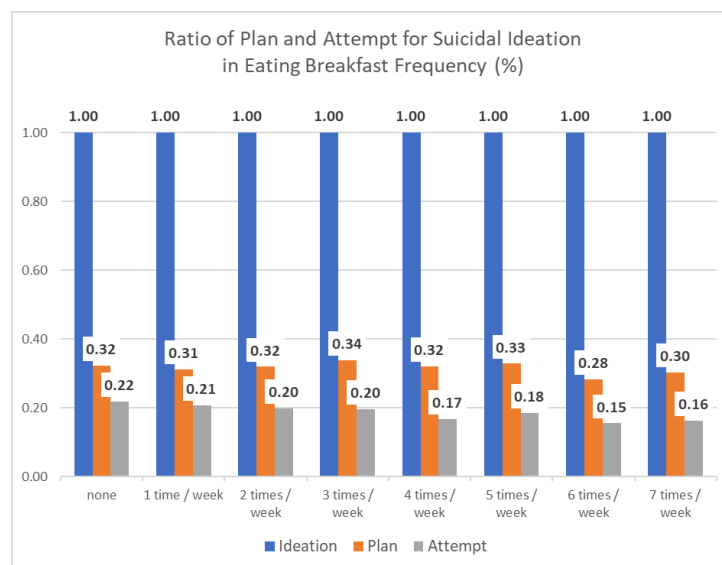
Discussion

Drinking caffeinated beverages, eating late-night snacks, and skipping breakfast had one common feature: when suicidal ideation leads to suicidal planning, there is a high probability of attempting suicide. Caffeinated beverages showed the highest correlation with suicidal risk. From Table 2, it is shown that consuming more caffeinated beverages leads to a higher rate of suicidal attempts. Comparing the group with no caffeine drinking and the group with the highest frequency, the percentage of suicidal ideation tripled; the percentage of suicidal planning sextupled; and the percentage of suicidal attempts increased by nine times. Figure 2 emphasizes the percentage of suicidal ideation leading to planning and the percentage of suicidal planning leading to suicidal attempts. As the frequency of drinking caffeinated beverages increased, the percentage of suicidal planning and attempts increased as well (29% to 57% / 15% to 48%). For the group with the highest frequency, 84% of participants who planned suicide attempted suicide, proving that drinking more caffeinated beverages leads to a higher rate of suicidal attempts.

Late-night snacks also showed a positive relationship with suicidal risk like drinking caffeinated beverages. Table 3 shows that the percentage of suicidal attempts gradually increased as the number of days with late-night snacks increased. Comparing the group with not eating late-night snacks and the group with the highest frequency, the percentage of suicidal ideation increased by 1.6 times; the percentage of suicidal planning increased by 2.5 times; and the percentage of suicidal attempts increased by 3.5 times. Similar to caffeinated beverages, the proportion of suicidal ideation leading to suicidal plans and suicidal plans to suicidal attempts showed a gradual increase (30% to 46% / 18% to 35%). However, late-night snacks didn't show a drastic increase in the proportion compared to caffeinated beverages despite the importance of sleep. This is because of the universalization of consuming late-night snacks among South Korean adolescents due to heavy academic workload. Since late-night snacks became a common

thing, it didn't have a huge impact on suicidal risk. However, the gradual increase in suicidal ideation, planning, and attempts should not be ignored.

Skipping breakfasts had the lowest correlation with suicidal risks. Although the percentage of suicidal ideation, plans, and attempts decreased as the frequency of eating breakfast increased, the change is very low. Suicidal ideation decreased by 4.1%, planning decreased by 1.6%, and attempts decreased by 1.6%. This shows breakfast is not always beneficial and it has less correlation with suicidal risk than caffeinated beverages and late-night snacks. However, skipping breakfast also leads to attempts with a high probability of going from thought to plan. For teenagers who do not eat breakfast, 1840 had suicidal ideation, 593 had suicidal planning, and 402 attempted suicide. Of those who had suicidal ideation, 32.2% led to suicidal planning. From suicidal plan to attempt, 67.8% of teenagers who planned suicide led to attempt.

This correlation with suicidal risk can be integrated into South Korean education. Foods with the highest suicide association rates can be prioritized in education. Caffeinated beverages, which have the highest correlation, should be focused on education. Then, late-night snacks should be emphasized; lastly, skipping breakfasts. This will help to remedy the excessive suicidal rate among South Korean adolescents by forming a balanced dietary pattern.

Conclusion

Although this study has the potential to remedy the high suicide rate, one of the most critical issues, in South Korea, researchers regarding this field are very trivial. This research was conducted to examine the relationship between South Korean adolescents' dietary behavior and suicidal risks, especially focusing on skipping breakfast, caffeinated beverages, and late-night snacks, to suggest possible solutions for the high suicide rate in South Korea.

This study utilized data from the 18th Youth Health Behavior Survey, an annual survey conducted by the Korea Disease Control and Prevention Agency. The 18th survey in 2022 involved 51,850 students from 7th to 12th grade in 800 middle and high schools nationwide. This study analyzed questions related to skipping breakfast, caffeinated beverages, and late-night snacks from the "diet" section of the survey using SPSS, a comprehensive system for data analysis.

The statistical analysis showed skipping breakfast, drinking caffeinated beverages, and eating late-night snacks all have a positive relationship with suicidal ideation, planning, and attempts although their level of correlation varied. It was shown that drinking caffeinated beverages had the highest correlation with suicidal risks, followed by eating late-night snacks and skipping breakfast. There was one commonality for all three behaviors: when suicidal ideation leads to suicidal planning, there is a high probability of attempting suicide.

The result of this study will be beneficial when constructing policies on youth suicides. Especially, the result suggests the need to regulate the unlimited consumption of caffeine in the diets of Korean adolescents. Policies, campaigns, and education are also needed to promote

healthy sleep patterns among youth, as staying up late for study can lead to late-night snacking, which can result in oversleeping, which can cause them to skip breakfasts.

Most importantly, the finding that most suicidal ideation stops at the thought of suicide, but progresses to a suicide plan and is followed through with a very high rate of suicide attempts should be considered seriously by health authorities and youth education authorities in the policy formulation process. Therefore, there is a need for systems, policies, and support to provide special care for adolescents with the possibility of having suicidal risk to prevent them from moving from suicidal ideation to planning.

This is a useful study that identifies and analyzes the latest trends in the relationship between South Korean adolescents' dietary behavior and suicidal risks. Although there are small differences between countries, the overall trend of adolescent suicide is similar and this study will be a good reference for constructing policies. Starting with this study, we will contribute to further research on adolescent dietary behavior to find solutions to suicidal risk.

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A Look at Accent Perceptions in Atlanta By Nora Glass

ABSTRACT

Previous dialect studies in the urban south have focused on the decline of the SVS (Southern Vowel Shift), with Renwick et. al. (2023) in particular looking at Georgia and Atlanta within it. This study seeks to find whether Atlantans' perceptions match reality, with the research question: *What do Atlanta natives perceive as Atlanta's linguistic identity?* This study, a set of sociolinguistic interviews and analysis based on the previous perceptual work of Hayes (2013) and others, seeks to determine what linguistic traits Atlantans associate with the city, finding that within a largely white and female population, there are large generational differences. I came to six conclusions, reflecting my participants' diverse opinions on Atlantan identity and its connection with accents. Overall, the participants perceived Atlanta as having a Southern accent in decline. They also viewed this accent negatively, and associated it with African-American Vernacular English. Their views varied generationally. Though the study suffered from a small and undiverse sample size, this leaves room for future researchers to look at more specific groups within Atlanta, as well as other demographic categories such as geographic location.

HISTORY OF SOCIOLINGUISTICS

In the eighteenth century, alongside the rise of rationalism and the Enlightenment came the beginnings of dialectology, the study of dialects. From a postal survey across German-speaking Europe to a 1,500-question survey conducted across France (McCulloch, 2020), these early studies had a wide range but were extremely taxing. The results were also unreliable, as they relied on transcription and notation by human ear, which was notoriously difficult and time-consuming, and still is, even in the modern day.

Centuries later, sociolinguistic studies of isolated communities and their unique traits would rise to prominence, being easier to carry out. In 1963, not long after portable tape recorders became available to the public, now-famous dialectologist William Labov studied 69 year-round islanders of Martha's Vineyard and their voice's relationship to their cultural identity. By interviewing and recording dozens of island residents of different classes, races, and opinions on Martha's Vineyard, he was able to find a strong link between the social identity of the residents and their voices. Labov studied the centralization of /au/ and /ai/ vowels, which was often a non-salient trait —hard for the untrained ear to differentiate between, and thus less likely to be affected by the observer's effect[1]. Labov found that centralization correlated to self-described identity and affinity to the island; for example, teens who planned to leave the island for college displayed less centralization than those who planned to stay. This was

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[1] "When you sit someone down with a tape recorder or hand them a list of questions [...] it tends to bring out the formal, standardized, job-interview style of language, which is […] already […] well documented. [...] [T]he people [the researchers are] studying are sometimes unaware or self-conscious about some of the most interesting aspects of their speech, so they can't or won't talk about it explicitly." (McCulloch, 2019)

fascinating as centralization is a non-salient trait; the teens who were planning to leave had nevertheless disassociated themselves from the linguistic identity of the island.

Since the studies of specific areas, in the later half of the 20th century, the research began to shift to large-scale surveys of massive areas. The dream was to capture all of North American English on a single map, or at least a large book full of them. In the '90s, Labov, along with Sharon Ash and Charles Boberg conducted telephone surveys to create a book of isoglosses of linguistic features from across North America, entitled the Atlas of North American English (Labov et. al., 2005). Additionally, the Harvard Dialect Survey of 2003 brought dialectology to the masses through an internet survey of 31,000 participants from across America (Vaux & Golder, 2003) and showed which traits were considered unique to the public: pronouncing the first syllable of "lawyer" to rhyme with "boy" is nothing of note, with 72.84% of participants pronouncing it as such. However, the first syllable rhyming with "saw", as it does for only 21.96% of the population, constitutes a trait of a dialectal minority.

One of the most distinct accents/dialects[2] of North American English, is Southern American English (SAE). SAE is the dialect encompassing the already well-established cultural identity of Southerners, being composed of many traits. The area of "the South" is huge and makes up much of the U.S; as such, many sociolinguistic studies have focused on the South and SAE.

IDENTITIES AROUND DIALECTS

In more modern times, many sociolinguistic studies have followed the lead of earlier ones. Childs and Mallinson (2006) conducted an in-depth sociolinguistic study of the teens of Texana, North Carolina, a small, majority-black community of a couple hundred. They studied conversations, including those over IM (Instant Messaging), a fairly new technology. Childs and Mallison found an interesting trend in the youngest generation of teens: while their dialects were unrecognizable as AAVE to outside listeners, the teens were picking up words and traits from friends in the Black communities of Atlanta and other cities, as well as hip-hop music. This includes slang such as "Holla back" and r-dropping, which was notated through IM (i.e. "Brotha") more often than it was actually pronounced. The teens associated these words with blackness and purposely integrated them into their vocabulary, even if they weren't always familiar with the context or full meaning of the word. Similarly to the teens in the Martha's Vineyard study, the Texana teens constructed an idiolect around their identities and relationship to their surroundings, with modernization leading to a more "black-sounding" Texana teen

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[2] An accent can be defined as a way of pronouncing words and sounds, while a dialect is the collection of words and phrases (along with an accent) that belong to a group. For example, a French man struggling to pronounce the "th" sound in the English word "this" would have a French accent, but no specific English dialect. Meanwhile, an African-American speaking AAVE (African-American Vernacular English) would be expected to display both accent traits (i.e. non-rhoticity) as well as others (i.e. double negation.) AAVE would be considered a dialect. In this paper, the two words will be used largely interchangeably.

population as they adapted the sound of nearby cities, which they saw as linguistic cultural epicenters.

CITIES AND THE URBAN SOUTH

The city, in fact, holds a unique place in dialectology. It's more complex to study than Martha's Vineyard or Texana; Labov (1963) notes at the end of his Martha's Vineyard study that in these complex locations, "multiple-style speakers are the rule, not the exception; instead of three ethnic groups we have a great many; mobility and change are far more rapid; and the population is huge". For this reason, the sociolinguistics of cities should be considered in a different manner. Karlander (2021) suggests that these sociolinguistic spaces should be thought of less with "identities" that apply to the entire city, and more so as the meeting place of several identities influenced by their urban surroundings and each other. So a city is not like a massive version of Martha's Vineyard, with its own unique quirks, but dozens of Martha's Vineyard-like communities put together, each influenced by its neighbors. It's for this reason that most studies of cities are narrow in scope: they either focus on one neighborhood, demographic of people, or status as an outsider — an analysis of the city's history and context can suggest which of these traits are most likely to be salient (Fridland, 2001)

Many papers have taken deep dives into the "urban South": cities such as Memphis, Houston, Raleigh, and Atlanta. In 2012, Dodsworth and Kohn investigated the change in the SVS[3] in Raleigh. In generations born after 1954, the SVS had diminished significantly in the urban area of Raleigh. This could be attributed to the massive influx of outsiders in the mid-20th century, with 56% of Raleigh residents in 2000 being born outside North Carolina. However, Dodsworth and Kohn suggest that the latter population is still being exposed to the SVS. Still, its purpose in identity construction has altered as Raleigh shifts from a "Southern culture" to an urban one. Of course, this cultural shift is likely also affected by the influx of immigrants. Either way, similarly to Labov's study, the year of birth was the most significant factor for the SVS.

ATLANTA

Atlanta is an example of the Urban South. Since its founding in 1897, the city has grown to nearly 500,000 people, with millions more in the metro area. The busiest airport in the world, Hartsfield-Jackson, is in Atlanta and in 1996, Atlanta was home to the 100th Olympics. Atlanta is also known for its centrality in the civil rights movement, with the famous slogan "The city too busy to hate".

In 2023, Renwick et. al. analyzed the SVS in comparison to the LBMS, or Low-Back-Merger-Shift[4], in Atlanta. The researchers found that across the state, there is a "cliff"

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[3] The SVS (Southern Vowel Shift) is a speech pattern that moves the placement of vowels in the mouth, and is largely associated with the SAE. For example, the word "price" would be shifted to sound like "pr/ai/se". (Renwick et. al., 2023)

[4] Renwick et. al. described the LBMS as a vowel shift exhibiting movements opposite to those of the SVS, mostly found in younger speakers.

after the Boomer generation, with rates of the SVS declining dramatically, and transitioning to the LBMS in the younger populace. With this paper, there is an understanding of the linguistic makeup of Georgia and Atlanta, which, like other areas, differs heavily, mostly depending on birth year.

PERCEPTIONS

The linguistic makeup of places and cultures are often not as they're perceived. Hayes (2013) studied how Southerners and non-Southerners perceived the SAE, finding that non-Southern participants associated the SAE with poverty, conservatism, and a lack of education. Southern participants, meanwhile, associated the South with positive traits such as humility and politeness, as well as negative ones such as "Bad English".

Renwick et. al.'s study may show the reality of Atlanta's linguistic makeup, but it's not clear whether this reality is reflected in the perceptions of Atlanta natives. As Atlanta stands apart from the South, it follows that Atlanta natives would have different perceptions of the SAE and South than other Southerners.

In the literature, there exists many papers on the SVS and its development throughout time, specifically in cities and Atlanta, as well as with the identification of its speakers. However, the gap in the research exists as follow: *What do Atlanta natives perceive as Atlanta's linguistic identity?*

IDENTIFICATION OF METHODOLOGY

To answer the research question, it is necessary to analyze the relationship between Atlanta residents' southern identities and voices. However, the perceptual aspect of the study would be incomplete without data on the identities of the participants. For instance, Boomers, likelier to exhibit a late-stage SVS, would likely have a different view of their own Southern identities than 18-year-olds, likelier to have LBMS tendencies. For this reason, qualitative and quantitative methods were combined into a perceptual sociolinguistic interview with analysis.

Unique from other qualitative methods, a sociolinguistic interview, as pioneered by Labov (1986), seeks to discover the connections between sociological and linguistic aspects of the interviewee. The sociolinguistic interview encourages interviewees to tell their own stories, and the interviewer prompts the interviewees rather than asking yes or no questions in a survey style. Often, the interview includes a "formal" aspect with the reading of a passage of other phonetic items for later analysis (Starks & McRobbie-Utasi, 2001). This is much more reliable than earlier attempts at quantitative analysis, which had the researcher writing down what they thought the participant had said (Labov, 1986). Overall, however, the sociolinguistic survey method has pitfalls, namely, the Observer's Effect (Rickford, 1987). Hayes (2013) found that a semi-structured interview where he let the participants talk about whatever they liked within the topic was conducive to the creation of "associative link" charts, mapping out participants' ideas. However, Rickford (1987) suggested that the spontaneous interview also be supplemented with repeated recordings of the participant in multiple scenarios to determine a "natural form of

speech" for quantitative analysis. Indeed, multiple sources (Renwick et al., 2023) (Knight, 2015) have used analytical programs to identify accents. These programs can be used to distinguish the presence of the SVS or LBMS in speakers.

CRITERIA FOR PARTICIPANTS

The data included 19 interviewees from Boomers to Gen(eration) Z, with generational cohorts being defined by the Pew Research Center (Dimock, 2019)[5]. All of the participants were

     a) A legal adult and born after 1946
     b) Lived in the Atlanta metro area[6] for at least 75% of their childhood (ages 0-14)
     c) Lived in the Atlanta metro area for at least 50% of their life
     d) Currently living in the metro Atlanta area

While there is no consensus on what exact age accents form, the participant having lived in the Atlanta area for a large majority of early childhood seems most crucial for the development of an identity shaped by Atlanta, and continued residence in the Atlanta area will ensure no loss of this identity in the participants.

The rest of the criteria was developed to enable feasibility for the researcher (who is based in Atlanta) and to find the greatest and most balanced number of participants. Specific cutoffs were chosen for ages; the lower limit of 18 was chosen for ease of consent, and those above the upper limit were deemed too difficult to find.[7]

PRELIMINARY SURVEY

In the days before their interviews, each participant completed a preliminary survey eliciting their age, race/ethnicity, and sex. The demographic information sought to classify the most commonly stratified aspects of accent development. Race and class are widely proven to be stratified (see: (Prichard, 2010) and (Labov, 1986)). However, intergenerational differences were expected to be starker than any other demographic category due to previous research (Renwick et al., 2023).

SOCIOLINGUISTIC INTERVIEW

The participants were each interviewed individually with the total number of interviews taking place over a span of 8 weeks. Each interview took place over Zoom, and each interview

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[5] Dimock defines Boomers as being born from 1946-1964, Gen X from 1965 to 1980, Millennials from 1981 to 1996, and Gen Z from 1997 to 2012.

[6] For the survey's purposes, prospective participants were allowed to designate on their own whether or not they fit the criteria; generally speaking, people have strong opinions on what counts as a metro area, but as long as the participants self-identify as being "Atlantan," their opinions matter for the purpose of the study.

[7] The Silent Generation, born between 1925 and 1946, made up only 11% of the population in 2015 (Dimock, 2019) and would make up a small minority of the already narrow parameters. Nevertheless, there is alternative research on the SVS within Silent Generation within Georgia (Renwick et al., 2023).

began with the same leading question: "Do you believe you have a Southern accent?" However, from there, there was no set length. I let the participants ramble about their perceptions of Southern accents, positing another question if there was a lapse in conversation or if the participant asked for one. When questions were necessitated, they were asked to prompt answers connecting the participants's opinion on the SAE to their own experiences.[8] Once all questions were answered, the participants were asked if they had anything else to add. After checking to make sure the recording had been saved and all necessary information was acquired, each participant was dismissed.

DEMOGRAPHIC DATA

The study took place from November 29th, 2023 to January 29th, 2024. During this time, 19 participants completed an interview.[9] 15.8% of participants (n=3) identified as male, 5.3% (n=1) identified as agender, and 78.9% (n=15) identified as female. 10.5% (n=2) identified as transgender: one male, and one agender person (See Figure 1). As such, gender is not considered a statistically significant data point.

Of those who did an interview, 89.8% of participants (n=17) identified as White only. 5.3% (n=1) participants identified as Hispanic, and 5.3% (n=1) identified as mixed (White and African-American). Due to a lack of diversity (see Figure 2), race is not a statistically significant data point.
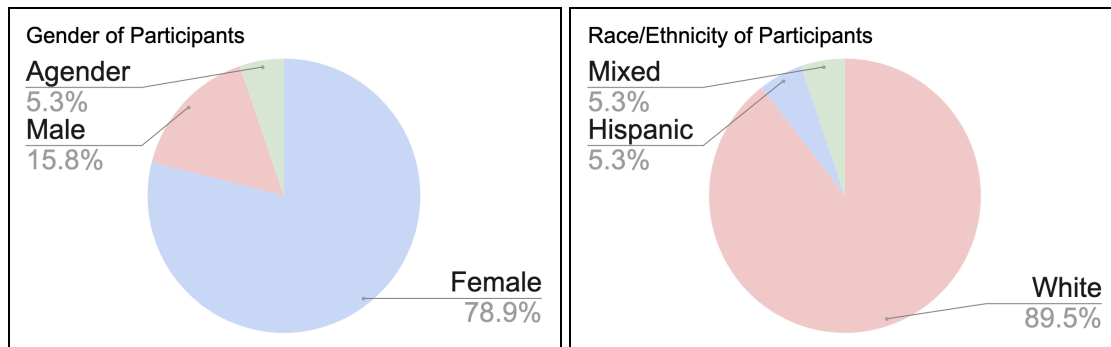
Figures 1 & 2: Gender of Participants and Race/Ethnicity of Participants

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[8] Questions included: What comes to mind when you think of a Southern accent? What traits do you think count as 'Southern'? Do you think Atlanta sounds like the rest of the South? Do you think that different races across Atlanta sound different? What do you think Atlanta will sound like in 10 or 20 years? And other questions relating to Atlanta's culture and accent, as well as those of the South at large.

[9] 33 respondents completed the preliminary survey, and 57.6% (n=19) proceeded to the interview phase. 42.4% (n=14) didn't proceed, either due to lack of contact (n=12) or failing to meet the criteria (n= 2).
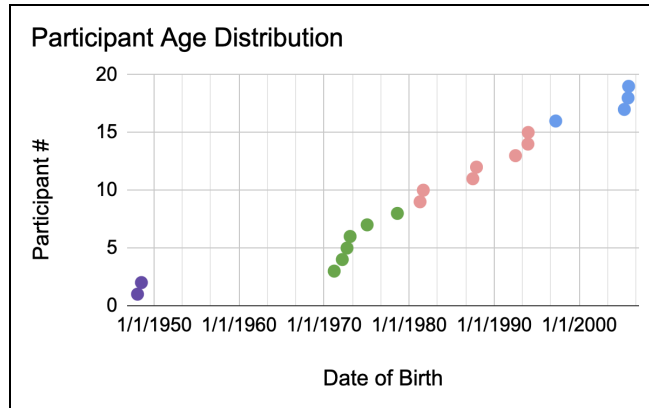
Figure 3: Age Distribution of Participants

Age proved to be the most diverse demographic. 21.1% of participants (n=4) were Gen Z, 36.8% (n=7) were Millennials, 31.6% (n=6) were Gen X and 10.5% (n=2) were Boomers. The age distribution is pictured in Figure 3, with colors designating generations: purple for Boomers, green for Millenials, pink for Gen X, and blue for Gen Z. The participants were designated with numbers in chronological order of birth, with Participant 1 being the oldest, born in 1948, and Participant 19 being the youngest, born in 2005. These numbers will be used for the remainder of the paper.

IDENTIFICATION OF OLD ATLANTA ACCENT

The participants had differing opinions on the state of an "Atlanta Accent", as well as what it consisted of. 8 participants identified an "Old Atlanta Accent", distinguished by its prestige, association with "old money", and rarity or extinction in the modern day. Participant 2, born in 1948, described it as:

> A kind of refined Southern accent. I think of that as being lady-like…[Spoken by] people that behaved in ways that would have made them at home at the Piedmont Driving Club or one of those kinds of institutions where membership was restricted, and that sort of thing. Certainly everybody didn't speak that way.

The participants described the old Atlanta accent as a "classic Southern drawl", comparing it to characters Scarlett O'Hara from *Gone with the Wind* and Benoit Blanc from the *Knives Out* franchise, though one participant noted that Blanc's accent is "more of a caricature".

	Born Before 1988	Born After 1988	Total
Mentioned "Old Atlanta Accent"	8	0	8
Didn't Mention Accent	4	7	11
Total	12	7	19

Figure 4: Split in Participants over "Old Atlanta Accent"

The old Atlanta accent was only identified by Millennial participants and older; while nobody born after 1988 mentioned the accent, most born before 1988 mentioned it. (see Figure 4) Interestingly, when excluding the two Boomer outliers, 1987 was the median birth year of participants. Participant 9, born in 1981, posited about the old Atlanta accent, "I think it's dying out […] if it exists at all? And I think it does, but I would say it's probably very much generational, meaning people 50 and above," suggesting that the younger population of Atlanta could've never heard the accent. Additionally, none of the participants self-identified as having this accent, though multiple said that their older relatives used to speak that way.

IDENTIFICATION OF NEW ATLANTA ACCENT

When asked, participants consistently identified other cities with distinct accent identities. 73.7% (n=14) identified Boston, and 84.2% (n=16) identified New York City. These accents were stated to be identifiable even outside the context of the city itself (ie. during a trip to another country). On the whole, though, participants denied that Atlanta has a distinct accent identity, at least to outsiders. Participant 1, born in 1948, noted: "I doubt if Atlanta is that distinctive. People are just gonna say it's a Southern accent, if they hear an accent. They're just gonna say it's a Southern accent. I couldn't tell [myself] from somebody from Savannah, or, you know, Augusta." Others had similar sentiments: outsiders would recognize a Southern accent, but not be able to pinpoint it to Atlanta. However, Participant 4, born in 1972, stated, "If I went to another state to visit [and] if there was another person from Atlanta, I think that they could probably guess that I was from Atlanta."

Many participants didn't differentiate between a Southern accent and an Atlanta accent, or defined an Atlanta accent as a weaker or more diluted Southern accent. For this reason, many of their traits and connotation descriptions were identical.

When speaking of an Atlantan accent specifically, though, participants named vocabulary that were tied to knowledge of Atlanta, specifically, such as the pronunciation of Cairo, Georgia, or use of everyday vocabulary like ITP and OTP (inside and outside the perimeter, respectively, referring to I-285, encircling the city.) This vocabulary was unique to Atlanta by virtue of being Atlanta-specific. One of these is also the word "coke" as a generalization to describe all soda. One participant attributed this to Atlanta's position as Coca-Cola's headquarters: "We're Coke City."

An oft-mentioned trait was the dropping of the second "T" in "Atlanta". Participant 10, born in 1981, recognized a dropping of the second T as well as a dropping of the first in many Atlantans. Participant 14, born in 1993, outright stated: "If you're from Atlanta, you don't pronounce that last T." Participant 5, however, born in 1972, attributed T-dropping to transplants:

> *I use the T—"Atlanta". And I feel like people used Atlanta more with the T sound when I was younger, and it's kind of softened. But since I use the T, I would*

assume that Atlantans as a linguistic thing used it. And it was foreigners coming in, I guess, who made that second T softer.

T-Dropping was one example of a larger association of the Atlantan accent, which is the dropping of letters—for example, the -g in -ing words and "gonna", "woulda" and "shoulda". Participants often paired this with a description of the Atlantan accent as "slow" or a "drawl".

When describing broader differences, Participant 12, born in 1987, described the Atlanta accent as a Southern accent with influences from African-American Vernacular English. On the other hand, Participant 8, born in 1978, differentiated a White Atlanta accent from a Black one, but acknowledged that it's not that simple:

I think White Atlanta has an accent. And I think Black Atlanta has an accent [...] and I think they're both very heavily influenced by the Southern accent and by each other. [...] To me, it seems like both the White version and the Black version of the Atlanta accent came from a more rural Southern accent. And so they're very similar, but there is a divergence. I think not acknowledging it would be disrespectful, because I think for a long time, I probably would have said, "Oh, there was one accent." But my accent, you know. And I don't I don't think that's it. I think there are multiple Atlanta accents. [...] Because it's not like everybody in Atlanta is just White or Black.

The description of the Atlantan accent as a Southern accent with other influences was popular with participants; many cited Atlanta's diversity as a contributing factor. Participant 9, born in 1981, said: "Using the umbrella term of Southern accent, Atlanta accent falls under that umbrella. But it's distinct. It's more distinct than just a Southern accent."

ACCENT CONNOTATIONS

When asked about connotations of accents, 78.9% (n=15) associated the Southern and/or Atlantan accent with a lack of education or intelligence. Participant 7, born in 1975, called the phrase "fixin' to" incorrect grammar, commenting, "I still say it even though I know it's not proper grammar. And it causes people to look at me weird. [...] I was an English minor in college. So I know the right way to speak and write [...] it's not that it bothers me. But I hear it." Other participants agreed, stating that they used this accent despite knowing that it's grammatically incorrect.

Some participants expressed a personal affection for the accent, saying that it creates a sense of belonging or reminded them of family. Overall, however, all participants agreed that the wider connotation of the accent(s) was negative. Participant 16, born in 1997, shared her adverse experiences with a Southern accent: "I think people look at the South with a lot of disdain. I'll tell people, 'Oh, I'm a Georgia girl. I was born and raised here.'. And they'll say things like, 'Oh, I'm sorry.'"

CURRENT TRENDS AND ATLANTA'S FUTURE

Participants had many ways of describing Atlanta's current accent. Two participants used soup metaphors:

> *You have a bowl of soup. And if you start out with a Southern accent as your base, and then you start putting in other things, like, like water, and spices and carrots, and all these other kinds of things, then you're diluting the Southern accent part of it, because you're putting all these other things into it. So a bit of a melting pot.*

Others described Atlanta as a series of pockets of bubbles, with in-groups influencing each other. When asked how Atlanta had changed across their lifetimes, participants broadly responded saying diversification and globalization.

Many participants were asked: "What do you think Atlanta will sound like in 10 or 20 years?" On the whole, participants expressed uncertainty, but said that current trends would continue. Participant 10, born in 1981, pointed out how much American accents in general had changed in the past 100 years, citing the evolution of newscasters' voices. She suggested that any change in the Atlanta accent would be part of a larger nationwide trend. Despite previous assertions that the Atlanta accent was defined by its diversity and many influences, participants generally believed that Atlanta would grow to sound less distinct due to transplants and other influences. Many also cited globalization and Atlanta's current position as home to the busiest airport in the world, as well as the booming film industry. Participant 4 commented: "I feel like we're such an international city, number one because of our airport. And number two, because of the job opportunities that are here. I'm not sure that our Southern accent is not getting diluted by everyone else who is living here."

ATLANTA WITHIN THE SOUTH

Participant's opinions on Atlanta's place within the South were highly varied. Participant 12, described Atlanta as a bubble within the South, saying, "I'm in Atlanta, I'm not in Georgia." He emphasized Atlanta's diversity and inclusivity compared to the rest of the South, sharing an anecdote wherein his friend was called a racial slur only an hour away from the city. He called Atlanta, comparatively, a "safe-ish area". However, Participant 19 (born in 2005) argued that it's necessary to include Atlanta as a Southern city for the South to move forward.

> *I think it's just a little silly to be like, "Oh, well, it's not really Southern", [...] because then you're operating off of a preconceived notion of what the South is, which is difficult. Because there is a good reason that people have preconceived notions. People have stereotypes for a reason. And a lot of the stereotypes about the South are built off of Southern history and things that have happened, twisted by however many years and whatever viewpoint benefits the observer, obviously. But I think it would be silly to discount Atlanta as a Southern city entirely, just because it doesn't fit the mold. Especially if you're looking for a future for the South that isn't the stereotypical deep south because you can't really have both.*

[...] [I] Feel like people instinctively make a difference between Atlanta and the South. [...] Any large city is going to bring a change in demographic and community to the area it sits in. But nonetheless, it is a city. It is in the South. It is a Southern city. It is <u>the</u> Southern city.

Other participants also named Atlanta as the "leader of the South" and "paving the way", citing its role in the civil rights movement and Black and music culture. Participant 1 said, "We're the definition of the South."

ATLANTAN IDENTITY

When asked "who should count as Atlantan?" participants introduced many qualifiers, both geographical and biographical. These tended to range from broad ("Lived here 10 or 20 years", "Atlanta Metro Area") to narrow ("Born and raised", "Inside the Perimeter") to no qualifier at all. Participants 10 expressed her discomfort when those outside the City of Atlanta proper self-identified as Atlantan, since they didn't pay taxes to the city. She described it as a "sliding scale", stating that Woodstock, a suburb of Atlanta, is "too far".

Participants also, however, expressed nuance in how they identified themselves and the qualifiers. Participant 14, born in 1993, explains her thoughts:

If I'm here in Nashville, or Tennessee, I tell people I'm from Atlanta, but if I'm in Atlanta, I tell people I'm from Roswell. [...] When I say I'm from a place, I think that's what I tie it to [...] where you grew up, and those kind of formative years, elementary school, middle school, high school. So yeah, I think it depends on who you're talking to. [...] I don't know if I would consider myself from Atlanta with some people, but I do with others.

Participant 13, born in 1992, struggled to identify as Atlantan, despite being born and raised in the metro area, due to cultural differences:

I feel very personally connected to Atlanta. But the reasons that I feel personally connected to Atlanta have more to do with pride in history, then being part of Atlanta's culture, I think, because I live spitting distance outside of the perimeter. I feel like I've straddled a line of am I really Atlantan? Like, am I really an Atlantan? Or am I just from Atlanta? [...] I do think Atlantan and Southern are different. Just because you're Southern, doesn't mean you're Atlantan. But I think if you're Atlantan you are also Southern. And so with the accent, there is an Atlanta accent. It just doesn't belong to me. Also, I feel hesitant to even speak what Atlanta accent is [sic] because I'm not one of the people who has it. In my mind, I do not perceive myself as having an Atlanta accent. I perceive myself as having a Southern accent. And when I think of Atlanta and Atlanta culture, I think of Black Atlanta. And I am not a part of that group. And I feel like it's hard for me to speak on.

NEW UNDERSTANDINGS

Several new understandings were reached during the study, several of them seemingly contradictory:

a) Participants identified iconic linguistics traits of Atlanta
b) Participants didn't believe Atlanta has a very distinct accent identity today
c) Participants believed Atlanta's accent identity has become and will become less distinct
d) Participants' identification of accents differed based on birth year
e) Participants viewed an Atlanta accent as a variant of SAE and/or AAVE
f) Participants described the accent's connotation as overwhelmingly negative

The participants' wide variety of opinions on Atlanta's relationship with the South reflected their varied opinion on the Atlanta accent's relationship with the SAE. Older participants were more likely to identify the "Old Atlanta accent", a variant closer related to Southern culture and history.

Many of the traits attributed to an "Atlanta accent", such as a drawl, are associated with SAE in the research. However, others consisted of Atlanta-specific vocabulary words. These provided evidence of a collective Atlantan linguistic identity, but not a particularly strong one, as all cities have words that only apply to them, such as names of buildings, events, and other city-specific items. Participants didn't name any unique Atlanta vocabulary outside of these, suggesting that Atlanta isn't distinct in that sense, at least in participants' communities.

Similarly, participants described Atlanta's trajectory as becoming more globalized. The decline of Atlanta's previous accent may be caused by this globalization, shown by the ages of those who both perceived the accent and had grown up in a different Atlanta.

Despite participants attributing Atlanta's uniqueness within the South to its globalized and international nature, participants believed that as Atlanta became more international, it would become *less* unique. At some point, Atlanta goes from a melting pot with many influences to an indistinct blur without an identity, at least in the minds of participants.

Transplants, as such, were given an interesting role in Atlanta's identity, both creating it and destroying it. Furthermore, participants' likelihood of accepting transplants as "Atlantans" differed depending on their generation, with Gen Z participants and the two Boomer ones being less likely to introduce narrow qualifiers on who should "count".

As almost all of the participants were White, these conclusions cannot be applied to other populations in Atlanta. Indeed, opinions on transplants, globalization, and Atlanta's identity would likely vary wildly for groups with different histories within Atlanta.

COMPARISON TO OTHER RESEARCH

Anecdotal evidence from the study confirmed data on the declining SAE within Atlanta, previously studied by Renwick et al (2023). Though none of the participants named the SVS directly, they named traits consistent with descriptions of the SVS. This study works hand in hand with that one, and further analysis can be done to match the perceptual data of this study with the numerical data of Renwick el al's.

Many participants' descriptions and connotations of Southern accent and culture matched those of the non-Southern participants in Dean Hayes' (2013) study; these included racism, conservatism, and a lack of education. Even when participants expressed positive features of the Southern accent (personal connection, community, relaxedness), these usually came with the caveat that the accent still wasn't "correct", or still seen poorly by others. As such, the population of this study had much more in common with Hayes' population of non-Southerners than Southerners, reflecting the group's mixed identification with the term "Southern."

The data in this study was also largely stratified by generation, with older participants exhibiting different views than younger ones. When paired with data on vowel shifts and SAE, such as that of Fridland (2002), It's clear that not only are different generations in Atlanta speaking differently, but they're perceiving Atlanta differently, and have different ideas about Atlanta's history and culture.

By identifying (some of) what Atlanta natives perceive as Atlanta's linguistic identity, the research gap has been filled.

LIMITATIONS

The study largely suffered from a small and undiverse sample size. The participants, largely found through family friends, reflected the researcher's environment (largely White and female), but weren't close to Atlanta's actual population. As such, the new understanding is mostly limited to the White population of Atlanta.

Additionally, many participants had never lived anywhere else and struggled to compare Atlanta to other areas. Participant 2 mentioned, "I've always lived in Atlanta, and therefore it is very difficult for me to isolate in my own head, the distinctive Atlanta accent." This limitation is to be expected however, due to the participation criteria. Participants who lived outside of Atlanta for long periods of time may have a better grasp of unique aspects of Atlanta's accent, but be less likely to exhibit these aspects.

The study also likely was affected by the Observer's Effect; most participants refused to do an impression of any accent when asked, citing embarrassment. However, as participants' voices weren't analyzed, and the conversation was kept largely informal, this is not anticipated to be a major limitation.

IMPLICATIONS

Several participants mentioned having never seriously considered their own accents before, or their places within Atlanta, until asked within the study. Perceptual studies can shed light on other sociological topics, such as race and class relations in Atlanta. Participant 8, in her quote under the "IDENTIFICATION OF NEW ATLANTA ACCENT" section, explained that she wasn't always as cognizant of accent differences in Atlanta: "I probably would have said, 'Oh, there was one accent,' [that being] my accent." These studies can also help with accent discrimination; as participants put their own biases into words, they become more aware of them and can begin to change the way they think negatively about certain groups.

FUTURE RESEARCH

Researchers should seek to further quantify the anecdotal data produced by this study, and confirm it with a larger sample size. In particular, participants born between 1948 and 1971 should be sought out, to fill the gap of more than twenty years of the birth years of participants in this study.

Future perceptual studies should also organize participants geographically, looking for differences between neighborhoods in the Atlanta area. Researchers should seek to understand how different cultures between neighborhoods translate to different accents, and what traits make participants more likely to introduce narrow qualifiers on who counts as Atlantans.

Long term perceptual studies provide a map of changes in Atlanta; as Atlanta's demographic and linguistic makeup continues to change, further research should be conducted to track the perceptual changes that occur alongside them. This same study, replicated every 10 years, could map the changing culture of Atlanta. Perceptual changes could even be recorded longitudinally in individuals, as many participants said that their own opinions had changed over time.

Finally, future research should also focus on demographics other than generation. Racial data, in particular, was unable to be compared in this study, and should be studied, diving deeper into participants' claims of "White" and "Black" Atlanta having different cultures and ways of speaking. Additionally, more research needs to be done on the linguistic makeup of other races and ethnic groups in Atlanta, who are often erased.

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The Political, Legislative, and Religious Debate over Cannabis in Modern Islam and its Intersection with Historical Use By Anfissa Pruitt

Abstract:

The Western world grapples with a definitive separation of church and state to determine the legislative legality of actions and substances without the influence of religiosity. Public opinion is often driven by religious perspective which indirectly affects decisions regarding the legality of substances like cannabis. This is in contrast to other religions, especially Islam, where church and state are inextricably linked together. In Islam, the most basic concept of actions and substances being "halal" (allowed) or "haram" (not allowed) is defined by the Quran and a complex and comprehensive Islamic legal system based on interpretations of sharia. These ethical standards function as fundamental guides to living a moral spiritual and worldly Islamic life (Robinson). If there are any ambiguities or questions concerning whether something is halal or haram, it is interpreted by religious scholars using a process called *fiqh* (Robinson). The most controversial of these substances is marijuana. As a natural plant product it could be considered halal, however, recreational use for its intoxicating effects makes it a haram product. The discourse over marijuana in the Middle East serves as a microcosm of the larger debate over substance control, religious doctrine, and political authority in Islam during times of globalization.

Introduction:

The Western world grapples with a definitive separation of church and state to determine the legislative legality of actions and substances without the influence of religiosity. Public opinion in the Western world is often driven by religious perspective which indirectly influences decisions regarding the legality of substances like cannabis. This is in contrast to other religions, especially Islam, where church and state are inextricably linked together. In Islam, the most basic concept of actions and substances being allowed "halal" or not allowed "haram" is defined by the Quran and a complex and comprehensive Islamic legal system based on interpretations of "sharia", ethical standards that serve as a fundamental guide to living a moral spiritual and worldly Islamic life (Robinson). Today, the *Cannabis sativa* plant, commonly referred to as cannabis, is one of the most controversial substances in the world and is labeled as haram by Islamic scholars. It has a complex component profile comprised of more than 480 chemical substances complicated by a wide range of 80-100 cannabinoids, 300 non-cannabinoid chemicals, and two primary cannabinoids - cannabidiol "CBD" and delta-9-tetrahydrocannabinol "THC" (Rock and Parker). The word marijuana refers to parts of or products from the plant *Cannabis sativa* that contain substantial amounts of THC, the psychoactive component of marijuana. In high concentrations, THC is known to provide the signature sensations of relaxation, euphoria, or feelings of intoxication and is responsible for the effects of cannabis on a person's mental state (National Center for Complementary and Integrative Health). However, there have been numerous scientific studies performed to evaluate THC with results that indicate

a multitude of potential medical benefits associated with its use. Marijuana creates an inscrutable definition as an intoxicant as well as a medically beneficial substance. In the Islamic world, this presents the religious philosophical conundrum; if the substance should ultimately be labeled as halal or haram.

Marijuana has found a resurgence around the world with the advent of deregulation and legalization of its use in several U.S. states, as well as in several countries around the world. In the United States, there has been a proposed reclassification of marijuana from a drug labeled Schedule I, "drugs with no currently accepted medical use and a high potential for abuse", to a less strictly regulated and medically accepted drug classification of Schedule III, "drugs with moderate to low potential for physical and psychological dependence", (Preuss et al.). Thus, a new legal market has erupted throughout the world with more than 40 countries currently passing legislation to legalize marijuana fully or partially for medical or adult recreational use (Leafwell). In the Middle East, however, this sudden rise in popularity hasn't found a definite conclusion regarding the legal standing of the substance and its relation to Islam. To understand today's argument surrounding cannabis in Muslim culture and consider the future of deregulation, one must recognize the convoluted intersections of its context. The Islamic world has struggled to keep a balance between authenticity and globalization, and the issue of legalized Marijuana is simply part of this phenomenon. This debate can be examined through a historical comparative lens to illustrate how the use of Cannabis and marijuana in the Middle East serves as a microcosm of the larger discussion over control in Islam; control over politics, thought, and culture during a time of modern liberalization around the globe.

Part I: Substances

The controversy over legalized marijuana in the Middle East may be new, however, the larger question of whether or not to allow cannabis and other substances that stimulate the human central nervous system, alter consciousness, or otherwise affect brain function in Islamic communities is a conflict that is almost as old as the religion itself. As a community guided by a clearly defined set of ancient religious texts, Muslims must decide on the interpretation of those texts to determine whether new substances that enter its domain are recognized as halal (permitted/lawful) or haram (banned/impermissible/unlawful). The decision of whether or not to allow the use of a substance is especially challenging when the religious text does not explicitly mention a substance. Historically, the Muslim community has settled these debates by turning to religious scholars to rule on the permissibility of substances and actions according to their interpretations of Islamic law. Opium and coffee are examples of substances that have alternated in their status of being either halal or haram. Today's conflict over marijuana mirrors debates over opium and coffee, however, it represents a key difference in that religious scholars hold a less centralized influence on the modern community than they had in the past. The current discourse over cannabinoid substances represents an opportunity for non-ecclesiastical figures to directly participate in religious interpretation and application of these interpretations in their community.

One of the first contentions of Islamic law regarding haram substances was Opium. Opium is a known narcotic that is specifically gathered from the *Papaver Somniferum* plant (Drug Enforcement Administration). Native to Asia Minor, the opium poppy was introduced to Egypt during the 18th dynasty and then passed to the Greco-Roman world, where medical writers recorded its sleep-inducing, mind-altering, and at times fatal effects (Hamarneh 226-228). By the 7th century, opium was mainly utilized for its medical potential, with several pharmaceutical forms like powders, liquids, or simply consuming the seeds used to solve problems like insomnia, kidney stones, bronchitis, and headaches (Hamarneh 229). At this time, abuse of opium was not realized until one Muslim scholar, Al Biruni, a Khwarazmian Iranian scholar, noticed those living in Mecca, the holiest city in Islam, took opium daily to relieve stress from the hot climate (Hamarneh 230). This daily use would eventually lead to increased doses as the user's tolerance to opium would grow, and from larger doses, there is a greater possibility of overdose and death. Practitioners of mystic rituals, also known as Sufis, also used opium to glimpse what was promised after death and share their experiences with believers (Nahas 814-831). Others, outside of this movement, however, saw Sufi rituals as excuses to abuse substances like opium under religious pretexts. Widespread use of opium, recognized as a narcotic, continued, although legally only for medical use, until the 20th century. Countries across the globe, including the United States, Britain, China, the Soviet Union, and almost every Third World, and Global South state adopted forms of regulation and prohibition of narcotics (Ghiabi et al. 121-122). These countries have banned the import, export, preparation, manufacture, possession, use, and consumption of opium and its derivatives.

Coffee, a seemingly uncontroversial substance in the modern world, was the subject of much debate in the 15th century. One legend about the discovery of coffee was by an Arab goat herder named Kaldi around 850 CE when he experienced a sense of exhilaration when he consumed the berries and proclaimed his discovery to the world (Myhrvold). First cultivated in Ethiopia, coffee was introduced to the Arabian peninsula as a hot liquid beverage by Sufi mystics who used it during *dhikr* ceremonies, which often lasted through the night (Ali et al. 114-117). Due to coffee's stimulating effects, some saw it as a substitute for alcohol. This substitution was not only for its physiologic effects but also for social gatherings centered around the beverage. Coffeehouses became popular throughout the Arabian peninsula in the 1500s and sprang up as new attractions for men from a variety of social classes (Hattox 4). These same attributes, however, brought coffee under the scrutiny of Islamic authorities, who tasked themselves with guiding Muslim's spiritual guidance over eight hundred years after Muhammed's death (Crawford).

Several concerns mounded into an outright movement against the beverage in the Islamic world. First, the name for coffee, *qahwa*, was derived from the ancient Arabic word for wine, leading many to misunderstand it as being related to alcohol (Najiya 113). In addition, coffeehouses were seen by more conservative leaders as promoting non-Muslim values and leading men astray from religious duties. Ottoman administrators were concerned that political dissidence was spreading through coffeehouses and eventually decreed that all coffeehouses be

banned in 1544; later, Sultan Murat IV decreed that the consumption of all coffee was a capital offense after his brother and uncle were killed by infantry units that had been known to frequent cafes. With this, all coffeehouses in Istanbul were ordered to be destroyed (Rotondi). Although this development proved to be a setback for coffee consumption in the Islamic world, it was far from the end of coffee culture.

Many scholars began to argue for the benefits of coffee due to the presence of religious ceremonies. Some scholars went so far as to issue *fatwas* (legal decisions formulated by qualified Islamic legal scholars) that sided with coffee consumption to connect with Allah through rituals like the *dhikr* and as a beverage that may have possible health benefits (Najiya 114). Because of the rising dispute, several investigations including test subjects were used to determine the true effects of caffeine on behavior. These experiments showcased that the physiologic effects and level of intoxication were not equivalent to that of alcohol. With the first concern alleviated, the scholars turned to the second concern about coffee and narrowed in on the culture within the coffeehouses. They ultimately found that the illegal activities, such as gambling and prostitution, that had been attributed to coffee drinking were in fact due to the gathering of men to consume the novel substance and associating it with the ability to engage in "risque" activities. (Najiya 113).

Like coffee, marijuana started with a similar trajectory of acceptance. Marijuana is in no way new to the Arabian Peninsula. Evidence of medicinal and ritual cannabis use dates back to over 2,500 years ago in the regions of Western China and Central Asia (Bachir et al.). From there, it is believed to have been brought to the Arab world by Hindu and Muslim travelers, from the peninsula, it was brought to the Maghreb by the expanding Muslim invaders between the 9th and 12th centuries (Bachir et al.). At the time, cannabis was widely used in the form of hashish, also known as "hash", a concentrate, and close relative to marijuana, made from the resin derived from the cannabis plant, which was either eaten or smoked to access its mind-altering effects ("Hashish: Cannabis, THC, Intoxication").

The surging popularity of marijuana in the West has reintroduced an old problem via a new substance. The Islamic community again must grapple with a substance that demands its own laws and exceptions. In recent years, marijuana has led to sharp divisions between traditionalists, who interpret the Quran and the hadith as frowning on the use of marijuana, and "secular" Muslims, who value marijuana use for its medical benefits as justified and as an act of personal autonomy and freedom, given the Quran does not explicitly forbid its use. (Robinson et al.). From an Islamic law perspective, cannabis has an ambiguous status with the majority of scholars of the opinion that it can be used for medical purposes with no ban when the use is justified for reasons other than intoxication. As such, cultivation for pharmaceutical production would be considered legitimate, and religious authorities would not pose objections. Marijuana consumption remains in the Islamic community, albeit with significant stigma amongst many individuals and some clerics, but has ascended to the limelight in today's explosion of cannabis products worldwide.

The Quran, which formulates in detail all of the rules of daily Muslim living, does not explicitly forbid the consumption of cannabis (Nahas 815). There is no documented use of cannabis during the time of the Prophet Muhammad (A.D. 570-632). The use of cannabis preparations was unknown when Muhammad was alive. This may be the reason why the Prophet Muhammad did not explicitly forbid intoxication by cannabis in the Quran. There is no evidence that people in the Muslim world were familiar with hashish before the ninth century (Nahas 814). This lack of direction in the Quran has been a point of contention among religious scholars interpreting the status of cannabis in Islam. A widely accepted basis in Islam is, "Everything is allowed for you [*halal*] until you learn it is forbidden [*haram*]…" (*What Is Zabiha Halal*). Hence, cannabis does not carry a total prohibition among most Muslim scholars (Ghiabi 123). Some Muslim scholars permitted the consumption of a small amount of hashish, agreeing that prohibition is only for amounts that lead to intoxication; therefore, it is lawful to use hashish if one is not intoxicated (Mohd Safian and Faculty of Shariah and Law, Universiti Sains Islam Malaysia 8). If hashish is used for its intoxicating effects, it would be classified as a recreational product and, therefore, prohibited.

Part II: Politics

Ever since its conception, Islam has been inextricably tied to politics. During Muhammad's lifetime, he took on many responsibilities that would qualify him as not only a religious guide but also a political leader. Muhammad established new laws and social standards based on the principles of Islam, most notably that those of all social classes should be treated with honesty and respect (Qadri 31). Muhammad also introduced new "appropriate" taxes, a bureaucratic system to collect and use those proceeds, and gathered soldiers to create a standing military to protect the fledgling Muslim community (Qadri 31). After he died in 623, the immediate companions of Muhammad continued the administration he had built. This first caliphate, rulers of the Islamic community after Muhammed, were called the Rashidun caliphate ("Rashidun: History, Caliphs, and Facts"). The subsequent Umayyad caliphate expanded Muslim rule and, in less than a century, came to control much of central Asia, North Africa, parts of the Indian subcontinent, parts of Spain, and multiple islands in the Mediterranean (Khan). This theocratic form of governance continued long after the era of caliphates no longer ruled over the Islamic world.

Today, the most notable examples of direct religious rule are in Iran and the current Taliban government of Afghanistan. Even outside these theocratic outliers a majority of the countries within the Arabian peninsula, Middle East, and North Africa have laws either influenced by or directly taken from Sharia law (Otto and Van Vollenhoven Institute). These laws strictly regulate the legality of mood-altering substances like alcohol which are haram under Muslim scripture. For example, in 2018, Afghanistan, Brunei, Iran, Libya, Maldives, Mauritania, Saudi Arabia, Somalia, Sudan, and Yemen all had a complete ban on the production, sale, distribution, and consumption of alcohol (World Health Organization). The views and

interpretations of Islamic law by those in power have been, and continue to be, important to the permittance and use of substances in Islam.

Many different substances were allowed for medical purposes in the Muslim tradition, however, jurists in the early periods of Islam, specifically in the 6th and 7th centuries, began to notice new widespread trends in drug use that were likened to recreational and led to abuse (Mohad 2). It was at this time that fiqh, or the human debate and interpretation of sharia law (that from Allah as written in the Quran) and hadith (laws from the words and actions of Muhammed), began to scrutinize the permissibility of these new trends (Mohd 14). Before this period, the decision of whether or not to use a substance was based on its potential to be harmful or fatal to the user. However, consensus proved difficult due to the lack of scientific and conclusive ways to test the "true effects" of different substances (Mohd 9-10). One must use *qiyas*, or analogical/logical thinking, to deduce what is forbidden from sources like the Quran and hadith ("Qiyas: Sharia, Sunnah, Jurisprudence"). The four Islamic schools of thought (Hanafi, Shafi'i, Hanbali, and Maliki) interpret, process, and apply religious texts differently. The Hanafi school took a more lenient approach to intoxicants like hashish, where only those who ate the substance should be punished (Ali 919). Some scholars even permitted the use of other drugs like opium as long as the amount used was small enough not to cause severe impairment of cognitive function. The Hanbali school, however, found that any form of hashish, for any purpose, is haram; they found all drugs to be intoxicating, similar to alcohol (Nahas 825).

Due to a lack of standardized Islamic laws, citizens of the many Islamic empires throughout the centuries had to rely on the rules and judgments provided by individual localities' and, more broadly, those of the state. Unfortunately, there are very few records of the laws and regulations imposed on the lives of common people during the early Islamic empires. Despite the discrepancies, it is possible to refer to the accounts of nobles and their behaviors to determine the various rulings on drug use within the pre-modern Islamic world. This is especially true of the Mughal Empire (1528-1857), located in and around the Indian subcontinent ("Mughal Dynasty: Map, Rulers, Decline, and Facts"). It was mainly a Sunni Hanafi kingdom that, for the majority of its rulers, tolerated other religions and practices due to the high concentration of Indian Hindus within their territory.

Babur, the founder of the Mughal dynasty, transformed the area from coalitions of nomadic tribes like his own to a settled and more formal government that brought with it Muslim culture. This changed patterns in alcohol and opium use from public to private affairs as Islamic practices were embraced (Honchell 77). Throughout the history of Muslim empires, there has been a pattern of tolerance towards substances or bans that are largely ineffective due to the volume of trade and nobles being able to circumvent punishment due to their vast resources and status. In his memoir, Babur writes that he would take periodic fasts from alcohol in an attempt to fulfill his Islamic duty, but that this kind of abstinence should not be forced onto others (Honchell 25-26). When he was in a period of sobriety, Babur confessed his use of other drugs like opium or edible marijuana increased. (Honchell 27). Only one emperor, Aurangzeb Alamgir, broke away from the precedent of tolerance by issuing decrees banning alcohol for Muslim

inhabitants and establishing strict adherence to Sharia rules while allowing Christians and Hindus to continue production, provided that they did not sell alcoholic goods to Muslim citizens (Honcell 69). In addition, the emperor encouraged non-Muslim people to grow cash crops like opium poppies and indigo, allowing the empire to earn more money through the exportation of these substances (Honcell 48). However, to maintain Islamic purity, it was illegal for a Muslim to participate in the opium business at any level (Honcell 48). This type of arrangement made it convenient to collect taxes on opium while denouncing the substance as haram.

After World War II many Muslim states adopted European laws from former colonial powers like Britain, France, and Germany as templates for their newly established Islamic governments (Yassari). Further, the creation of the United Nations and similar regional institutions in the West caused some states to Westernize and become more involved in European trade. This is most evident in Turkey, which for decades attempted to pattern itself on European norms to join the European Union to no avail (Acemoglu and Ucer 23-25). Although some Islamic scholars saw this trend as a continuation of colonial affairs, most Muslim states opted to create a mixed legal system with sharia and international laws (Robinson).

Part III: Globalization

In the 19th century Western European societies were spreading their way of life in Islamic territories through colonialism. Almost every Muslim country on the planet was conquered and colonized by Europeans or Russians. Colonization did not only occur solely through the physical seizing and displacement of peoples from land, but also by impacting the political, sociological, and cultural values even after occupation by colonizers had ended (Dei and Kempf). In the early 20th century, the inevitable collapse of the Ottoman empire and growing interest in the greater Middle East empowered Britain and other imperialist empires to stake a claim upon Arab lands. These nations were guided by the idea of the "White Man's Burden", a concept derived from a poem by Rudyard Kipling written during the Spanish-American War ("The White Man's Burden"). The "White Man's Burden" was a belief that colonial powers had a moral obligation to expand their influence and that it was "necessary" for them to teach non-white peoples how to become "civilized" and be taught to rule themselves. This led to the first major introduction of Western political ideas in the Arab world. After the end of WWII, many Middle Eastern countries began to establish internationally recognized states (Payind and McClimans 55-56). More so than directly presenting Islamic countries with new forms of government, European powers introduced a system of imperialism regardless of a country's sovereignty. To be influential in global affairs, the Islamic governments assumed European institutions and customs.

In 1983, economist Theodore Levitt coined the term *globalization* as the adoption of liberal trade policies to facilitate the selling of products to interconnected countries around the world (Levitt). The concept of globalization, as we know it today, has been extrapolated to include the social, political, and technological dissemination of information, policies, and ideologies. The advent of new technologies, based on internet platforms, became commonplace

in the late 20th century and blossomed into a social force at the beginning of the 21st century. Like colonialism, globalization has many more implications than simply economics. At the beginning of the 21st century social media platforms enabled people to interact with one another on a global scale in terms of economics, politics, and culture. These new internet-based tools made it possible to manipulate public opinion. Through the use of these new technologies, exposure to drugs and drug culture has spread through social media within the Western world and across the globe. Through social media, people share a wide variety of personal experiences with one of the most popular topics being the use of cannabis products for medicinal and recreational properties. The surging numbers of social media users in the Islamic world, and online platforms illustrate the vast influence social media has on many aspects of people's lives, beliefs, and opinions.

Today, hashish is one of the most popular drugs among students in Saudi Arabia. Smoking marijuana is also very common among young people and has been used for self-medication for depression and other medical issues, as a pastime, and as a relaxant (Joni et al.). However, the line between recreational and therapeutic use is often hard to specify; using marijuana to relax and relieve stress may be defined as medicinal even though no immediate medical problems are necessarily being "treated" (Joni et al.). This has become a point of contention for many Muslims as some states have renewed interest in debates regarding Cannabis use. As a result, younger generations have become more comfortable with using cannabis products. This phenomenon is illustrated by a new proliferation of "stoner jokes" in Middle Eastern social media which is indicative of the relative relaxation of taboos regarding drugs among youth (Schaer). This trend is contrary to traditional Islamic government which has made it common practice to restrict "internet freedom", demonstrating their ability to shut down local internet access to inhibit access to social media platforms, and block divisive activists, websites, hashtags, and personal accounts, as well as imprisoning "influencers" as offending sources of information that are critical of the government policies, and religious agenda (Radcliffe et al. 33). The Islamic government and scholars appear to be reconsidering their position on cannabis, perhaps swayed by scientific data and public opinion. In Iran, laws regarding the use of cannabis and opium are currently being considered to bring legislation of medical drug consumption through a state-supervised system (Ghiabi et al., "Islam and Cannabis: Legalisation and Religious Debate in Iran").

Part IV: Conclusion

The debate regarding the use of cannabis in the Islamic community has changed very little since the 9th century. The religiosity, lawfulness, and justification of its use have been consistently contentious in the Muslim population, causing fragmentation and dissolution that stretches across centuries. Historically, substances such as opium, coffee, and alcohol have all had alternating designations as halal or haram as religious scholars modified their opinions. Though the basic tenets of Islam remain unchanged, Islamic scholars responsible for defining the religious beliefs and principles have used their authority to modify the religious and legislative

context. The impetus of change from halal to haram and vice versa relies on overcoming the inertia of Islamic scholars to re-evaluate the status quo beliefs attached to actions and substances. Given the fast-paced dissemination of information via social media and its sway over tolerance and social norms, marijuana and other cannabis products may be accepted as medically beneficial substances. Legalizing marijuana in Islam would indicate a significant shift in the alignment of Islamic culture and indicate the acceptance of scientific data and public opinion by Muslim scholars facilitated by modern globalization.

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Factors Influencing Maternal Satisfaction in Rural San Juan Sacatepéquez, Guatemala By Zohar Ester Azar

Abstract

This study merges a phenomenological approach with a qualitative investigation, delving into the specific aspects of the maternal experience while investigating the satisfaction levels experienced by mothers in public and semi-private hospitals and clinics in San Juan Sacatepéquez, Guatemala.

Guatemala is a country that continues to grapple with its challenges of poverty and healthcare, particularly challenges in the maternal fields. This study analyzes how different factors contribute to the satisfaction that mothers experience regarding the care they receive. This investigation features 8 semi structured interviews with women between the ages of 17 to 42. The participants were expected to fit specific criteria in order to be eligible, including having given birth within the last 12 months.

There were significant findings about how factors such as knowledge and awareness, access to medical support and resources, and patient-provider relationships affected the satisfaction with maternal experiences. It was discovered that over half of the participants lacked fundamental knowledge and understanding of the psychological and physiological aspects of childbirth, including prenatal and postnatal care. Furthermore, San Juan Sacatepéquez is an area that is particularly deficient in access to medical support, which was primarily due to financial barriers. Various concerns about the quality and approach of healthcare professionals in both public and semi-private hospitals arose. The interviews highlighted multiple instances where the participants experienced negative and unpleasant interactions with their providers, indicating severe malpractice and mistreatment. In essence, this study aims to underscore the complexities that are faced by the women of San Juan Sacatepéquez throughout their maternal experience vehicle exploring the various contributing factors.

Introduction

According to the United Nations (2023), approximately 134 million babies are born yearly. Being one of the most intense experiences a woman can have in her lifetime, childbirth can also be one of the most challenging experiences to go through. During the pregnancy and birthing process, mothers constantly question how things will go and if they are doing what is best for their baby and themselves, putting them in a vulnerable position where they need the guidance of healthcare professionals. Satisfaction with the experience can depend upon various factors, including pain relief and emotional support, which are relatively inaccessible in low-income public institutions. In Guatemala, where a "significant share of people lack access to health care services" (Marini et al., 2013), it is essential to investigate how these disparities can affect the child-birthing experience, considering that it has one of the "highest infant mortality rates and lowest life expectancies at birth" (Marini et al., 2013).

The motivation behind this study delves into specific and critical aspects of childbirth:

the satisfaction levels experienced by mothers during the process in public hospitals. In a country that constantly grapples with challenges in maternal care, this research depends upon different factors affecting the satisfaction with the care they receive. This research aims to bridge various factors affecting satisfaction levels in San Juan Sacatepequez. This includes examining the quality of care, availability, accessibility, medical resources, and human interaction through the birthing process.

Literature review
Childbirth Satisfaction

Childbirth, being one of the most challenging events in a woman's life, leaves her with psychological, social, and physical consequences. Therefore, a woman's satisfaction with her birthing experience must be considered as it measures the quality of reproductive healthcare systems (Jafari et al.). According to Petra Goodman (2004), "A woman's satisfaction with the childbirth experience may have immediate and long-term effects on her health and her relationship with her infant, but there is a lack of current research in this area" (p. 1). Investigating how varying factors influence women worldwide is essential, especially in countries where facility-based childbirth is not as accessible.

Global Childbirth Challenges

In the modern world, 93 percent of women give birth with the support of a skilled healthcare professional (World Bank). Womens and newborns lives can be saved if experienced health personnel are present before, during, and after childbirth. Despite this, women and babies are still losing their lives as a result of inadequate medical care. In 2020, there were an estimated 800 daily childbirth related deaths from entirely preventable causes, with one fatality occurring every about two minutes (Maternal et al., 2023). This issue becomes significant in low income countries as 95 percent of maternal deaths occur in such places, and urges low income countries to better assess the care given to their citizens (World Health Organization, 2023). To do this effectively, it is best to gather data directly from mothers experiencing these conditions to understand the experience in real time.

Impact of Socio Economic Factors

A study in Pakistan by Sonia Omer, 2021 presented data about how a delay in seeking medical care during pregnancy often leads to higher maternal mortality rates, which in turn, increases the role of family in guiding women during pregnancy, which can be potentially risky or harmful to the mother and child. These practices were found to primarily be influenced by poor economic conditions and limited education about maternal health. In rural Guatemalan areas, about "66 percent of girls who enroll in first grade dropout of school before they complete the third grade" (Nunez, 1994), meaning that a large majority of them do not attend school past the average age where sexual education is typically received. In a comparative study, it was

found that "maternal education is often considered one of the most important factors explaining child health outcomes" (Vikram et al., 2019), further expanding on the fact that lack of resources and education can impact not only their own well-being but their childrens too.

Accessibility to Healthcare in Rural Guatemala

According to the World Bank, Guatemala is a country with one of the highest maternal death rates, with an average of 93 deaths per 100,000 live births (World Bank Open Data, 2023). Further contributing to the cause, experts attend only one out of every four births in Guatemala, with the majority being attended by untrained caregivers (A Deeper Dive, 2023). Guatemala is also one of the Latin American countries with the greatest rates of economic inequity in the world, with 55.2 percent of the population living in extreme poverty (The World Bank In Guatemala, 2023).

Private, public, and semi private or governmental hospitals and institutions are Guatemala's three main types of facility based treatment. These systems, which are scattered throughout Guatemala, contribute to the aspects that influence maternal satisfaction. However, about 80 percent of doctors are located in Guatemala City, where there are just about 1 million residents. Meanwhile, Guatemala has a total population of 17 million people (Philipp, 2020), leaving around 16 million people with minimal access to healthcare professionals who are experienced in their field. San Juan Sacatepéquez is a municipality in Guatemala where this issue becomes relevant and where there are very few clinics and public hospitals where mothers can attend. If any minor complications were to occur in maternal facilities, they would have to be transported to urban areas where they could not afford the quality of care. Although public healthcare in San Juan Sacatepéquez is mainly directed towards maternal care, mortality rates remain high due to low education, quality, and hygiene levels (Teijido, 2010). Moreover, minorities experience higher mortality rates, and because rural areas are less advanced, they have limited access to basic necessities. Only about 46 percent of women in rural Guatemala have access to or know about the use of contraceptives (Philipp, 2020), which dramatically affects how monitored birth is and how many children a woman can handle, considering women get pregnant at a very young age.

In an exploratory study on client and provider experience conducted in Quiche, Guatemala, methods were combined to explore respectful maternity care (RMC) in rural Guatemala and delve into how language and cultural factors may come into play with indigenous communities seeking maternal care (Sethi et al., 2022). In this study, it was found that there was an unstable physical environment that was unclean and with no access to private toilets or showers, which highly affected the satisfaction of birthing mothers. Additionally, this study aims to understand how language barriers affect womens treatment through the maternal experience. Another study by Emily Peca (2018) found that women in the western highlands of Guatemala have a higher risk of disability and death after childbirth through population based surveys. Peca says, "Those at highest risk of not receiving adequate care are the geographically isolated, rural poor, residing in certain low and middle income countries" (Peca & Sandberg, 2018). She also

states that her study was one of the first attempts to depict a womans experience and perception of institutional childbirth and how that affects the likelihood of them seeking care in the future (Peca & Sandberg, 2018). Further justifying the necessity for such research in more areas of rural Guatemala.

Gap in the Research

Nevertheless, studies on maternal experience and quality in Guatemala are highly relative to location. What is available in certain areas and research predominantly focuses on Guatemalas western highlands and pacific lowlands. These studies do not solely focus on rural facilities and often include people with access to more advanced and private healthcare systems, which do not show the actual disparities amongst underserved communities.

Research regarding maternity care in Guatemala encompasses a broad range of locations nationwide. However, San Juan Sacatepéquez has diverse cultural and economic health dynamics with clinics run by local doctors and volunteer university students aiming to improve the experiences. Still, some factors specific to the area and the country do not allow maximum satisfaction. The factors being investigated are greatly affected by limited equipment, medication, and occupancy rates. Understanding these specific nuances is crucial for evaluating such data in Guatemala, as it can significantly affect the satisfaction and experience of the patients. In addition, there is limited data in the area; this study seeks to amplify the research on maternity in Guatemala to raise awareness, provide better care for citizens, and close the geographical location gaps.

Hypothesis

When investigating the factors influencing the satisfaction levels of womens maternal experience in rural San Juan Sacatepéquez, Guatemala, levels of satisfaction are significantly impacted by the interactions with the healthcare providers, access to medical resources, and financial barriers that one may face. Given the socioeconomic and academic barriers that a majority of women in San Juan Sacatepequez have, their contribution to the overall maternal experience will be evident as they are limiting factors to ones life

Methodology

This qualitative research study was conducted with a series of semi structured individual interviews guided by a phenomenological approach to research. This approach to researching the effect of personal experiences on understanding the participants perspectives on their overall satisfaction with childbirth is the most effective method to evaluate this topic. 8 women who gave birth in public/semi private hospitals in San Juan Sacatepequez, Guatemala, within the last 12 months were interviewed, and their responses were thematically analyzed with the Quirkos software. The average length of the interview was 16 minutes. The shortest interview was 11 minutes and the longest was 24 minutes. The demographic data collected can be seen in Appendix A.

A Qualitative Methodology

 This type of methodology was chosen primarily because childbirth and maternity is a sensitive topic, in which experiences could drastically vary. According to Dr. Lorelei Lingard (2016), utilizing a qualitative method allows for a more in depth understanding of " how people make sense of things and how issues unfold in real world settings". When evaluating childbirth experience and satisfaction, the mothers in this case, are patients at the hospital, which also classifies them as consumers of the institution. Jeremy Merchant (2015) says that service to a customer is something logical, not rational, and it cannot be quantified because human relationships derive from emotions. This is important to note, especially when researching an emotionally heavy topic in this field of health.

Semi structured individual interviews were selected for this methodology as they provide specific, in depth information about the overall experience and satisfaction. Participants can answer open ended questions with room for conversation, allowing for trust when touching sensitive topics. The interviews were conducted on a one on one basis. According to Dr. Frances Ryan, individual interviews are widely used in healthcare and social research. She says individual itineraries are an extremely "valuable method of gaining insight into peoples perceptions, understandings and experiences" (Ryan et al. 2009). Moreover, this method was chosen to reduce participants pressure when discussing such vulnerable topics.

The **interview questions** were selected regarding the study about husbands and maternal health matters in rural Guatemala by Marion Carter (2002). These questions were chosen as a guide for the semi structured interviews as they approach maternal satisfaction from various perspectives and ask numerous questions about both broad and specific topics. Within this interview, there are 3 categories of questions. The first is the pregnancy experience, the second is the birthing experience, and the third is the post birth experience. The interview questions can be found in Appendix B.

Convenience sampling was the sampling technique used. It was chosen solely because of the availability of participants for this study. As the availability of the specific criteria may be limited, any person who qualifies for the criteria of being a participant in this study (shown in the table below) and becomes convenient can participate. Convenience sampling is accessible, flexible, and suitable for this study, as additional inputs are unnecessary (Lee et al. 2014). Therefore, following the criteria for inclusion in this study is sufficient to be a participant and relies on convenience. Criteria and justifications can be found in Appendix C.

Ethical Considerations

 It is crucial that all participants understand the purpose of this study and have given consent to be interviewed by signing the consent form or by giving verbal consent. All the participants information is kept in a safe, locked Google drive with data available only to the researcher and to participants upon request. Childbirth can be a highly vulnerable experience, and participants have the right to opt out of the study at any given time. If, throughout the study, the participant is

undergoing any type of distress they will be reconsidered as a participant as their safety comes as a priority. Moreover, prior to beginning the investigation process, an IRB certification was obtained to ensure proper ethical training.

Results and Discussion
1. <u>**Knowledge and Awareness about Pregnancy and Childbirth**</u>

The participants presented a variety of levels of knowledge and awareness regarding pregnancy and childbirth. Some participants did feel adequately informed and prepared to give birth and claimed to have sufficient knowledge about the bodily processes occurring during pregnancy. Nevertheless, some participants were entirely unaware that they were pregnant and what pregnancy was, and they did not know how to care for a child. Based on the data collected from the sample, over 50 percent of the participants lacked fundamental knowledge and understanding about pregnancy and the physiological changes a woman experiences. Professor Emily Smith at the University of Southern California conducted a study in Ghana investigating the role of health knowledge and the relationship between education and use of maternal health services demonstrates how mothers with previous education have a much stronger association with healthcare knowledge and increases the use of available healthcare services (Smith et. al 2012). Professor Smiths study directly aligns with the findings of this study as women with lower levels of education sought less health support, whereas women who had some type of advanced education not only accessed better health, but were able to determine what was best for themselves and their children. Participant 2 expressed her feelings about the pregnancy. She said, "I was tired. Very sleepy, and it was not what was expected. I did not know what it would be like". Participant number 5 shared similar feelings; she said: "I felt that nobody told me anything. I was terrified because it was my first time, and I did not even know what labor was going to be like". Therefore, when examining the knowledge and awareness about pregnancy and childbirth among women in San Juan Sacatepequez, it is evident that there are significant educational barriers to understanding female reproductive health.

Many of the interviewed participants expressed extreme reliance on their mothers and mothers in law for pre and postnatal advice. Two participants mentioned how this is the way "Their mothers learned," further extending misinformation and lack of knowledge among multiple generations. In accordance with the literature found, the gathered data in this study verifies that a large majority of the participants indeed lacked knowledge, primarily due to a lack of education. This was evidently noticeable when interviewing the participants because most lacked an advanced vocabulary, could not read or write, and confirmed that they did not have any previous knowledge of maternity. Similar patterns were found in the study previously mentioned in the literature review about socio cultural practices on reproductive health in Pakistan (Omer, 2021), both showing that mothers relied heavily on female figures in their families rather than healthcare providers due to both tradition and mistrust. Moreover, the data also has a correlation with Nunezs 2019 study indicating that a majority of girls did not receive proper education in the rural area of San Juan Sacatepéquez, which is further implied by the fact that over 50 percent of

the participants had their first child before turning 20, and as early as 16. It must also be considered that starting a family at a young age may be part of the tradition of the people of San Juan Sacatepéquez. However, this falls back on the fact that women trust those traditions due to a lack of healthcare and knowledge.

Nonetheless, participant 4, who is 29 years old, stood out in particular. She mentioned how her experience in a semi private hospital was one of the most degrading experiences of her life. She commented of the physical and verbal abuse she endured in the delivery room, as well as how the doctors disregarded her concerns. Despite her prior lack of knowledge, she stated that she was determined to educate herself after what had happened at that hospital. Participant 4 said : " after everything that happened to me, I began to read a lot about womens rights to avoid being mistreated. And I made a self promise to stop allowing them to treat me badly if I had to return to the same clinic". "Not many people have the courage or knowledge that I did," she added. Even though this individual stood out from the others, the fact that none of them had any prior information shows how dire things have to go before someone takes the initiative to educate themselves. This underscores the urgent need for attention because in such an environment, most women are susceptible to being mistreated because they do not know what the right way to be treated is.

2.   Access to Medical Support and Resources

Access to medical support in rural San Juan Sacatepequez is a challenge that has been proven to significantly impact maternal satisfaction with the experience of their motherhood journey. Upon numerous interviews, the participants consistently reported having trouble accessing medical facilities, compounded by financial and geographical constraints. Participant 3 mentioned how "it was hard to get to the clinic because I had to pay for the bus ride and it was expensive" therefore leaving mothers with little options to attend to their health concerns. The absence of access to healthcare facilities or professionals leaves mothers to rely on midwives who may not always have adequate training. Nonetheless, it is essential to know that all the patients interviewed who at some point had contact or consultation with a midwife, it was the same one. A consensus from the investigation demonstrates that the patients were not unhappy with the midwifes service; however, as the midwife isnt medically certified, she could not help with more advanced complications, which most patients experienced. Participant 8 expressed her reliance on alternative healthcare options: "Yes, all births with a midwife" due to a lack of "better" choices. The participant implied that she chose a midwife because she could not afford private healthcare or did not trust the quality of public facilities in the area. Moreover, participant 2 commented on the financial hardships that she faced in the process, which led to an unpleasant experience. She said, "With the first, I paid Q4,500 (577 USD), and with the second baby, I paid Q4,700 (602 USD)," considering the average yearly income of a Guatemalan in San Juan Sacatepéquez is Q41,700 or 5,350 USD (World. data, 2024) This means participant 2 had to use 20 percent of her familys income just for the birth.

Participant 2s statement revealed the economic burden that childbirth can impose, especially considering the average income in San Juan Sacatepequez. This financial strain is further exacerbated by societal pressures and gender roles that limit womens financial independence. These factors, combined with the lack of proper education, create a significant gap in the healthcare system of rural Guatemala, underscoring the need for more affordable and accessible healthcare services.

The existing literature emphasizes the importance of having access to skilled healthcare practitioners to ensure a positive and healthy experience in maternity. For instance, the WHO highlights how 95 percent of maternal deaths occur in low income settings with a lack of hygiene and insolvent accessibility to medical resources such, as described by the participants in the interviews. Moreover, research done by Omer in Pakistan demonstrates parallel findings by showing how delays in seeking medical attention can be a resulting factor of economic and educational limitations, decreasing maternal satisfaction, and increased mortality rates.

3. **Provider and Patient Relationships**

To understand the dynamics between the healthcare providers and patients, it is crucial to note that patients have most likely never experienced any other type of healthcare and may not know what "good quality" healthcare is like. Nonetheless, the participants expressed numerous concerns about the quality and approach of healthcare professionals in public and semi private hospitals. About 50 percent of the patients attended semi private facilities, 30 percent attended only public facilities, and 20 percent participated in both types of facilities. The interviews highlighted multiple instances where the participants experienced negative or unpleasant interactions with their healthcare providers, demonstrating malpractice and mistreatment.

The lack of professionalism in the clinics contributes to the lack of trust of mothers in San Juan Sacatepéquez in the healthcare system and shows the need for improvements in patient care. Participant 5 gave a disturbing description of what happened to her, pointing to severe indications of mistreatment: "They hurt me during the birth, and they did not help me when I asked for help." She also mentioned that the hospital she attended was far from her home so she would leave as early as 4 AM to get medical attention for her 8 AM appointment during her pregnancy, and would often go in the evening without having any consultation. When the time came for her birth, she said: "They did not want to admit me to give birth to my baby. I arrived after talking with my midwife; she said "I had 8 cm dilation and was almost ready to give birth. And when I went there, the doctor said it wasn't true without even checking me. He said it was a lie." she proceeded to say, "I couldn't handle the pain anymore, and my water broke. When I told the nurses, they said no, and they did not know what I was talking about because it was my first time and that I should stop making a fuss or any noise." They told her she would not be attending if she did not keep quiet. The participant was refused examination despite being 2cm away from the maximum dilation, which points to a lack of respect from the healthcare providers, as well as putting the patients life at risk. The doctors accusations of a "lie" further demonstrate how trust can be broken between the patient and the provider, eliminating any feeling of safety during such a vulnerable experience. The same participant said: "They told me they were going to cut me

because it was my first time having a baby; they cut me a lot. It took them almost an hour for them to stitch me up because the doctor could not figure out how to do it. He did not know how. He did it over and over again and did not give me any anesthesia even though I was crying". These severe malpractices in semi private government run hospitals, where patients pay monthly to be attended, demonstrate a severe breach of medical ethics and insufficient medical knowledge to provide care, violating the HIPPA laws, and medical negligence. Nonetheless, the participant claimed to have had a better experience in a clinic with her second child that college medical students ran. Some Guatemalan medical schools select medical students to complete their residencies in clinics at low resource communities, and in turn, they get to apply their knowledge from private higher education universities in metropolitan Guatemala. Essentially, the goal of this program is to provide more skilled and educated professionals in low income communities. Participant 7 mentioned " I had a much better experience because they knew what to do". Nevertheless, it may not be accessible to everyone due to lack of equipment in the outdated clinic, reduced occupancy rates, and low staff. But still, the ethics of this must be considered as they are being put to practice in low income communities before serving to private high end clinics in the city.

Another participant, participant 6, described her interaction with the healthcare providers as "unpleasant and scary. She said: "They did not let me ask any questions, and I got very sick, so the experience was not great. I had severe pain in my legs, which was not treated. During the surgery, the anesthesia was not working. I could feel them cutting my stomach, and the doctor only acknowledged it after I repeatedly told him how much pain I was in. He said the anesthesia just did not work properly during the surgery. The pain was so severe that I fell in the bathroom because of it, and the doctors completely ignored my complaints," further highlighting how no matter the type of service in rural areas, negative experiences are prevalent, along with malpractice, judgment, and unethical approaches.

These experiences align with existing research that highlights the impact of patients interactions with their healthcare providers and its effect on overall satisfaction with the experiences. Literature mentions that negative experiences with healthcare can increase mistrust and drive patients away from seeking care, which essentially reduces their satisfaction with the experience (Jafari. et al.). The data also aligns with existing findings in Guatemala, where only one in every four births is attended by professionals, and a majority is attended by untrained people (A Deeper Dive, 2023). Existing literature based on research in Guatemala supports these findings, considering that 80 percent of Guatemalan doctors are in the city, and rural areas lack skilled providers (Philipp, 2020). The results reveal the flaws in healthcare delivery in the rural area of San Juan Sacatepéquez, and these experiences must be addressed to provide a higher quality of life to all residents of San Juan Sacatepéquez.

Limitations

Although this study provides valuable insights into maternal satisfaction and wellness in San Juan Sacatepequez, several limitations must be acknowledged in order to fully comprehend

the research. These limitations consist of four main limitations: participant distractions, communication barriers, understanding and interpreting questions, and sampling methodology.

The environment and setting where the interviews took place included significant distractions, as the location was outdoors in a healthcare clinic. There were several distractions, including outside patients attending the clinic, animals such as dogs and cats walking around and barking, and vehicles passing by, which made it difficult to hear the person being interviewed. Moreover, the interviewees came with their young children, considering the requirement was to have given birth within the last 12 months. Nonetheless, the young children often caused a distraction during the interview because they were crying and needed their mothers attention, which disrupted the flow of conversation and potentially influenced the quality of data gathered.

Communication barriers were also a significant limitation related to language and expression. Most participants lacked advanced vocabulary, which hindered their ability to articulate and express their experiences fully. Responses were often concise and incomplete, with difficulty speaking in cohesive sentences. This could have altered the data because, though necessary, it could have affected the specificity of the information provided.

Interpretation and understanding were also significant and related to communication barriers, as it was necessary to rephrase questions for the interviewees to understand. This generates concern about how consistent the interpretation of the questions is across all the participants and could lead to variation in the data, as questions may have been interpreted differently.

Finally, the sampling methodology could have also altered the data, as convenience sampling is a limitation. Though this method is rather practical, it does not guarantee a sample that fully represents the broader population of mothers in San Juan Sacatepequez. Nonetheless, the sample size was proven sufficient as the interviews reached a level of saturation where the responses demonstrated consistency and similarity in responses

Conclusion:

Essentially, this study sheds light on the multifaceted adversities that women of San Juan Sacatepeques face throughout their maternal experience. By a qualitative study investigating the various factors that affect maternal satisfaction levels through semi structured interviews, this paper aims to reveal the authentic experiences of those women living in low income communities in rural Guatemala. Through a thematic analysis, it is evident that various challenges and disadvantages exist within the Guatemalan healthcare system, ranging from limited access to medical support and considerable educational barriers to unsatisfactory and adverse interactions with healthcare professionals. This study calls attention to advancing research in San Juan Sacatepequez to ensure better maternal experiences in marginalized communities. Through extensive research, interventions, and enhancement of educational and medical facilities, a more equitable maternal experience can be achieved for women in Guatemala and beyond.

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What Psychological Challenges Do Individuals Face as They Attempt to Reintegrate into Society After Being Wrongfully Convicted? By Isabela F. Oliveira

Abstract

This paper explores the profound psychological difficulties faced by individuals attempting to reintegrate into society after wrongful convictions. It draws upon various sources to underline the significant mental health challenges these individuals encounter, exacerbated by a lack of societal support and recognition of their unique circumstances. It highlights the severe emotional trauma and social isolation that exonerees experience, akin to the distress faced by war veterans and disaster survivors. The paper ultimately argues for comprehensive reform in post-exoneration support systems, emphasizing the need for targeted mental health services, social reintegration programs, and broader public education to alleviate the stigma associated with wrongful convictions. The research suggests that legal exoneration is merely the first step towards rehabilitation, with ongoing psychological support being crucial for the full restoration of exonerees' dignity and societal function.

SECTION 1: Introduction

As of April 2024, the National Registry of Exonerations has recorded a total of 3,497 exonerations since 1989, with each exoneree losing an average of 9.1 years of their lives due to wrongful convictions (The National Registry of Exonerations, 2024). 3,497 exonerations is significant, but it is important to note that this figure is not fully representative of the total number of individuals exonerated and that the true number of wrongfully convicted individuals is unknown. Moreover, the estimate of the wrongful conviction rate can vary substantially. Some studies suggest that the rate of wrongful convictions could be as low as 0.016% to as high as 11.6%, depending on the type of crime, quality of legal representation, and other factors (Walsh et al., 2017; Gross et al., 2014; Cassell, 2018; Thomas, 2018). The estimated wrongful conviction rate among those sentenced to death may be more reliable because those cases often undergo heightened scrutiny and thorough evidence collection due to the severe nature of the crimes and the irreversible punishment. The introduction of DNA evidence may substantially alter the data; yet in a 2014 study, it was estimated that 4.1% of defendants sentenced to death in the United States from 1974 to 2004 were wrongfully convicted (Gross, 2014). If that estimate is applied to the 2,382 individuals on state and federal death row as of the end of 2021 (Snell, 2023), it would mean that approximately 97 of those individuals were wrongfully convicted. If the 4.1% wrongful conviction rate among those sentenced to death is applied to the rest of the over 1.2 million individuals incarcerated in 2022, approximately 50,338 individuals would be wrongfully convicted[10] (Carson, 2023). The frequency of wrongful convictions underscores the importance of addressing the consequences exonerees face, including significant mental health challenges upon exonerees' return to the community (Chinn & Ratliff, 2009). Wrongful

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[10] I performed the calculations, applying the 4.1% wrongful conviction rate cited by Gross (2014) to the total incarcerated population in 2022 (Carson, 2023).

convictions inflict serious consequences on people's lives, including mental health issues (depression, anxiety, etc) and social stigmatization, leaving them to mend the damage. This goes beyond legal ramifications; it highlights the importance of society's commitment to justice within the judicial system. This research paper examines these psychological challenges that exonerees face after being wrongfully convicted.

Wrongful convictions can have severe psychological consequences on individuals, even after they have been exonerated or had their convictions overturned. The experience of being wrongfully accused has been compared to trauma experienced by military veterans, refugees, disaster survivors, and prisoners of war (Brooks and Greenberg, 2021, p. 4). Wrongful convictions precipitate profound emotional distress for both the wrongfully convicted individual and their family members. The resulting stress, trauma, and pervasive uncertainty can strain familial relationships as loved ones endeavor to navigate the complexities of the situation (Jayanthan & Hennessy, 2021, p. 258). Exonerees often confront the challenge of reconciling their innate sense of innocence with the unjust conviction they endured. The enduring trauma of wrongful imprisonment leaves indelible emotional imprints, engendering feelings of anger, frustration, and incredulity at the injustices inflicted upon them (Jayanthan & Hennessy, 2021, p. 259). Throughout this research paper, it will become clear that the psychological wounds left by unjust convictions go far beyond exoneration, creating long-term obstacles to reintegration into society.

As articulated by John Wilson, a professor of psychology at Cleveland State University who studies the psychological impact of wrongful imprisonment, those wrongfully convicted are "normal people who by circumstance ended up in a very horrific system of injustice by the criminal justice system itself" (Scott, 2010, p. 13). This observation underscores the critical need for fair treatment to prevent further injustices for those wrongfully convicted. This pursuit extends beyond the borders of courtrooms into areas of empathy and understanding, recognizing the importance of a justice system that is responsive to the long-term psychological consequences of its acts.

SECTION 2: Challenges

Individuals encounter an array of problems beyond the scope of law as they start on the difficult process of reintegration following a wrongful conviction. This section discusses the significant challenges faced in the areas of relationships and mental health. From the delicate process of rebuilding trust to the long-term struggle with mental distress, each problem poses a challenging barrier to the successful reintegration of wrongfully convicted individuals into society. Although exonerees experience multiple types of mental illness to different extents after serving time in jail for crimes they did not commit, one thing is certain: they all suffer (Scott, 2010, p. 10).

Relationships and Rebuilding Trust. Rebuilding trust with family and friends arises as a critical problem for those who were wrongfully convicted. The very foundation of trust on which relationships are based is compromised, requiring extensive efforts for restoration. Wrongful

conviction not only shatters the individual's confidence in the judicial system, but it also reduces the trust of loved ones who may struggle to connect their beliefs with the reality of innocence (Scott, 2010, p. 11). Every interaction is filled with a profound sense of fear and uncertainty as people go through the process of re-establishing connections destroyed by injustice. Social networks, friendships and relationships appear to break down after individuals are wrongfully accused. In a study from 2017, it was found that 27 out of the 30 participants reported a fractured social network, 17 participants reported a strain on intimate relationships, and 8 participants reported a strain on relationships with children or grandchildren, with many reporting feeling 'forced out' of friendships (Burnett et al., 2017). For example, Michael Anthony Williams, an individual who was incarcerated at the age of 16 as the result of a rape conviction and exonerated 24 years later said that, after being released, " . . . he faced a different kind of prison. He had become a stranger to his family; his six brothers and sisters wanted nothing to do with him. He describes his life now as 'very lonely.' He feels cut off from society in part because he was only a teenager when he was locked up" (Scott, 2010, p. 10). This severe isolation that not only Michael Williams went through, but also many other exonerees, exceeds relationships with family members and affects every element of the wrongfully convicted person's life. The remaining social stigma associated with wrongful conviction throws a shadow over all interactions, leaving people feeling alienated and excluded. Isolation becomes not just a result, but also a coping strategy, as people retreat from social engagements to avoid the judgment and scrutiny of a society that is unwilling to extend the presumption of innocence. This isolation adds to the difficulties of reintegration, combining the intense loneliness and sense of detachment felt by wrongfully convicted individuals.

Guilt. The stigma associated with being accused or convicted of a crime, even if wrongful, can lead individuals to internalize feelings of guilt and shame (Brooks & Greenberg, 2021, p. 14). They may struggle with self-stigma and question whether they could have done something differently to prevent the wrongful conviction. To explain this self-stigma (that is, stigma from within the individuals themselves), Burnett et al. conducted a study where he concluded that it was due to a combination of abhorrence at what they had been accused of and their inability to clear their name fully. In this study, ten out of thirty participants reported blaming themselves for the accusation and struggled between wanting to fight the allegations and wanting to isolate themselves due to shame. Wrongfully convicted individuals may also face intense external pressure from law enforcement, the legal system, or society in general. This pressure can lead them to question their own innocence and feel guilty, especially if they are coerced into false confessions or manipulated during the investigation process (Brooks & Greenberg, 2021, p. 14).

Research indicates that exonerees often experience intense feelings of guilt despite their factual innocence (Leo & Gould, 2009). Additionally, the scrutiny and skepticism of others can exacerbate these feelings, further complicating the exonerees' struggle to maintain a sense of self-worth and innocence (Garrett, 2012). Coping with these complex emotions presents a formidable task for wrongfully convicted individuals. Exonerees commonly employ various

coping mechanisms, such as seeking social support, engaging in self-reflection, and participating in therapy to navigate their feelings of guilt and societal judgment. However, despite these efforts, exonerees often continue to grapple with profound doubts regarding their own innocence (Leo & Gould, 2009). Furthermore, cognitive theories of PTSD and depression show that self-blame and other negative self-attributions predict psychological discomfort (Elwood et al., 2009). As a result, the DSM-5 criteria for PTSD and severe depressive episodes also mention self-blame (American Psychiatric Association, 2013). Individuals with a negative cognitive style, defined as a tendency to negatively assign blame for the causes and consequences of events and make negative conclusions about one's self-worth are more likely to experience depressive episodes and have stronger depressive symptoms (Alloy et al., 2006).

Mental Health. Johnson and Engstrom (2020) analyzed the post-release experiences of wrongfully convicted and exonerated individuals in a qualitative, exploratory study that sought to understand exonerees' long-term psychological consequences and reintegration challenges. This study analyzed the diverse impacts of wrongful convictions by examining a deliberate sample of twelve male clients from an innocence organization who had been exonerated and released from state prisons in a major Western state. Researchers invited exonerees to voluntarily engage to better understand their complex experiences. Three exonerees were diagnosed with post-traumatic stress disorder (PTSD) and three reported symptoms. Exonerees describe PTSD as hyperarousal, avoidance, and flashbacks. Avoiding upsetting circumstances, feeling anxious in public, and dealing with regular flashbacks are examples of these traits. Four exonerees also expressed caution about law enforcement and fear of re-conviction. This shows their long-term distrust and fear after being wrongfully convicted. Loss of confidence, which is linked to various aspects of wrongful conviction, was evident in obstacles like adapting to life after a long time in prison and reintegrating into normal life. The findings show that unjust convictions have enduring impacts on exonerees' mental health and stress the need for targeted care and treatments to help them reintegrate into society (Johnson et al., 2020, p. 199-205).

SECTION 3: Solutions

While exonerees tend to face similar traumas and obstacles as other former inmates, they receive less post-release support than parolees, including transitional services such as job training and housing aid due to their innocence (Baumgartner et al., 2013). Given the data indicating high rates of mental illness among exonerees, various research papers and organizations, such as The Innocence Project, have urged legislatures to ensure exonerees' access to mental health counseling. 13 U.S. states representing over 1,100 exonerees have already done so (National Registry of Exonerations, 2021). The growing exoneree population, combined with greater access to mental health treatments, highlights the urgent need to discover effective therapeutic approaches for this population (Kukucka et al., 2022). Section 2 of this paper will go into the potential solutions aimed at alleviating the profound consequences faced by wrongfully convicted individuals during their reintegration into society.

Support. Exonerees who experienced more social support reported less severe PTSD and depressed symptoms (Kukucka et al., 2022, p. 19). Maximizing post-release social support could therefore improve an important resiliency component for exonerees. Haimson (2021) stressed social support as the most significant aspect of exonerees' reintegration, stating that it provided not only emotional support but also opportunities for employment and financial security. Indeed, prior to any therapeutic strategy, extensive case management and resource connections are likely required to secure adequate housing, legal aid for civil litigation, and vocational assistance, among other things (Heilbrun et al., 2020).

Peer support groups are one way for exonerees to discuss their lived experiences with people who can sympathize (DeShay, 2016). According to DeShay (2016), exonerees reported that regular meetings with fellow exonerees helped their coping process by providing relationships, as well as advice on how to navigate post-release challenges. While sharing their experiences may be healing for some, it may be retraumatizing for others. Furthermore, family support was the only factor that helped lessen both PTSD and depression symptoms, highlighting the necessity of including exonerees' relatives in treatment as well (Kukucka et al., 2022, p.19). This could take several forms, including teaching families about the causes and consequences of wrongful convictions, establishing similar support groups for family members, and/or offering psychological education on how to best support their loved one's mental health.

Therapy. Individuals who had a greater number of pessimistic views toward themselves and/or the world experienced a greater risk of post-traumatic stress disorder (PTSD) and depressive symptoms, along with reduced social support (Kukucka et al., 2022, p. 20). Although individuals may find these beliefs understandable based on their own experiences, they have the potential to prevent the development of significant relationships and engagement upon reentry. Consequently, exonerees may encounter difficulties in seeking, obtaining, or perceiving social support as advantageous (Robinaugh et al., 2011). As a result, treatments may focus on modifying or defusing negative ideas.

Currently, there have been no clinical trials done to assess the effectiveness or efficiency of certain therapy techniques among individuals who have been exonerated; however, there are still some options (Heilbrun et al., 2020). Trauma-focused cognitive behavioral therapies, such as Cognitive Processing Therapy (CTP), is a form of psychotherapy consisting of 12 sessions. This therapeutic approach has demonstrated efficacy in reducing symptoms of post-traumatic stress disorder (PTSD) and depression by targeting negative cognitions related to oneself, others, and the future (Resick et al., 2017). One potential therapeutic approach that has been shown to enhance cognitive flexibility is acceptance and commitment therapy. According to Hayes et al. (2012), the focus on values and dedicated action within this approach can assist those who have been exonerated in the process of evaluating their identities and future goals. Additionally, it could promote meaningful engagement with their lives.

Reintegration Programs. In an in-depth exploration of the psychological impacts and societal perceptions of individuals who have been wrongfully convicted, Faison and Smalarz emphasize the necessity of comprehensive reintegration programs for exonerees, who

paradoxically receive less support than rightfully convicted offenders upon release. The absence of reintegration services—such as housing, job placement assistance, health insurance, drug rehabilitation, and mental health services—poses significant challenges for exonerees. The psychological trauma experienced by many, including symptoms of PTSD, depression, and anxiety compounds the difficulty of reintegration. The lack of support not only hinders the exonerees' ability to rebuild their lives but also contributes to societal misconceptions and stigmatization. The authors also propose the development of holistic support services that address the multifaceted needs of exonerees, including mental health support, skills development, and community education programs. Such initiatives aim to mitigate the stigma associated with wrongful convictions and facilitate exonerees' social reintegration (Faison and Smalarz, 2020).

Zannella (2020) also advocates for holistic reintegration programs that not only address exonerees' immediate needs but also tackle the broader social challenges that they face. This includes public education to mitigate societal stigma and discrimination, legal support to navigate post-release challenges, and psychological counseling to address mental health issues such as PTSD, depression, and anxiety, which are prevalent among exonerees (Zannella, 2020). By providing a detailed account of exonerees' experiences and the systemic failures they encounter, Zannella's (2020) dissertation strongly supports the idea that holistic reintegration programs are essential. These programs should be comprehensive, addressing both the tangible and intangible needs of exonerees to ensure their dignity is upheld and justice is served not only in their exoneration but also in their subsequent reintegration into society (Zannella, 2020).

SECTION 4: Discussion

The significant and multifaceted psychological challenges encountered by individuals experiencing reintegration into society after a wrongful conviction are evident. These challenges, spanning from rebuilding shattered relationships to battling deep-seated mental health issues, underscore the complex process of psychological liberation and societal reacceptance that exonerees must navigate (Scott, 2010; Brooks & Greenberg, 2021; Jayanthan & Hennessy, 2021).

The societal stigma associated with wrongful convictions gives rise to a dilemma where individuals who have been exonerated continue to struggle with the lasting consequences of their past, even after their innocence has been officially acknowledged. The presence of this social disapproval frequently results in isolation, making the individual an outsider in their own existence, detached from their family, friends, and society (Scott, 2010). The state of isolation not only impedes the process of emotional healing but also significantly delays the practical aspects of reintegration, such as obtaining employment or housing. The reintegration process is significantly impacted by mental health since individuals who have been wrongfully convicted face trauma similar to that endured by those in very distressing situations, such as war veterans or catastrophe survivors (Brooks & Greenberg, 2021). This disparity underscores the severity of psychological anguish experienced by exonerees, with post-traumatic stress disorder (PTSD),

depression, and anxiety being common symptoms. The psychological impact of wrongful conviction extends beyond the individual, affecting family members and complicating the reintegration process (Jayanthan & Hennessy, 2021).

The highlighted challenges require a thorough strategy to provide assistance and rehabilitation that goes beyond mere exoneration. It is important to acknowledge the significance of support mechanisms such as peer support groups, family-inclusive treatment, and trauma-focused cognitive behavioral therapies. Nevertheless, these interventions must be integrated into comprehensive reintegration programs that effectively accommodate the concrete and abstract requirements of exonerees (DeShay, 2016; Resick et al., 2017). Furthermore, societal attitudes towards wrongful convictions need to evolve. Education and awareness programs play a crucial role in addressing the stigma and prejudice experienced by those who have been exonerated. These initiatives seek to cultivate a collective comprehension of the injustices they have endured and the intricate process of reintegrating into society (Faison and Smalarz, 2020; Zannella, 2020).

While legal exoneration corrects a judicial error, the journey toward psychological and social reintegration is a complex and ongoing process. It requires the concerted effort of individuals, communities, and the legal system to ensure exonerees receive the comprehensive support needed to rebuild their lives. The psychological challenges faced by exonerees are not insurmountable, but addressing them requires acknowledgment, support, and a commitment to justice that extends beyond the courtroom.

CONCLUSION

This paper has delved into the profound psychological hurdles faced by individuals as they strive to reintegrate into society following wrongful convictions. These challenges are not just a matter of overcoming stigma or adjusting back into daily life; they represent a deeper, more ingrained battle with trust, mental health, and the lingering shadows of injustice. The importance of societal support in this context cannot be overstated. It is not merely about offering sympathy; it is about actively participating in creating a more understanding, empathetic environment that acknowledges the injustices these individuals have faced and the scars they carry. Societal support acts as a crucial bridge to normalization and healing for exonerees, enabling them to reclaim their places in their communities and to begin the process of rebuilding their lives. Hence, it becomes imperative for society to not only recognize the gravity of the challenges faced by wrongfully convicted individuals but also to commit to playing an active role in their journey towards reintegration. This matter concerns not only policymakers and the court system, but to every individual in society. It is essential to foster a culture that values empathy and assistance achieved via honest conversations, community initiatives, and sufficient psychological, social, and financial aid for individuals who have been exonerated.

Addressing instances of wrongful convictions and the consequences that follow demonstrates society's commitment to upholding principles of justice, fairness, and human dignity. The process of achieving recovery is long and filled with challenges. However, creating

a compassionate and helpful environment for individuals who have been wrongfully convicted and are reintegrating into society can have a profound effect on the lives of people who have been unjustly affected.

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An Examination of Immigrant Mothers and Breastfeeding Perception By Advika Srinath

Abstract

This study focuses on adult immigrant mothers to the United States, who typically tend to retain their cultural practices from their homeland in relation to infant nutrition while accounting for other possible external factors, like maternal health, education, or cultural background, which could contribute to a mother's decision regarding breastfeeding or a lack thereof. The overarching aim of this research is to transcribe these findings into functioning strategies that can enhance public health directives and further knowledge and support surrounding breastfeeding by healthcare providers working with new mothers. An online, self-administered survey containing questions presented through the means of a Likert Scale and one short answer question were included in the survey to accurately gauge maternal perspective.

When inquired if a longer duration of breastfeeding would have any positive impact on a child, Asian immigrant mothers typically reported scores of 4 (agree) and 5 (strongly agree), whereas American Indian, Hispanic, and Caucasian mothers displayed less agreement with this statement. Follow-up interviews with mothers of Asian origin revealed that cultural norms were one of the main factors in their decision to breastfeed, specifically guidance of elders.

Gaining a grasp of this research could greatly contribute to an understanding of the reasons why mothers either choose to or not to breastfeed their child for any given point in time, stressing the need for more targeted cultural competence within the healthcare industry to offer recommendations not only regarding a mother and child's health, but considering each factor that plays into such decisions.

Introduction

Breastfeeding, defined as maternal nurturing of a child in the form of feeding breast milk, has been a longstanding convention in many cultures worldwide. As stated by Wieslaw Jedrychowski, the chair of Epidemiology and Preventive Medicine at the Jagiellonian University Medical College, the exclusivity of breastfeeding infants is hypothesized to enhance cognitive ability in children later on (Jędrychowski, 2012).

Breastfeeding practices and abilities vary based on demographic and are highly dependent on cultural beliefs and the resulting implications. Cross-culturally, practices and beliefs regarding breastfeeding are known to concern two varying extremes. Individuals of some cultures, like those of Middle Eastern origin, claim to have experienced stigma as a result of breastfeeding. However, others have advocated for the polar opposite, claiming that they were encouraged by their values to pursue breastfeeding for a certain duration due to the possible benefits it could bear in regards to the child's health. This paper will address the following question: to what extent have sociocultural factors impacted the perception of breastfeeding duration of adult immigrant mothers in the United States?

    I.   *Formula Feeding*

Formula-feeding is a sharp contrast to the practice of breastfeeding which regards feeding infants or toddlers with an artificially prepared formula rather than breast milk; proponents of formula feeding often quote the lack of maternal health impacts and its overall feasibility as its principal benefits. Some mothers decide to return to professional workplace settings a short period after they have given birth, leading to a lack of the ability to nurture their child through breastfeeding. As stated by Jin Huang, faculty at the Saint Louis University's School of Social Work, a study regarding infant development analyzed the varying impacts of formula-feeding, breastfeeding for less than 4 months, and breastfeeding for greater than 4 months on mental development. From this study, it was concluded that mental development at 1 to 2 years of age was significantly higher for breastfed children in comparison to children who were formula-fed (Huang, 2014). However, these findings were contradicted by Sara Hamed Ibrahim, faculty in the Psychiatry and Pediatrics Department at Al-Azhar University, claiming that the effect of breastfeeding is dose-dependent; the longer the duration of breastfeeding, the greater the benefit, and thus far, the strongest effect for cognitive function in breastfed children was in psycholinguistic age (Ibrahim, 2019). One finding that has proved steady throughout the body of knowledge was that infants who were breastfed had higher cognitive development scores in comparison to those who had been formula-fed, even after accounting for factors such as maternal race, age, educational attainment, and childhood experiences.

Literature Review

The duration of breastfeeding is one of the leading indicators of the effect that it could have on mothers and children. First and foremost, it strengthens the bond between mothers and their children, fostering a closer relationship where the child seeks out maternal qualities. However, as mentioned by Dorothy Bai, assistant professor at Taipei Medical College's School of Nursing, mothers who choose to return to work or school early on after their pregnancy experience differing situations (Bai, 2015). Maternal education level is a large contributor to these situations; exceedingly educated mothers typically had a larger rate of autonomy over their work schedules, meaning they can enjoy a more breastfeeding-friendly work environment. Furthermore, Wieslaw Jędrychowski noted that in his study of a prospective birth cohort in Krakow, Poland, exclusive breastfeeding for six months or longer was associated with an average of a 3.8-point gain in intelligence quotient scores in comparison with mixed feeding practices (Jędrychowski, 2012). Additionally, while investigating the true impact of biological factors, environmental factors like the medical standpoint of the mother and child and the socioeconomic feasibility of breastfeeding practices are vital factors to take into consideration. However, in terms of durational breastfeeding, Seaneen Sloan, a research assistant at the Institute of Child Care Research, states that although short-term benefits of breastfeeding were noted, further longitudinal studies are required to determine whether the beneficial effect of breastfeeding on cognitive development continues past infancy (Sloan, 2010). In the next few years, Sloan's conclusions were supplemented by longitudinal studies proving that there was no

correlation between the two variables past infancy when disregarding confounding variables - proving Sloan's hypothesis.

The scientific community regarding practices within infancy and childhood has a well-observed disagreement regarding whether or not the effect of breastfeeding persists past the stages of infancy. Iwona Stelmach, faculty at Poland Memorial Hospital's Department of Pediatrics and Allergy, mentions that positive associations between breastfeeding and child neurodevelopment are notable beyond the age of two (Stelmach, 2019). Furthermore, after adjusting for confounding variables, some studies have described the correlation between breastfeeding and psychomotor development as statistically significant. For example, Sargoor R. Veena, an employee at Holdsworth Memorial Hospital in Mysore, India, mentions that in the South Asian demographic, adjusting for parental education, intelligence, and other confounders created discrepancies between sources as a result of the methodologies pursued (Veena, 2010). Adjusting for these confounders could allow for additional clarification of the findings to prove the true correlation between the duration of breastfeeding and the cognitive development of infants and toddlers.

To combat the idea that the impact of breastfeeding diminishes throughout the life of a child, A. Holme, staff at the British Royal Infirmary, reports on the commonly observed association between breastfeeding and higher intelligence quotient (IQ) scores in children may result from the numerous confounding factors in this complex relationship (Holme, 2010). Essentially, Holme argues that this relationship never truly existed as a long-term benefit, but only aids the child during the early stages of life.

Research

The perception of women in relation to breastfeeding is vital to the understanding of the works included in the body of knowledge. African mothers highlighted disparities within their own or neighboring cultures, and had reported a large number of cases in which they chose to halt their course of breastfeeding early due to being publicly shamed or facing dejection; contrastingly, Caucasian and European women advocated for the opposite. Anglo women reported that their community encouraged them to breastfeed rather than drawing them away from it. As mentioned by Bridget Beggs, a Masters of Science student at the University of Waterloo's School of Public Health, Caucasian and European women were often motivated by the phrase, "breast is best", and breastfeeding as a whole was seen to improve the bond between a mother and child (Beggs, 2021). However, this is highly influenced by the amount of support that European and Caucasian mothers receive in their choice to breastfeed or not within their home or work setting, which varies greatly between localities.

This study will focus on the demographic of immigrant mothers to the United States, who typically tend to retain their cultural practices from their homeland in relation to infant nutrition. For example, as observed by Adefisayo O. Odeniyi, a cancer transformation manager at NHS Hertfordshire and West Essex ICB, African immigrant mothers to Australia maintained practices such as eating special foods to aid milk production and enhance breastfeeding; mothers of this

demographic generally agree that the optimal duration of breastfeeding should be between 2 and 2.5 years to provide immunity, strength, and aid the development of infants (Odeniyi, 2020). However, the environment of Australia is poles apart from that of the United States which may cause discrepancies in the applicability of the findings of this study on the immigrant demographic of the United States. This study will also account for other possible external factors, like maternal health, education, or cultural background, which could contribute to a mother's decision regarding breastfeeding or a lack thereof.

Methodology

This study targets immigrant mothers in the United States in order to capture their perception on durational breastfeeding, and utilizes a correlational comparative analysis method to measure any differences between cultural influences within the sample population. The overarching aim of this research is to transcribe these findings into functioning strategies that can enhance public health directives and further knowledge and support surrounding breastfeeding by healthcare providers working with new mothers. Many women return to work after as little as 3 weeks postpartum and are unable to provide their children with the opportunity of exclusive breastfeeding. Additional factors like cultural stigma and public shaming of breastfeeding are also reasons why women choose to stop breastfeeding; even if they have concern over their child's development, breastfeeding is not feasible in some mothers' lives. Gaining a grasp of this research could greatly contribute to an understanding of the reasons why mothers either choose to or not to breastfeed their child for any given point in time. This aligns with the method and design by allowing for immigrant mothers to express their perception to various child-mother relationship topics on a qualitative and quantitative scale. Focusing on a more qualitative approach rather than numerical data enables this study to take cultural values, beliefs, and other confounders into account. In a study conducted by Adefisayo Odeniyi, Muslim mothers were surveyed in regards to how they perceived breastfeeding in the eyes of the public and how this impacted their personal view of the topic. This example study includes a very narrow demographic of Muslim mothers in Australia; however, the analysis implemented in the research presented regards all immigrant mothers to the United States and employs a comparative analysis to draw connections and investigate differences between various demographics of immigrants.

The demographic range for my subjects is adult immigrant mothers in the United States who are above the age of 18. Any race or ethnicity is permitted to fill out this survey as long as they are U.S. immigrants; however, this limitation in demographics may limit the results in this study because other regions may have differing perceptions regarding the duration of breastfeeding within their immigrant population. A wider range of participants were permitted to participate in this research to gain more participation to further public understanding of the subject. With a wider range of participants, it will be possible to compare and contrast and see what type of factors influence the decision to breastfeed among mothers of the given population. Adult immigrant mothers to the United States will be used as participants in this study, and the link to the online questionnaire will be published; as a result, the data will be collected through

voluntary responses. Moreover, this can cause a voluntary bias as people passionate about one side or the other are more likely to participate in the survey. Since the research wasn't able to compensate participants or have any raffles for the participants (due to the Institutional Review Board), the participants needed to be volunteers.

I.   *Survey Criteria & Data Collection*

      An online, self-administered survey containing questions presented through the means of a Likert Scale was utilized to gather qualitative data to use for the comparison. The data collected from the survey will be analyzed and potentially used to form quantitative data relating to perspectives through the Likert Scale as well. Along with this, one short answer question will be added at the end of my survey as a tool for more accurately gauging maternal perspective. Since breastfeeding is an activity restricted to mothers, my study will be limited to a certain age range. This research is focused on gaining perspective and understanding of the point of view held by all mothers, regardless of whether or not they breastfed any of their children at a given point in time. As a result, the methodology will be more qualitative based, opting for more psychological reasoning rather than statistical analysis.

      As part of the data collection process, participants will be asked to complete a survey regarding their personal perception on breastfeeding with consideration for the feasibility of this task. The survey consists of 2 different parts. The beginning part of the survey will be multiple-choice questions about demographics (age, race, city, state, etc.). All of the questions in this section are labeled as "not required," so if participants are not comfortable answering or do not recall any of this information, they may skip any part of this section. Then, the survey will pivot to questions given a statement, and the participant is requested to disclose their agreement to each of the following questions on a scale from 1-5 (strongly disagree - strongly agree). Each of the Likert scaled questions regarded health and nutritional benefits or limitations, financial influences, cultural influences, or the overall development of the child.

      At the end of the survey, individuals are requested to answer one short answer question to elaborate on any previously selected answers that they feel may need clarification or have confounding variables present. Additionally, there is a question at the end of the survey requesting additional contact information for interviews, but this is an optional field.

      To collect the data, Google Forms and Google Sheets will be used. Survey links and QR codes will be sent to hospitals and healthcare organizations, and supplemented by posts on social media platforms like Facebook, Nextdoor, and Reddit. This procedure provides a logical method for this study as it allows for another person to clearly understand the demographics and scales and the reasoning behind it. Then, the survey being sent out allows the other researcher to see where the survey was sent and how participants were gathered.

II.   *Analysis Method*

      The data will be coded into numerical values according to the Likert scale questions (from 1 to 5). Each participant has the choice to answer from strongly disagree, disagree, neutral,

agree, and strongly agree. Strongly disagree will have a score of 1 and strongly agree will have a score of 5. Each person's individual questions will be scored on this scaling and then averaged together with each of the responses.

The collection of data through a Likert scale allows the researcher to gain perspectives of the surveyees, due to the bulk of the research relating to individual perception. This will better allow the presence of quantifiable data for ease of collection and comparison. The research question is related to the current perspectives of mothers, thus, once having gathered said perspectives, a competitive analysis will be employed to compare the information received to previously held perspectives held by this demographic; as a result, this research study will contribute to the overarching question of how immigrant mothers to the United States believe durational breastfeeding impacts a child's cognitive development and how feasible this task is in their daily life.

Finally, the data will be analyzed with the help of charts, graphs, and divisions such as breastfeeding, nutritional patterns, cultural influences, and medical knowledge. For the more qualitative data, open-ended and interview responses will be included. These questions will look at the personal experiences of the individual interviewee and will be included as testimonials in the appendix of this academic paper.

The data will be analyzed by taking a percentage of participants who answered the survey in a specific way and by analyzing that quantitative data alongside qualitative descriptions given by research participants. Graphs and charts of the quantitative data will also be made to visually represent the quantitative data for further ease of analysis. Taking percentages of participants who answer the survey in specific ways, through the chi-squared test for independence, will be able to show any possible correlation between variables which will help answer the research question. By visually displaying the data using graphs, quantitative data will be further easily analyzed. Using qualitative descriptions given by participants, we can analyze if there are any similarities in the descriptions given by specific demographic groups and therefore find a correlation between variables to help answer our research question as well.

Results

56 immigrant mothers participated in the survey. Some results were excluded due to the participant not meeting the demographic requirement or not completing the entire survey. This research is aimed at comparing the presence of cultural values and stigma between the immigrant population of the United States; therefore, all results gathered from this study will be grouped by demographic of the mother along with the individual question.

Data was gathered from mothers of various demographics and was reported as follows. 75% of the mothers in this study were working mothers and could have had a time constraint on breastfeeding as a result of this added responsibility. However, the remaining 25% of individuals may have been able to allot additional time to their child and their own personal well-being. Furthermore, 100% of the immigrant mothers included in this study breastfed their child for any given point in time for any given duration, each of which attributed their decision to a perceived

benefit to the mental and physical well-being of both the mother and child. Contrastingly, 17% of mothers in this study also formula-fed their child for some duration of time. This could likely be attributed to time constraints, like the return to work, or health restrictions within the mother or child.

Data Analysis

   I.   *Scale*

A five-point scale was used to measure a mother's perception of breastfeeding for a given duration. The chi-squared test for independence was repeated for each Likert-scaled question to prove whether or not a true correlation exists between cultural values and a mother's perception of breastfeeding. The chi-square test for independence follows the equation below.

$$\textit{Chi-squared statistic: } X^2 = \Sigma \frac{(observed - expected)^2}{expected}$$

Figure 1

Subject	Hypothesis	P-Value
Correlation between cultural background and breastfeeding vs. formula feeding perceptions	Reject null … ▾	0.017
Correlation between cultural background and family life in relation to a mother's decision to breastfeed	Fail to rejec… ▾	0.635
Correlation between cultural background and a mother's decision to breastfeed depending on the return to work or school	Reject null … ▾	0.039
Correlation between cultural background and and a mother's decision to breastfeed depending on her inconvenience associated with breastfeeding	Fail to rejec… ▾	0.077

Subject	Hypothesis	P-Value
Correlation between cultural background and a mother's decision to breastfeed depending on financial concerns	Fail to rejec… ▾	0.997
Correlation between cultural background and a mother's decision to breastfeed depending on personal health concerns	Fail to rejec… ▾	0.594
Correlation between cultural background and health concerns regarding the child	Reject null … ▾	0.000203
Correlation between cultural background and a mother's decision to breastfeed depending on her lack of support	Fail to rejec… ▾	0.596
Correlation between cultural background and a mother's decision to breastfeed depending on cultural stigma	Fail to rejec… ▾	0.918
Correlation between cultural background and a mother's belief that she could have breastfed for a longer duration	Fail to rejec… ▾	0.800
Correlation between cultural background and a mother's perception of whether or not her child began to crawl at an approximately average age or earlier	Reject null … ▾	0.0008467

Subject	Hypothesis	P-Value
Correlation between cultural background and a mother's perception of whether or not her child began walking at an approximately average age or earlier	Reject null … ▾	0.000708
Correlation between cultural background and a mother's perception of whether or not her child spoke their first word at an approximately average age	Reject null … ▾	0.002
Correlation between cultural background and a mother's perception of whether or not her child began to identify colors and number at an approximately average age	Reject null … ▾	0.0003433
Correlation between cultural background and a mother's perception of whether or not her child began to read and write at an approximately average age or earlier	Reject null … ▾	0.0002553
Correlation between cultural background and a mother's perception that her decision to breastfeed had some impact on the rate of her child's development	Fail to rejec… ▾	0.060
Correlation between cultural background and a mother's perception that a child bears more of a benefit the longer	Reject null … ▾	0.026

Subject	Hypothesis	P-Value
the period of breastfeeding is		
Correlation between cultural background and a mother's perception that the current recommendation of 3-6 months of breastfeeding is feasible	Reject null … ▾	0.046
Correlation between cultural background and a mother's perception that breastfeeding for 2 or more years does not bear any additional benefits for the child	Fail to rejec… ▾	0.196
Correlation between cultural background and a mother's perception that younger mothers are more likely to breastfeed for a shorter duration	Fail to rejec… ▾	0.539
Correlation between cultural background and a mother's perception that older mothers are more likely to breastfeed for a shorter duration	Fail to rejec… ▾	0.441

II.   *Coding*

Additionally, short answer questions included at the end of the survey allowed participants to include any additional information that may not have been covered in the scaled questions. Short answer responses to these questions were thematically coded based on five major criteria: "health and nutritional benefits," "parent-child connection," "health and nutritional limitations," "financial influences," and "cultural influences." Each short answer response was coded individually following the trends included in the table below.

Figure 2

Health and Nutritional Benefits	"Better immunity" "100% because of my child's health" "Mother's well being too" "Like no other supplements or formula" "Necessary nutrition in its pure organic form"
Parent-Child Connection	"Improves intimacy" "Baby bonding time" "Bonding between my children and me" "Emotional bond"
Health and Nutritional Limitations	"Babies lack of interest in latching" "Lack of producing milk"
Financial Influences	"Price of milk is still so high"
Cultural Influences	"I believed that breastfeeding was essential" "Cultural influences" "I believe that a mother is supposed to nourish her child" "I believe that it's every child's right"

III.   *Discussion*

For each Likert scaled question included in the survey, a p-value was calculated - indicating the probability that the statistical measure of the assumed probability distribution will be greater than or equal to the observed results. The table below indicates the calculated p-values for each of the scaled questions and the investigative factor of each question, with the null hypothesis being that there is no correlation between breastfeeding and one's cultural beliefs, and the alternative hypothesis showing a correlation between the two variables. In this study, the α level was set at 0.05. If $p > 0.05$, the null hypothesis was proven to be true, but if $p < 0.05$, the null hypothesis was rejected.

Mothers were seen to not have a notable difference in race when regarding generalized statements surrounding the topic of breastfeeding in the public health climate. For instance, immigrant mothers typically attributed their decision to breastfeed to family life, and when each individual demographic was measured against one another, it yielded a p-value of 0.635. Since this is greater than α at 0.05, the null hypothesis failed to be rejected. Additionally, a similar data point seeking to uncover a correlation between cultural background and a mother's belief that she could have breastfed for a longer duration, was not seen to have any variation between demographic. The majority of mothers rated their agreement with this statement at a 4 (agree) or

5 (strongly agree) regardless of demographic, and in turn, this question yielded a p-value of 0.800, once again the null hypothesis had failed to be rejected.

However, with questions regarding public health knowledge and current recommendations, there was seen to be a noticeable attribution to race and cultural background. Immigrant mothers of Asian and Caucasian origin typically scored either a 1 (strongly disagree) or 5 (strongly agree) in terms of their perception in regards to the feasibility of the current recommendation of 3-6 months of breastfeeding, resulting in a p-value of 0.046. However, those who were of Caucasian and American Indian origin generally responded as neutral to this statement, which could be as a result of a lack of education within this population on breastfeeding, or an early switch to formula feeding due to external variables like family life or the return to work or school. Additionally, when inquired if a longer duration of breastfeeding would have any positive impact on a child, Asian immigrant mothers typically reported scores of 4 (agree) and 5 (strongly agree), whereas American Indian, Hispanic, and Caucasian mothers displayed less agreement with this statement, yielding a p-value of 0.026. This trend could be attributed to the large number of Asian countries that participate in exclusive breastfeeding. As stated by Yi Wang, professor at Shandong University School of Public Health, and Chengchao Zhou, researcher at the NHC Key Laboratory of Health Economics and Policy Research at Shandong University, the rates of exclusive breastfeeding in South Asian countries has been exponentially increasing and the Chinese healthcare system should take measures to encourage new mothers to exclusively breastfeed for a longer duration of time (Wang and Zhou, 2019). However, while implementing methods to increase awareness to a longer duration of breastfeeding, the Chinese government drafted policies and regulations to provide education to fertile women to raise the breastfeeding rate of China. This vigorous action taken by the Chinese government to raise the rate of breastfeeding of new mothers depicts the prevalence of cultural norms in the decision of mothers to breastfeed or not.

Similarly, when regarding possible differences in breastfeeding and formula feeding and which nursing method they found to be more effective, a p-value of 0.017 was calculated, indicating a notable difference in perception between demographic. American Indian mothers generally scored at a 2 (disagree) for this statement which was not found in any other demographic of immigrant mothers. Additionally, those of the Asian/Pacific Islanders demographic indicated responses between a score of 2 (disagree) and a score of 4 (agree), whereas Hispanic and Caucasian immigrant mothers responded positively with scores of between 3 (neutral) and 5 (strongly agree). However, this finding is contradictory because as noted by the qualitative results of this study, Hispanic and Caucasian mothers also displayed a higher rate of return to work or school than other demographics. As a result of the inability of these individuals to breastfeed for a longer duration of time, they likely felt as though this lack of attention that they directed towards their child influenced their overall development.

As indicated by the quantitative data gathered from the Likert scaled questions, the alternative hypothesis was proven to be true, demonstrating a correlation between cultural standards and perception of breastfeeding. However, general opinions regarding breastfeeding

did not shift much in relation to cultural background, which is likely due to each of these mothers' residence in the United States, a first-world country.

Qualitative results yielded conclusions regarding stigma and pressure from one's respective culture being most prominent within Asian cultures; this was attributed to stricter social norms and "unspoken rules and regulations" within the culture and society of these countries of origin. Follow-up interviews with mothers of Asian origin revealed that cultural norms were one of the main factors in their decision to breastfeed. The majority of Asian immigrant mothers attributed this influence that their culture had to the guidance of elders. However, as compared to second-generation immigrant mothers, first-generation mothers had a greater inclination towards aligning with the cultural norms of their country of origin, assimilating their values with the mainstream population of the United States. Mothers in the American Indian demographic also typically align with the beliefs of the Asian/Pacific Islanders group and display a strong correlation to their roots and societal values concerning breastfeeding practices.

Hispanic and Caucasian immigrants displayed a higher rate of return to work than other demographics mentioned in this study which plausibly played a role in their decision to breastfeed for a shorter duration. These individuals also perceived that the duration that they breastfed had less of an impact on their child and attributed their decision to financial, health and nutritional factors rather than cultural values.

Implications

This study has several key implications for the future. When assessing the gathered data, a clear divide within various cultures was observed while performing data analysis, which implies that first-generation immigrant mothers were more likely to be influenced by ideas and practices of their country of origin over the mainstream practices of the United States. This stresses the need for more targeted cultural competence within the healthcare industry to offer recommendations not only regarding a mother and child's health, but considering each factor that plays into such decisions.

Limitations

The results of this study on breastfeeding are limited by various factors that may affect the strength of the findings. Voluntary response bias could have affected the sample seeing that it was collected on a nonmandatory basis with no incentives offered. This bias may have skewed the depiction of certain demographics, which could possibly result in a more pronounced or lack of focus on specific ideas and perspectives. Moreover, there is a significant inconsistency in the demographics of the participants; with most of the participants being part of the Asian/Pacific Islander demographic and very few participants who identified as Caucasian, Hispanic, or American Indian. The uneven distribution of demographics in this study could have skewed the results by accounting for and favoring the population with greater representation, which in this case was the Asian/Pacific Islander demographic. Additionally, the study only had a data

collection period of 2-3 months which, in turn, would limit the findings gathered. Extending the data collection period would have allowed for a larger data pool, reducing the wide demographic split while increasing the overall accuracy of the study.

Conclusions and Future Directions

In consideration of the results of the findings, it is imperative to take substantial measures in order to gain a better understanding of maternal perception in relation to breastfeeding duration. One facet of this is ensuring that confounding variables such as age, religion, race, and educational attainment are accounted for. Furthermore, it is also crucial to obtain a more uniform sample which could be grouped by specific age, religious groups, or country of origin. The population of immigrant mothers in the United States consists of various different ethnicities, races, and cultural values and beliefs which could have caused the data to be slightly skewed. However, focusing on an alternative demographic of individuals that is relatively homogenous would likely yield a more uniform sample population to ensure validity of the findings. Contemporary solutions such as real-time experimental designs which depict the thoughts and opinions of mothers as they breastfeed are vital to obtaining a more comprehensive understanding of breastfeeding practices. Additionally, it is important for future researchers to focus on the cultural stigma of Asian cultures in relation to breastfeeding. It is pivotal to conduct an extensive analysis examining which beliefs or individual practices contribute to this decision the most, how culture plays an important role in their decisions, and how the choices of mothers in regards to breastfeeding are affected by the fear of nonconformity

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Evaluating Personality Changes as an Early Sign of Brain Tumors: A Literature Review By Abi Kizza

Abstract

The prognosis of brain tumor patients is unsatisfactory compared to other common cancers. The most common types of brain tumors are of glial origin and carry the worst prognosis, with a median survival of 12-15 months for a diagnosis of glioblastoma multiforme (Sreenivasa R et al., 2008) Brain tumors are much more difficult to detect in that they present symptoms synonymous with a wide range of noncancerous diseases, which are more likely to strike a clinician as a possible diagnosis as opposed to a conclusion of a brain tumor in a patient. Brain tumor prognosis is far worse than other cancers because efficient processes of early detection are still being researched. If a patient is suspected to have a tumor, they will often undergo a series of clinical screenings to understand their condition. When a patient arrives at the need for screening, the tumor has more than likely progressed to its later stage, making successful treatment hard, and leading to higher rates of death in brain tumor patients. The Hospital Anxiety and Depression Scale Test (HADS) can be used to attempt to combat this issue. It is administered before a patient is seen by a clinician, and capitalizes on personality changes such as anxiety and depression to indicate possible conditions a patient may have. Personality changes can be used as diagnostic factors as they show the possibility of tumors in a patient, as tumors covertly manifest in patients that express notable changes in personality and emotion. The updated HADS Test presented in this paper modernizes the old test. It caters to important factors such as age and question bias to strengthen its credibility as a tool for the first steps of brain tumor detection.

Introduction

Brain cancer incidence in the United States of America has shown ascending growth. The World Health Organization (WHO) projects that by 2030, there will be nearly 70,000 deaths from brain and central nervous system cancer compared to the reported 58,000 in 2015 (Ilic & Ilic, 2013). Although the US has seen a drop of 0.8% in annual incidence in geriatric groups, pediatric populations are seeing an increase in incidence (Ilic & Illic, 2013). Most types of cancer present more positive outlooks when diagnosed early, and the same is true for brain cancer patients. The typical 5-year survival rate of general brain cancer is estimated to be about 36% when detected at the local stage. The survival rate declines when the cancer progresses and begins to metastasize, even with treatment involved (Schaff & Mellinghoff, 2023). The many complexities involved with brain cancer and treating it result in it being the 8th major cause of years of Life Lost (YLLs) according to the Global Burden of Disease (GBD), in 2017 (Ilic & Illic, 2013). Brain tumors are considered a rare type of cancer in terms of incidence, as less than 100,000 people in the United States receive a diagnosis every year, account for 2.5% of all cancer deaths, and a mere 5% of patients diagnosed with glioblastoma survive past 5 years (Ilic & Illic, 2013).

Diagnosis is done through neurological and physical examination, depending on the symptoms a patient presents. Further tests include MRIs and CT scans for confirmation and localization of a brain tumor. Symptoms may include headaches, seizures, dizziness, and personality changes among many others. These symptoms are associated with many other possible conditions and often occur with varying intensity after the tumor has been growing for an extended amount of time. This commonly means that brain tumors are found after a substantial amount of incubation from the beginning of the tumor development, which results in a delay in subsequent action.

The Hospital Anxiety and Depression Scale (HADS) is often administered to all patients, unknowing brain tumor candidates or not, before being seen by a clinician. It aims to quantify symptoms of anxiety and depression in a patient, both of which are common psychiatric disorders associated with numerous conditions, including brain cancer. It can also be used as a post-diagnosis tool to gauge the mental status of a patient. When analyzing brain tumors, the HADS test is only given post-diagnosis as a way to measure symptoms that are believed to arrive after the confirmation of cancer. The post-diagnosis use of the HADS test makes distinguishing changes in mental standing as indications of tumor presence difficult. The HADS Test becomes a useless tool, in that it is given at unhelpful times, but when tweaked can prove efficient for early diagnosis.

Brain tumors present a unique relationship with psychology, as the location of the tumor directly impacts the psychological standing of a diagnosed patient (Weitzner, 2009). A cancer diagnosis of any nature bears significant emotional weight on a patient. Common reactions to a result screening positive for cancer cells in a host include anger, sadness, and loneliness, and the extremity of these emotions vary from patient to patient. Changes in personality such as those mentioned above, are recurrently associated with post-diagnosis of the tumor, and written off as effects stemming from a tumor present in a host's brain. When further understanding the complexities of brain tumors and personality changes, the importance of the interconnectedness of the physiological and oncological aspects of this field is necessary to mitigate brain cancer deaths through early detection.

There are relatively limited studies that dissect the relationship between personality changes and brain tumors in diagnosed patients. Through analysis of clinical data and review, the relationship between brain tumors and personality changes is further investigated and dissected for the betterment of cancer identification in the future. WHO, accompanied by the United Nations Sustainable Goals (UN SDGs), is working to reduce one-third of premature deaths from cancer, by 2030. It is essential that the navigation of current cancer diagnosis is analyzed, and improved, to catch cancer early, and provide a more positive prognosis as the oncological world develops. Brain tumors are often left behind in such conversations, although they carry significantly high mortality rates as compared to other cancers. The association between personality changes and brain tumors is a promising path to further brain cancer research. This paper will examine the concept of using tests such as the HADS Test to identify psychological symptoms that make the diagnosis of brain tumors in a host easier.

Brain Tumors

        Brain tumors are benign or malignant growths in the brain, and can spread to other parts of the body. Tumors of this fashion are graded on a scale of 1-4, with growths scoring greater than 2 being more serious (Hanif et al., 2017). Benign tumors are noncancerous and do not spread to other parts of the brain. They have a lower chance of recurring in patients after they are removed through processes such as craniotomy and neuroendoscopy. Grade 1 and 2 tumors are often benign, as they don't present the same grave prognosis that malignant tumors do. This is not to ignore the seriousness of a benign tumor diagnosis, as they can cause damage to the brain by creating pressure in different areas of the skull, as there is limited capacity in the cranium. There is also a high possibility that cerebrospinal fluid (CSF) movement may be blocked by the presence of a tumor leading to increased internal pressure (Hanif et al., 2017). Malignant tumors are cancerous and tend to spread to other parts of the brain including the spine, at higher rates in comparison to beginning growths. They have a higher chance of recurring in patients even after intensive and evasive treatments. Treatments such as radiotherapy and chemotherapy are used to shrink or decrease the growth of a tumor in a patient.

Types of malignant brain Tumor Causes, and their Symptoms

        Gliomas are the most common type of malignant brain tumor in adult patients, accounting for 40%-55%, of all diagnosed brain tumors, followed by tumors such as astrocytomas and ependymomas (Madhusoodanan et al., 2015). Depending on which cells the gliomas are driven by, they can subtype into Glioblastoma Multiforme (GBM) and comprise the body's white blood cells found in bone marrow. The growths resemble glial cells, which repair brain damage after injury. More commonly found in people ages 50-70, once diagnosed, the common professional response is to opt for immediate resection, as they are commonly categorized as stage 4 growths (Madhusoodanan et al., 2015). Symptoms of this diagnosis include headaches, seizures, drowsiness, memory loss, and changes in personality among others (Madhusoodanan et al., 2015).

Treatment

        When dissecting possible treatment for a respective brain tumor, the primary and secondary classifications are important to achieving effectiveness. Primary tumors are defined as malignant or benign growths that originate from the brain. They can spread to other sites in the body but originally developed in the brain. Secondary tumors originate from any other part of the body and eventually spread to the brain, they can also be referred to as metastatic tumors, and this spreading results in more neuropsychiatric symptoms (Madhusoodanan et al., 2015). In the United States primary brain tumors have an incidence of 9:100000 in adult patients and metastatic brain tumors have a rate of 8.3:100000 per year (Madhusoodanan et al., 2015). "an annual incidence of 9 per 100000 for primary brain tumors and 8.3 per 100000 for metastatic brain tumors," in adult patients (Madhusoodanan et al., 2015).

There are various treatment options when assessing tumor elimination in a host. Surgery often poses many risks along with the benefits. Tumors cannot always be fully removed, as tumor location and size play a pivotal role. Tumors are hard to separate from surrounding brain tissue, and they may also be found near an important segment of the brain, restricting full removal to avoid further implications in a patient. The partial removal of a tumor is called subtotal resection. Other avenues of treatment include craniotomy– when an incision is made in the scalp, a surgeon cuts out a part of the skull, removes the tumors, and inserts the cutout skull back in place. Endoscopic brain surgery – a thin tube, an endoscope, is inserted in the brain through the nose and sinuses. Radiation therapy can be disposed of as a less invasive mode of treatment. Often time maneuvering diagnosis proves difficult as grade 1 or 2 tumors have slow rates of proliferation, and surgery does not appear as a feasible option. Tumors should aim to be caught at stages 1 or 2, to avoid resection and negative prognosis, as stages 3 and 4 carry higher chances of recurrence as well.

Personality Changes

When a person behaves uncharacteristically, they can be categorized as dealing with personality changes. When a host's behavior becomes inconsistent with the manner in which they usually act and function, it can be a stifled reason for alarm. Personality changes include many things, such as unusual functioning, delirium, and extreme mood swings (Moersch, 2006). Even though less worrisome, personality changes can also be positive as seen in a considerable amount of cases. Personality changes also include mood swings, which are aggression, detachment, anxiety, and depression. Personality changes can be used as an umbrella term to group such fluctuations in a host. The term will be used to describe the effects of the extremities of anxiety and depression, which present as psychiatric symptoms, as they are classified as disorders. 80% of brain tumor-positive individuals subjected to a study had psychiatric symptoms, supporting the association tumors have with cognitive malfunction (Lupton et al., 2019).

Although tumor location has been noted to play a role in the type of mood change observed, there are unclear connections between the location of the tumor and the subsequent change to evolve from the growth, in neurobiological research. A study done on two boys, 13 and 5, provides data on the unexplored connection. The first case involved a 13-year-old boy, who was diagnosed with a small, dormant tumor that was not causing any intracranial pressure. He was extremely violent towards both children and adults, and his temper escalated to him attempting to hit an adult in the head with a brick while he was being observed. His violence was labeled impulsive, and he was restrained for a fourth of his day, during his stay in a psychiatric facility as an inpatient. The teenager underwent tumor resection, and all signs and exhibitions of aggression ceased (Najaki et al., 2003). The 5-year-old in the second case began to randomly show signs of aggression, violence, and rage towards his peers in school, to the point of removal from the premises. It was later discovered that he had a right mesial temporal tumor, completely unassociated with intracranial pressure. Upon removal of the tumor, his negative symptoms were subdued (Najaki et al., 2003).

In another study, a large sample of deceased cancer patients was examined to assess the causes of death as well as the data behind individuals with cancer dying from accidental vs, suicidal death (Kendal & Kendal, 2012). 2,557,385 deaths were examined, and among them, 0.26% were due to suicides. Of those suicides, 65,000 individuals had been diagnosed with brain cancer, resulting in 0.65% of brain cancer patients dying by suicide (Kendal & Kendal, 2012). These cases highlight the interconnectedness of tumors and symptoms such as depression and anger, as the resection of the tumor in both instances seemed to reverse the negative traits in each patient. Studies like these can be used to validate the relationship between brain tumor presence and extreme expressions of varying types of emotions, more negative than not.

In discussions, brain tumor location has shown a slight correlation to the type of personality change present in a host, although it is not pertinent to the discussion relating to the use of changes as diagnostic factors. When a patient starts to display minor yet increasing or major shifts in personality, it is worth noting that a brain tumor could be developing, as personality changes present as an unexpected indicator of tumor presence. As the clinical data suggests, the negative changes in character have proved to indicate the existence of tumors in the brain.

The Test

The Hospital Anxiety and Depression Scale is a self-administered evaluation used to screen for the presence of anxiety and/or depression in a patient (Figure 1). It is not unique to any illness and is given to patients suffering from all types of diseases and conditions. Developed in 1983 by Dr Phillip Snaith and Anthony Zigmond, the 41-year-old test became a practical tool for quantifying anxiety and depression, in a standard way. It is not a tool used for complete diagnosis, but rather a way to identify a need for further psychiatric evaluation in general hospital patients. The HADS test asks a patient to self-reflect on their mood in the past week. Seven questions are designed to assess anxiety and can be subcategorized into two questions for autonomic (commonly known as the fight or flight response) anxiety, and 5 for restlessness (Dunbar et al., 2000). The other seven questions are designed to assess depression, and can be subcategorized into two questions for appearance, and 5 for anhedonia, the inability to experience pleasure (Dunbar et al., 2000).

When scoring, questions in this test are often referred to as "items". Each subscale of the HADS and its respective items are added together to construct HADS-T, the total score of the test. However, HADS-A and HADS-D, the individual anxiety and depression scores, are important categorizations as well. These are the subcategories of the test, and their resulting scores can range from 0-21. Each item in those subcategories is graded on a 4-point scale, as a patient can choose to answer from 0=not at all, to 3 = most of the time. Some items hold a reverse score, administering 3-not at all, to 0=yes. Two items from HADS-A and four from HADS-D are scored this way. The closer a total score is to 21, the higher the indication of distress a patient likely is facing. A subscale score of 0-7 is often normal, a score of 8-10

indicates slight concern for the stature of mind, and a score of 11 or higher displays a high probability for a mood disorder in the patient taking the test (Zigmond & Snaith, 1983).

The administration of the HADS is quick and is often given to patients while they wait to be seen by a clinician. The test can be given in a hospital, in a waiting room, and in other nonstructured environments. Materials for administration are the questionnaire and a writing utensil, and the test lasts 2-5 minutes, with scoring taking about 1 minute if done by an experienced clinician (Herman, 1997). Alternative forms of administration include asking questions over the phone, or interview style in person, for patients that display difficulty with self-administration. Patients who are illiterate or have vision issues are advised to opt for the alternative modes. The HADS is effective in its speed, in that it is a quick way to broadly assess the status of a given patient. It does not require much and produces important results from the simple screening. Its rapid quantification of clinical mood disorders helps the further diagnosis of a patient. Patients with results implying a possibility of anxiety, depression, or both can be better understood by the physician they are evaluated by, if the test is administered at its best.

The HADS is a test created almost half a decade ago, which means the items are catered to older signs of negative mental health. More modern indications and signs are excluded from the test, which provides a hindrance to results. Factors such as gender and race go unnoticed which is important to note as anxiety and depression manifest differently across such categories, and the HADS test does not take into account how all these factors impact mental standing (Desai & Jann 2000/ Bailey et al., 2019). Given the growing attention to the intricacies of mental health, questions created 41 years ago, may not have the same effect as they do now. It is administered to all ages as long as a patient presents positive signs of comprehension and literacy, which proves another hindrance. Without properly assessing a patient, it is difficult to comprehend the extent of their literacy which can affect the results of the given test. Implications of poor mental health look different across different age groups as younger patients may experience differing symptoms of anxiety and/or depression in comparison to their older counterparts. Anxiety and depression will look different in a teenager compared to an elderly patient, as things like life experience, environment, social factors, and culture play a role among many other factors.

As shown in Figure 1, HADS is not disease or condition-specific, as it is given to all types of patients who exhibit symptoms synonymous with an incredible range of illnesses. Its broadness proves both a negative and a positive factor, as diseases or conditions with mental health symptoms as requirements for diagnosis are not specifically targeted in HADS administration.

Hospital Anxiety and Depression Scale (HADS)

Tick the box beside the reply that is closest to how you have been feeling in the past week.
Don't take too long over you replies: your immediate is best.

D	A		D	A	
		I feel tense or 'wound up':			**I feel as if I am slowed down:**
	3	Most of the time	3		Nearly all the time
	2	A lot of the time	2		Very often
	1	From time to time, occasionally	1		Sometimes
	0	Not at all	0		Not at all
		I still enjoy the things I used to enjoy:			**I get a sort of frightened feeling like 'butterflies' in the stomach:**
0		Definitely as much		0	Not at all
1		Not quite so much		1	Occasionally
2		Only a little		2	Quite Often
3		Hardly at all		3	Very Often
		I get a sort of frightened feeling as if something awful is about to happen:			**I have lost interest in my appearance:**
	3	Very definitely and quite badly	3		Definitely
	2	Yes, but not too badly	2		I don't take as much care as I should
	1	A little, but it doesn't worry me	1		I may not take quite as much care
	0	Not at all	0		I take just as much care as ever
		I can laugh and see the funny side of things:			**I feel restless as I have to be on the move:**
0		As much as I always could		3	Very much indeed
1		Not quite so much now		2	Quite a lot
2		Definitely not so much now		1	Not very much
3		Not at all		0	Not at all
		Worrying thoughts go through my mind:			**I look forward with enjoyment to things:**
	3	A great deal of the time	0		As much as I ever did
	2	A lot of the time	1		Rather less than I used to
	1	From time to time, but not too often	2		Definitely less than I used to
	0	Only occasionally	3		Hardly at all
		I feel cheerful:			**I get sudden feelings of panic:**
3		Not at all		3	Very often indeed
2		Not often		2	Quite often
1		Sometimes		1	Not very often
0		Most of the time		0	Not at all
		I can sit at ease and feel relaxed:			**I can enjoy a good book or radio or TV program:**
	0	Definitely	0		Often
	1	Usually	1		Sometimes
	2	Not Often	2		Not often
	3	Not at all	3		Very seldom

Please check you have answered all the questions

Scoring:
Total score: Depression (D) _____   Anxiety (A) _____
0-7   = Normal
8-10 = Borderline abnormal (borderline case)
11-21 = Abnormal (case)

Figure 1: The current Hospital Anxiety and Depression Scale Test (Rishi, 2017).

The New Test

The HADS test can be used to detect personality changes in patients, which can be further used for earlier brain tumor detection and subsequent early treatment. Early brain cancer detection is limited in its success, by the lack of attention to early warning signs of cancer. As studies have shown, some patients behave uncharacteristically when a tumor is present, and go back to their respective normal following resection. Usually, when a patient presents other tumor symptoms such as headaches, weakness, and numbness among other things, a clinician is not immediately prompt to scan for abnormal growth, leaving the cancer to grow and worsen. Since personality changes have been noted to be symptoms of brain tumors, the HADS test can be redeveloped in order to present its results as a possible detection rather than just the surveillance of the state of a patient. The current HADS test that is being administered quantifies anxiety and depression in a way that plots patients on a scale. That scale is then further used to identify if they are undergoing any type of change and its extremity regarding the two big disorders. It falls

short in its inability to measure other types of personality changes that can be seen in brain tumor patients, such as aggression and nonchalance. Some research suggests that the location of the tumor, especially those found in the frontal lobe, plays a big role in the prevalence of personality changes in respective cancer patients. However, the biochemistry underlying the relationship between changes in personality and brain tumors remains unclear as it continues to be studied.

An improved version of the test can be used as an attempt to speedrun cancer diagnosis. The prognosis of patients affected by primary malignant brain tumors is often grave, as 25% of patients diagnosed with glioblastoma multiforme survive 2 years after diagnosis, even with treatment involved (Pranckeviciene & Bunevicius, 2015). To attempt to avoid such outcomes, Patients can become eligible for MRIs or CT scans much earlier if signs of personality changes are prevalent through the score they receive on the updated HADS test. For example, current research suggests that the HADS-D subscale test performs well in the base recognition of depression in a patient (Pranckeviciene & Bunevicius, 2015). This is important as a meta-analysis of 37 observational studies concluded that depression had a 21.7% prevalence in a total of 4518 patients suffering from intracranial tumors (Madhusoodanan et al., 2007). Such data supports the HADS test as a strong candidate in aiding faster brain tumor diagnosis.

Such personality changes are often underlooked or only taken into consideration after diagnosis but instead can be used as diagnostic factors through the updated test. Newer versions of the HADS can be used to identify early signs of personality changes through its screening for anxiety and depression, to allow for further screenings to be done for accurate and timely tumor diagnosis. Avoiding conclusions of tumors present in a patient before the prognosis becomes dismal is imperative to the future of cancer detection and treatment. I have developed a new test that attempts to improve some of the most striking drawbacks of the current test.

Administration

The current HADS test has ambiguous administration. It can be given to a patient in a waiting room, or an examination room, and is usually left for the patient to do alone, or without any supervision. There are no clear-cut guidelines on how to administer this test. The new test will require that the test is taken by a patient, alone, in a quiet room, away from any distractors that could cause inaccurate results.

Specification Bias

The current HADS test shows which questions are screening for anxiety, and which questions are screening for depression. The specificity and categorization of the questions, although they are dispersed on the actual questionnaire, disallow for a truly unbiased assessment and answer from the patient. The new test presents the questions and the scoring, without the ability to see an "A" or "D". Giving a patient the chance to see which questions are targeting a specific mood, may produce answers that differ when the distinctions are absent.

Age

Indications of suffering mental health appear differently in different age groups. The causes and impacts of negative mental standing are not the same when analyzing a pediatric

population as opposed to an adult population. The current HADS does not account for age-based questions in the way the new test does. Decades-old, the HADS test does not use more modern indicators of poor mental health in older populations and does worse in younger ones. Using general knowledge and symptoms synonymous with the current generation, the new test considers age as an influence for the questions asked, and the signs to look for, to produce more accurate results in respective age groups (Figure 2A & 2B, Kizza 2024).

The updated HADS test will better target any indicators of possible brain tumor presence, but if edited further, can be used across many other fields. Personality changes are not unique to brain tumors and can be symptomatic of a range of many other diseases and conditions. The updated HADS test can notify a clinician of the standing of a patient in a way that can be taken and used as data to catch a disease like brain cancer in a patient, before it grows and enters higher grade status, making treatment much harder.

Test A.

UPDATED Hospital Anxiety and Depression Scale (HADS) - Geriatric

Please tick the box beside the reply that is closest to how you have been feeling in the past week. Your immediate answer is best: don't take too long on one question.

	I feel tense or 'wound up':		Worrying thoughts go through my mind:
3	Most of the time	3	A great deal of the time
2	A lot of the time	2	A lot of the time
1	From time to time, occasionally	1	From time to time, but not too often
0	Not at all	0	Only occasionally

	I still enjoy the things I used to enjoy:		I feel cheerful:
0	Definitely as much	3	Not at all
1	Not quite so much	2	Not often
2	Only a little	1	Sometimes
3	Hardly at all	0	Most of the time

	I get a sort of frightened feeling as if something awful is about to happen:		I can sit at ease and feel relaxed:
3	Very definitely and quite badly	0	Definitely
2	Yes, but not too badly	1	Usually
1	A little, but it doesn't worry me	2	Not Often
0	Not at all	3	Not at all

	I can laugh and see the funny side of things:		I feel as if I am slowed down:
0	As much as I always could	3	Nearly all the time
1	Not quite so much now	2	Very often
2	Definitely not so much now	1	Sometimes
3	Not at all	0	Not at all

Cont.

	I get a sort of frightened feeling like 'butterflies' in the stomach:		I have lost interest in my appearance:
0	Not at all	3	Definitely
1	Occasionally	2	I don't take as much care as I should
2	Quite often	1	I may not take quite as much care
3	Very often	0	I take just as much care as ever

	I feel restless as I have to be on the move:		I look forward with enjoyment to things:
3	Very much indeed	0	As much as I ever did
2	Quite a lot	1	Rather less than I used to
1	Not very much	2	Less than I used to
0	Not at all	3	Hardly at all

	I can enjoy a good book radio or TV program:		I get sudden feelings of panic:
3	Often	3	Very often indeed
2	Sometimes	2	Quite often
1	Not often	1	Not very often
0	Very seldom	0	Not at all

Please check that you have answered all questions.

Figure 2A - The new recommended personality change test for geriatric patients (Kizza, 2024).

Test B.

UPDATED Hospital Anxiety and Depression Scale (HADS) - Pediatric

Please tick the box beside the reply that is closest to how you have been feeling in the past week. Your immediate answer is best: don't take too long on one question.

Do you feel sad?		Are you content with your social life?	
3	Most of the time	3	A great deal of the time
2	A lot of the time	2	A lot of the time
1	From time to time, occasionally	1	From time to time, but not too often
0	Not at all	0	Only occasionally

I still enjoy the things I used to enjoy:		Are you always afraid something awful might happen?	
0	Definitely as much	3	Not at all
1	Not quite so much	2	Not often
2	Only a little	1	Sometimes
3	Hardly at all	0	Most of the time

Do you isolate yourself on purpose?		Is it easy to fall asleep?	
3	Very definitely and quite badly	0	Definitely
2	Yes, but not too badly	1	Usually
1	A little, but it doesn't worry me	2	Not Often
0	Not at all	3	Not at all

I can laugh and see the funny side of things:		Do you sometimes wish you were not alive?	
0	As much as I always could	3	Nearly all the time
1	Not quite so much now	2	Very often
2	Definitely not so much now	1	Sometimes
3	Not at all	0	Not at all

Cont.

I spend a lot of time in my bed:		I have lost interest in my appearance:	
0	Not at all	3	Definitely
1	Occasionally	2	I don't take as much care as I should
2	Quite often	1	I may not take quite as much care
3	Very often	0	I take just as much care as ever

Do you feel happy in your body?		I look forward with enjoyment to things:	
3	Very much indeed	0	As much as I ever did
2	Quite a lot	1	Rather less than I used to
1	Not very much	2	Less than I used to
0	Not at all	3	Hardly at all

Are you easy to irritation?		Do you get overwhelmed easily?	
3	Often	3	Very often indeed
2	Sometimes	2	Quite often
1	Not often	1	Not very often
0	Very seldom	0	Not at all

Please check that you have answered all questions.

Figure 2B - The new recommended personality change test designed for pediatric patients (Kizza 2024).

Conclusion/ Discussion

The evaluation of personality changes concerning brain tumors contains limitations. It does not assess changes in personality according to factors such as race and gender. The updated test is an improvement, but many more are essential to creating an examination that attempts full accuracy at detecting personality changes in a way that can be used for brain tumor diagnosis. The HADS test works as a useful benchmark for analyzing personality changes in brain tumor patients, although it is not perfect. Deeper questions of administration, and test length, as the approach remains unclear. As the type of questions, age group, and mode of administration are changed to aim for a better test, other aspects that were left unaddressed are essential to the progression of the HADS test to bring efficiency to the process of brain cancer detection. Understanding the level of literacy in a patient taking the test is extremely important, as excellent reading and comprehension of the questions asked are imperative to the test's success. Pre-administration procedures such as sitting a patient in a quiet room would also need to include confidence on the clinician's part so that the patient can understand what is being asked of them. Although a standard test, the HADS should be edited and confined to work for generations to come and adapt to the current world. To accurately assess and quantify anxiety and depression, the test must be flexible, instead of stagnant over deceased. Brain tumors presenting obvious personality changes are somewhat rare, and treatment for tumors is not as advanced for other types of cancers. Creating tests and screenings to better understand patients would help to avoid the death rates synonymous with brain cancer diagnosis. Catching brain cancers at the earliest stages possible by considering personality changes as valid diagnostic factors, can help ensure

the early treatment of patients diagnosed with brain tumors. Future research in this bridge between oncology and neurology involves investigation into the biochemical interactions that occur, how that may shape the type of personality change expressed, and the extent to which it is prevalent in a patient. Research like this is crucial to the effort to catch brain cancer early, as to increase the survival rate, and better understand the types of cancer that live among us. For the future of oncology, conversations surrounding psychology need to come into play for the advancement of brain cancer detection and treatment.

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Floating Currency Market Volatility and its Correlation with Bitcoin Valuation By: Nitish Elangovan and Pranav Senthilkumar

Abstract:

In today's fast-paced society, money is made, spent, and saved in numerous ways. Cryptocurrency, notably Bitcoin, is a prominent transaction method, though its value is highly unpredictable. This study examines the overlooked relationship between floating currency exchange rates and Bitcoin prices. By addressing this correlation, the research aims to reduce investor uncertainty and provide reassurances for Bitcoin decisions, complementing existing theories. Our research design involved a quantitative analysis of historical Forex and Bitcoin price data. The study utilized financial databases for data collection, and statistical techniques were employed to analyze correlations and patterns. Our results demonstrated overall floating currencies with large fluctuations correlated with Bitcoin prices, while pegged currencies with no fluctuations in exchange rates showed little to no correlation. The major conclusion drawn from this data analysis is factors influenced by market dynamics (supply and demand and investor sentiment) tend to show a parallel in growth or decline in value highlighting the similarity between floating exchange rates and fluctuating Bitcoin prices. These findings sparked further research on how global economics shows interconnectedness. Within our paper, several key terms play crucial roles in understanding our analysis. Firstly, we delve into "pegged currencies," referring to currencies with values fixed to another currency or a basket of currencies. Conversely, "floating currencies" are those whose values are determined by market forces rather than being fixed. Finally, we explore the "Forex Market," the global platform where currency exchange occurs, enabling the seamless exchange of one currency for another.

Intro:

Cryptocurrency's ability to soar like a bird and sink like a stone is still a mystery the financial world faces today. The advent of Bitcoin in 2009 brought about a new era of finance that propelled the globe into cryptocurrency—introduced to the public in 2008 by Satoshi Nakamoto through the paper titled *"Bitcoin: A Peer-to-Peer Electronic Cash System"*. From this point on Bitcoin has taken over the public and completely revolutionized how we transact value through a new decentralized infrastructure.

Cryptocurrency operates on the principle of solving complex algorithms to create unique hashes. This is done through "mining" in which users strive to solve these complex problems and add blocks to the Blockchain. It is worth noting that past transactions are unalterable to ensure transparency and legitimacy to users. Since the number of generatable hashes is finite, Bitcoin preserves its rarity and value. The process takes a remarkable amount of computational power and energy usage, which has been brought up by many activists. Yet these limitations are often shrouded by the allures of financial rewards as the value of Bitcoin peaked at nearly 70,000 USD.

The fundamentals of the Foreign Exchange market are governed by the principles of supply and demand. The exchange rate determines the value of each currency with another, and as demand for one increases, the price of that currency will rise against the other.

The crypto market, is relatively unpredictable, leading us to the research question that we will answer in this paper, "How do floating currency fluctuations correlate with fluctuations in bitcoin prices?" By analyzing these currency fluctuations in the Forex Market, we aim to draw a meaningful relationship between the global economic landscape and Bitcoin prices. Analyzing these trends, we can conclude and gain a more nuanced insight into the interplay of traditional markets in the emerging cryptocurrency market. This information can be used for investors, businesses, and a wide array of individuals who want to navigate the ever-evolving landscape of finance. By equipping oneself with this knowledge, stakeholders can strategically position themselves to capitalize on the dynamic interplay between traditional and digital markets, seizing opportunities in a rapidly transforming financial realm. Understanding additional factors that show a strong relationship to Bitcoin prices strengthens an investor's success in making crypto investments as one has multiple reassurances before investing. Our study hopes to fill the gap in discussing floating exchange rates' correlation to Bitcoin prices as this is a topic largely overlooked when determining the typical correlating factors with Bitcoin prices.

Our scope of study is on developed countries' economies as we analyze currencies across affluent countries between 2019 and 2023. Our major limitation in this study is pegged currencies as their reduced fluctuations inhibit correlations with Bitcoin prices.

Our research method employed an observational approach, involving gathering historical data from financial databases and using quantitative analysis techniques to examine patterns and relationships. The detailed methodology will be presented in the Methods section later in the paper.

Literature Review:

Few researchers cover the element of currency exchange rates' correlation with bitcoin prices. Currency exchange rates dictate the financial world we live in today by determining the worth of one's money in an international setting. Such a factor oftentimes lacked consideration while searching for behaviors of bitcoin prices. This section of the study addresses the gap in understanding the specific factors that influence or correlate with Bitcoin prices which translates into our thematic analysis.

For instance, a financial study done by Investopedia on the craziness of crypto values highlights the importance of the number of competitors looking to buy Bitcoin plays a major role in dictating the price of the coin (Bloomenthal, A, 2022). Specifically, Bitcoin has attracted the attention of institutional investors, increasing demand powered by rising media coverage, investing experts, and business owners forcing the value a bitcoin has and will have. Another study involving bitcoin prices getting swayed by societal factors is the media hype given on the currency's relevance. (Reiff, N, 2022) Social media has a major effect on swaying people's opinions on cryptocurrency as these factors alone have contributed to the bandwagon of people

purchasing crypto. News and media outlets are businesses that need content for their readers and viewers, they often present information and predictions from experts that are not always verified by evidence other than opinions. Yet another example of dictating the price of a bitcoin is the production cost put into mining. (Singh, J, 2024) Bitcoin mining through the various algorithms needed can be quite exhausting for the systems running. The cost of producing Bitcoin includes not only direct costs like infrastructure for miners but also indirect costs correlating with the complexity of the cryptographic problems. These costs contribute to establishing a break-even point for miners, influencing the lowest price at which they might consider it economically viable to mine Bitcoin. Moreover, the Bitcoin network adjusts the difficulty of its cryptographic challenges in response to the overall mining power, influencing how quickly new Bitcoins are mined. These subsections determine the availability of bitcoin in a certain period influencing the fluctuations of bitcoin prices. A final factor prominently featured in research studies about bitcoin price fluctuation is the regulation of the coin's activities. (Singh, J, 2024) Regulations are changing rapidly, with some countries, such as El Salvador, making Bitcoin their legal tender. However, others are taking a strict approach to crypto, such as China, officially banning crypto usage. Regulatory actions can alter the coin's price by creating uncertainty on the consumer's end. Specifically when authorities introduce strict measures on the coin, it experiences downward trends in prices. In contrast, regulatory measures that enhance accessibility, like approving spot Bitcoin exchange-traded funds (ETFs) in the USA, can foster market participation and grow Bitcoin costs.

Method:

The methodology of our research consists of an observational approach. As stated before our analysis involves tracking the correlations between currency exchange rate fluctuations and the shifts in Bitcoin prices to conclude whether there is an average correlation. A literary review mentions pre-existing studies on the most common factors affecting bitcoin prices other than currency exchange rates. We employed statistical and thematic analysis to arrive at our conclusion. Our research contains primarily quantitative data due to the numbers analyzed to form conclusions. Employing data analysis on a quantitative data-heavy study allowed for a deeper understanding of our topic. Our thematic data was obtained through a literature review, which included research studies, academic papers, and reports from many different sources such as news and socioeconomic analysis. Quantitative data is all numerical measurements that cover how much certain currency exchange rates have shifted and the percent correlation to that value in terms of bitcoin prices over the years. Quantitative data will be extracted from various financial history databases, primarily Yahoo Finance. The conclusions from the data analysis on quantitative data were compared with the thematic data correlating to bitcoin prices in a certain period to avoid bias towards factors other than currency exchange rates correlating with bitcoin prices. For example, we noticed Bitcoin prices had a sharp negative inverse with the USD's value diminished during COVID-19 from governmental actions like the stimulus checks (Divakaruni, A., & Zimmerman, P., 2022). Governmental intervention allowed us to identify a

factor other than currency exchange rate which significantly altered bitcoin pricing in the period 2020 - 2021 though the exchange rate and coin had similar trends. A key thing to note is that our currency exchange rates go against USD in this study as Bitcoin value is most easily measured using the Dollar.

Upon extracting our data from the financial history platform of y-finance we used the libraries of Matplotlib, pandas, and SciPy.stats to build our algorithm analyzing the financial data and provide us with a graph and correlation coefficient between two data sets. To further strengthen our findings we integrated a probability value, also referred to as "p-value", that represents if the results graphed and calculated were statistically significant. By doing so, we aimed to determine whether appropriate financial variables influenced the results or if they occurred solely by chance. This step mitigated the chances of obtaining a correlation value formed by chance rather than confounding variables. This algorithm was designed so that we could easily modify it to analyze any currency exchange rate against USD by simply changing the forex data Y-finance is accessing. We determined whether the correlation coefficient was weak or strong using the following inequalities.
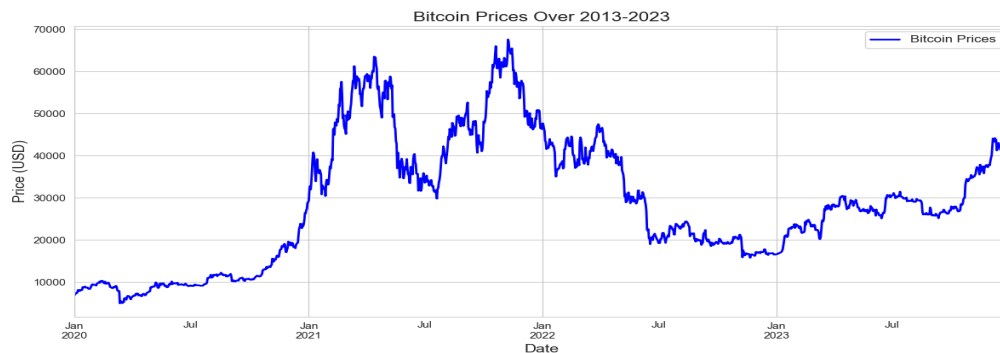
correlations <0.20 as **very weak**,
correlations between 0.20-0.39 as **weak**,
correlations 0.40-0.59 as **moderate**,
correlations 0.60-0.79 as **strong**, and
correlations >0.80 as **very strong**

Figure 1: Bitcoin prices from 2013 - 2023 and coefficient strength categories

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We started with deciding the currencies we were testing using our algorithm. This was done by compiling the top seven floating currencies in terms of value (Figure 2). (Groves, J, 2023) Our control for this experimental research was pegged currencies. The main question this paper is trying to answer is whether floating exchange rates, which are currencies that fluctuate freely according to market dynamics, correlate with the fluctuation of bitcoin prices. However, to mitigate bias we needed to involve currencies that do not fluctuate as freely to act as a control, these are known as pegged currencies. The pegged currencies(Figure 3) we are using for our control are all linked to the USD and did not have any significant fluctuations

for the past 5 years unlike our floating currencies used in the main experiment. The results were staggering as they showed how little these pegged currencies correlated to bitcoin prices.

Currency position (determined by value)	Currency	Country	Ratio to USD
Kuwait Dinar(pegged to basket so still allows fluctuations)	Kuwait Dinar (KWD)	Kuwait	0.31 : 1
British Pound	British Pound(GBP)	UK	0.8:1
Swiss Franc (CHF)	CHF	Switzerland, Liechtenstein	0.91 : 1
Euro (EUR)	EUR	20/27 countries that form the European Union	0.93 : 1
Singapore Dollar(SGD)	SGD	Singapore	1.35 : 1
Canadian Dollar(CAD)	CAD	Canada	1.37 : 1
Australian Dollar(AUD)	AUD	Australia, Kiribati, Tuvalu, Nauru, Christmas Island, Norfolk Island, Cocos (Keeling) Islands	1.51 : 1

Figure 2 - Top 7 floating currencies globally

Currency position (determined by value)	currency	country	Ratio to USD
(BHD)	Bahraini Dinar (BHD)	Bahrain	0.38 : 1
(OMR)	Omani Rial (OMR)	Oman	0.38 : 1
(JOD)	Jordanian Dinar	Jordan, Palestine, Palestinian territories	0.71 : 1

Figure 3 - Top 3 currencies pegged to USD as Control for the experiment

While extracting financial data we focused on a specified time range from 2019 to 2023. The algorithm calculates the correlation between these two datasets over time, employing Matplotlib for plotting time series data, which illustrates how the correlation evolves, providing a comprehensive view of the dynamics between the cryptocurrency and currency exchange rate. The addition of probability value is for the sole purpose of determining whether the correlation output was a number attained purely by chance. **A probability value of less than 0.05 allows us to determine that the correlation was indeed generated by patterns and otherwise, if it is more than 0.05.**

To delve a bit closer into how our algorithm provides us with a correlation coefficient and probability value based on the input currency (pegged or floating) from SciPy.stats, we will provide the equations used by the Pearson function to calculate the outputs (Figure 4).

1. **Compute the t-statistic:**

$$t = r\sqrt{\frac{n-2}{1-r^2}}$$

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

2. **Degrees of Freedom:**

$$\mathrm{df} = n - 2$$

r = correlation coefficient

x_i = values of the x-variable in a sample

$\bar{x}$ = mean of the values of the x-variable

y_i = values of the y-variable in a sample

$\bar{y}$ = mean of the values of the y-variable

3. **Two-tailed p-value:**

$$p = 2 \times (1 - \mathrm{CDF}(|t|, \mathrm{df}))$$

Figure 4 - Pearson correlation coefficient and probability value equations

The two data sets being checked for a correlation are the currency exchange rate and Bitcoin prices over four years. Before calculating the correlation, the function ensures that both datasets have matching indices (dates), realigning them if necessary. The algorithm (source code) removes any remaining undefined(NaN) values that might affect the calculation, ensuring that the correlation coefficient is based on clean and complete data to allow the proper calculation of the intended coefficient.

Data acquisition KWD:

Although the Kuwaiti Dinar is not officially a floating currency, it is linked to multiple currencies (none of which are USD) allowing room for more fluctuation with USD exchange rates, unlike the other pegged currencies maintaining a single exchange rate over a long period. The dinar was first introduced in Kuwait on April 1, 1961, and is used exclusively in Kuwait with a population of 4.3 million people. The Kuwaiti Dinar is the most valuable currency in the world currently worth 3.25 USD (May 2024).

The currency exchange rate of KWD to USD from 2019 to 2023 had a .**5267** correlation coefficient with fluctuations in bitcoin prices. This coefficient can be trusted as our probability value generated was **5.5275e-105**, well below 0.05 demonstrating statistical significance. Based on the correlation coefficient, probability value, and Figure 5 we can state the changes in exchange rates between KWD and USD **moderately** correlated with fluctuations in bitcoin prices during 2019 - 2023. Our thematic analysis found that the global slump in demand caused a crash in oil prices which contributed to the drop in Kuwait Dinar's exchange rate in 2020 as the economy is heavily dependent on oil. (Arezki, R., & Nguyen, H, 2020). This may serve as a limitation to our correlation coefficient for Kuwait specifically due to a factor other than the exchange rate, Oil prices drop, related to a slump in Bitcoin prices in 2020.
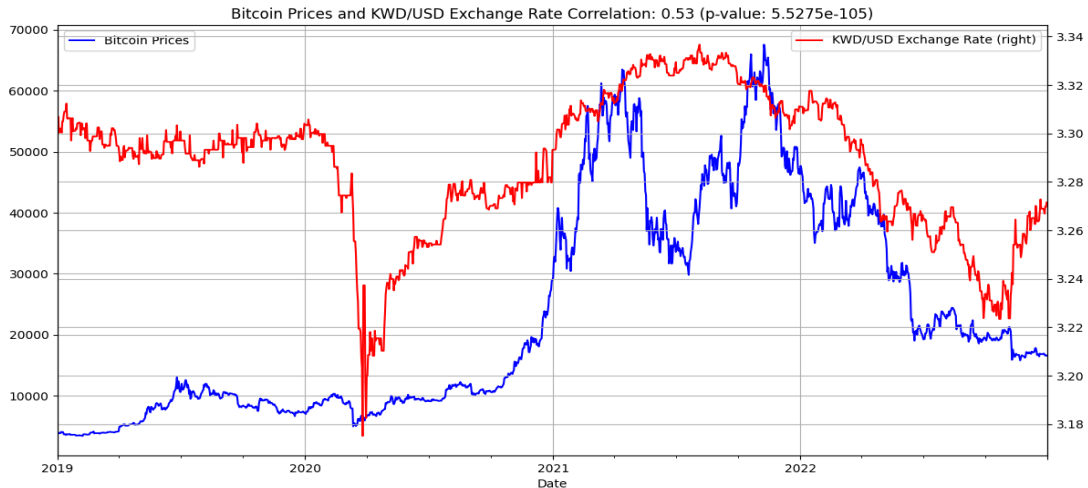
Figure 5: Bitcoin prices and KWD/USD exchange rates between 2019 - 2023

Data acquisition GBP:

The British Pound (coin format) was introduced in 1489 during the rule of King Henry VII. The Pound is the official currency of the United Kingdom(UK), and approximately 67 million people use it. The currency is completely floating and is currently worth 1.25 USD (May 2024).

High floatability makes the GBP a perfect candidate for our financial data analysis. Upon plugging GBP into our algorithm we received a correlation coefficient of .**5693** and a probability value of **3.6086e-126**. Due to this p-value being well below 0.05, we concluded that the correlation coefficient was an outcome produced demonstrating statistical significance rather than pure chance. Using the graph produced(Figure 6) and the strong p-value we concluded that the relationship between exchange rate fluctuations for GBP/USD and Bitcoin price fluctuations was **moderately correlated** during 2019 - 2023. Our thematic analysis for the GBP identified a limitation to our correlation coefficient as announcements about the risks of cryptocurrencies from the UK Financial Conduct Authority (FCA) influenced market sentiment and prices during 2021(Best, R. de, 2024). Negative public interest due to regulatory announcements in the UK correlates with Bitcoin prices in 2021. This limits our coefficient's argument as an element in the UK apart from exchange rates demonstrated a correlation.
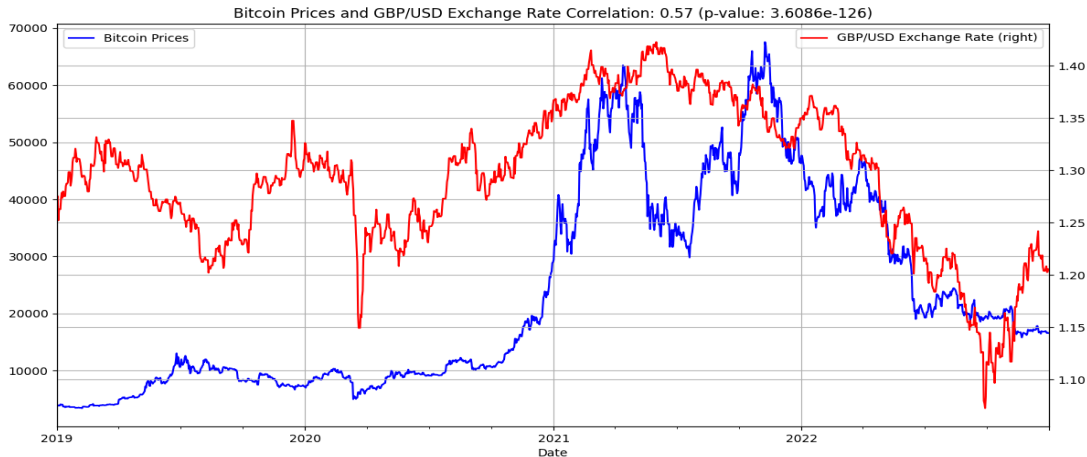
Figure 6: Bitcoin prices and GBP/USD exchange rates between 2019 - 2023

Data acquisition CHF:

The Swiss Franc was introduced in **1850** and currently circulates in Switzerland and Liechtenstein. It is used by approximately 8.8 million people(May 2024) and is currently worth 1.1 USD(May 2024).

Our algorithm generated a correlation coefficient of .**6245** with a probability value of **1.1038e-158**. CHF's exchange rate fluctuation showed a **solid correlation** with Bitcoin prices as the graph demonstrates the similarity between the two data sets. (Figure 7) The probability value is significantly smaller than 0.05 showing the CHF's strong correlation coefficient did not occur by pure chance backing the algorithm's output.

Our thematic analysis found no major Switzerland-specific economic factors correlating with Bitcoin prices between 2019 and 2023 other than general market trends and global cryptocurrency movements. From these results, we concluded the coefficient for Switzerland had no limitations.
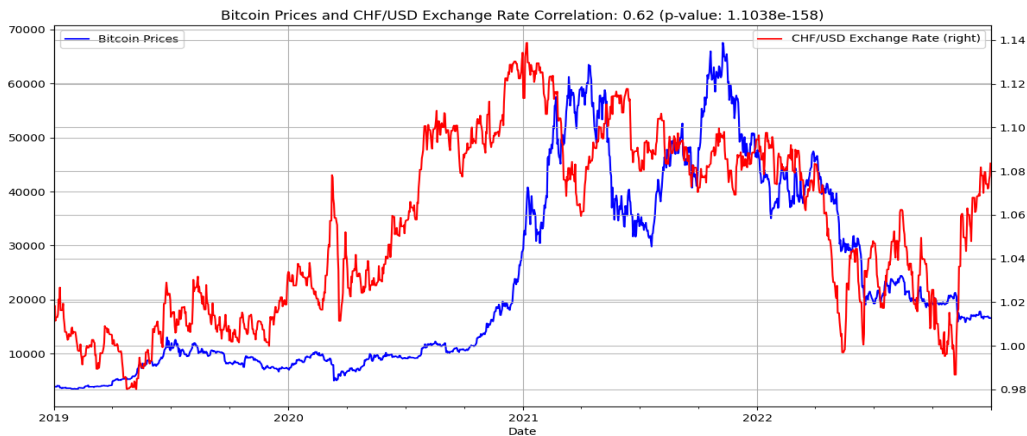

Figure 7: Bitcoin prices and CHF/USD exchange rates between 2019 - 2023

Data acquisition EUR:

The Euro was formed in 1999 and is the official currency of the Euro-zone, it is used by more than 343 million people as of 2023. Currently, each euro is valued at 1.08 USD(May 2024).

Our algorithm produced a correlation coefficient of **.3280** with a probability value of **5.8612e-38** showing statistical significance as this number is well below 0.05. The graph showed some relationships during the period of 2021 to 2023. (Figure 8) Based on the correlation coefficient being weak and the graph only having significant intersections after 2021 we concluded this demonstrates a **weak correlation during 2019 - 2023**. Our thematic analysis found another factor correlating with Bitcoin prices in the EuroZone during 2019 - 2023 as the European Central Bank implemented policies like interest rate decisions and quantitative easing measures. These policies caused negative investor behavior in the Eurozone leading to shifts away from riskier assets like Bitcoin after 2021 contributing to the fall of crypto value. (Bank, D, 2024)
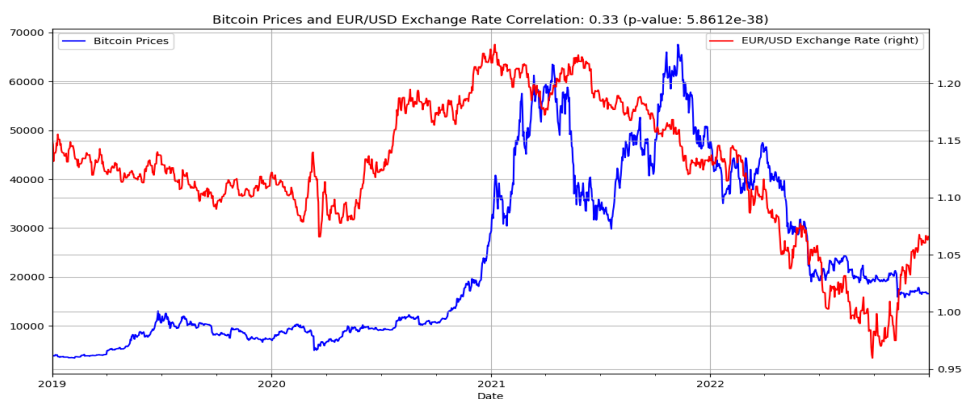

Figure 8: Bitcoin prices and EUR/USD exchange rates between 2019 - 2023

Data acquisition SGD:

The Singapore Dollar(SGD) was formed in 1967, managed by Singapore's Central Bank, and is used by about 6 million people. Since 1985, it has shifted and been pegged to an undisclosed basket of currencies not containing the USD. The SGD exhibits the characteristics of a floating currency, even though, it is controlled by the Monetary Authority of Singapore (MAS). (*Naga, N.D.*) The SGD is currently worth 0.74 USD (May 2024).

Our algorithm produced a **.45** correlation coefficient with a probability of **8.5614e-74** (Figure 9). These two showed a lot of correlation between 2020-2022, as both had an upward trend and followed each other on the descent(Figure 9). Based on the correlation coefficient and graph produced we concluded there was a **moderate correlation**. Our thematic analysis identified that the provision of guidelines for cryptocurrency given by the MAS has significantly impacted BTC. With the Payment Services Act of 2019, the MAS aimed to mitigate the risk associated with trading cryptocurrencies and helped make Singapore a hub for Bitcoin and blockchain-related technology investment. (Singapore, F. N, 2021) This shows the factor of increased public interest in the coin that correlates with Bitcoin prices during this period as they both grew in parallel.

Figure 9: Bitcoin prices and SGD/USD exchange rates between 2019 - 2023

Data acquisition CAD:

The Canadian dollar was introduced in 1858 and is exclusively used in Canada. The currency is used unofficially in Saint Pierre and Miquelon. Approximately 39 million people currently use the CAD's as of 2024. The CAD is valued at 0.73 USD (May 2024).

Our algorithm produced positive results as the CAD has a correlation coefficient of **0.79** and a probability value of **5.6605e-315.** These results were astounding as even the graph(Figure 10) showed heavy intersections between the two lines allowing us to conclude that exchange rates with the CAD/USD and Bitcoin prices **correlated strongly**. Our low probability value was another victory as these results were statistically significant because the value was much lower than 0.05. Our thematic analysis found no major factors other than the currency exchange rate in Canada correlating to Bitcoin price fluctuations.

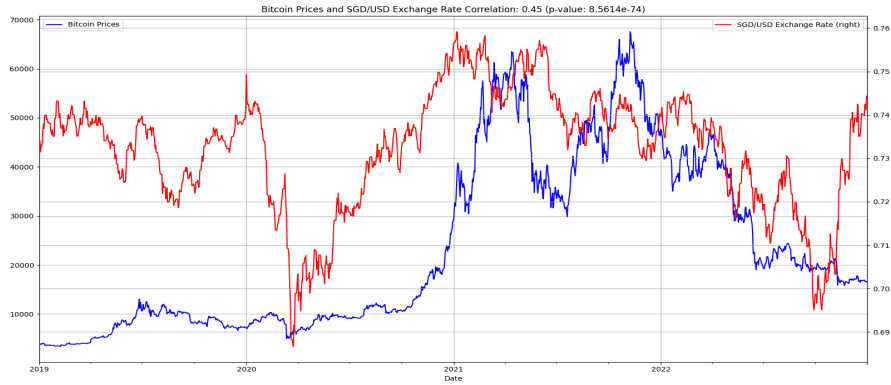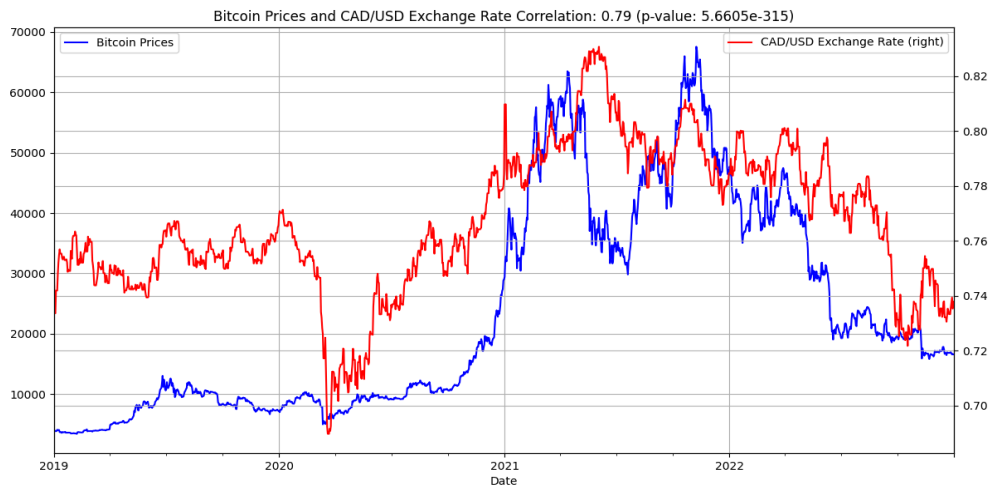

Figure 10: Bitcoin prices and CAD/USD exchange rates between 2019 - 2023

Data acquisition AUD:

The Australian dollar was introduced as a decimal currency in **1966** and is currently used in **Australia**, Kiribati, Tuvalu, Nauru, Christmas Island, Norfolk Island, and Cocos (Keeling) Islands and is currently valued at **0.66** USD(May 2024).

We acquired a correlation coefficient of **0.66** and a probability value of **2.4117e-176**. With these results and Figure 11, we concluded that the AUD/USD currency exchange rate and Bitcoin prices show a **good correlation** as the coefficient is between 0.5 and 0.7 and the graph shows a good amount of intersections in this period. Our thematic analysis for the AUD did little to go against the correlation coefficient as no other major events in Australia caused another factor to correlate with crypto prices.
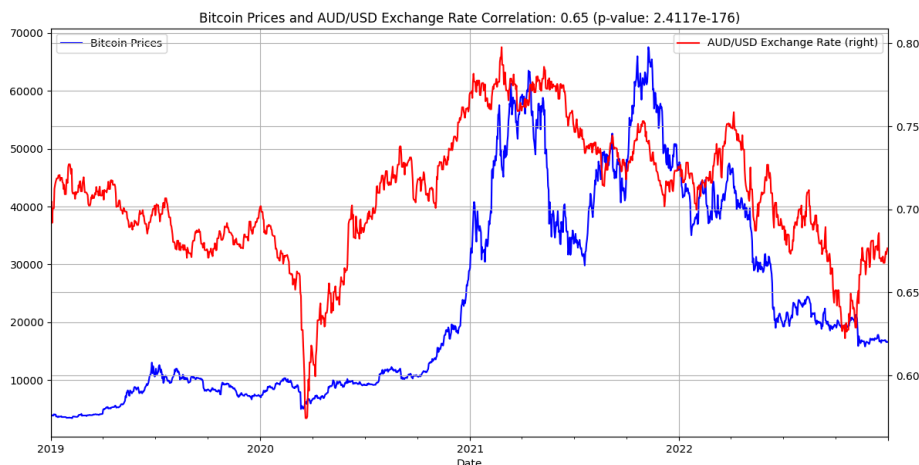
Figure 11: Bitcoin prices and AUD/USD exchange rates between 2019 - 2023

Now moving on to our control for this financial analysis, currencies pegged to the USD. We are using three currencies: BHD, OMR, and JOD, these are ordered in terms of value relative to USD(just like our main currencies being tested).
Data acquisition BHD:

The BHD (Bahraini Dinar) was established as the currency of Bahrain in **1965** and is exclusively used in **Bahrain** with a population of around **1.5** million people. The BHD is currently valued at **2.66 USD** (May 2024).

Our algorithm produced a correlation coefficient of **0.02** and a probability value of **0.39400**. The probability above 0.05 means the coefficient produced is not statistically significant further weakening the correlation between BHD exchange rate and Bitcoin prices. **Figure 12** shows the graph produced by the algorithm showing how little intersections these two data tables had between 2019 - 2023.

Based on the graph and coefficient we concluded that the correlation between BHD exchange rate and Bitcoin in this period was **very weak**. Upon conducting our thematical analysis we did not find any factors correlating with bitcoin prices from 2019 to 2023, this shows how little relevance the country of Bahrain has with Bitcoin prices.
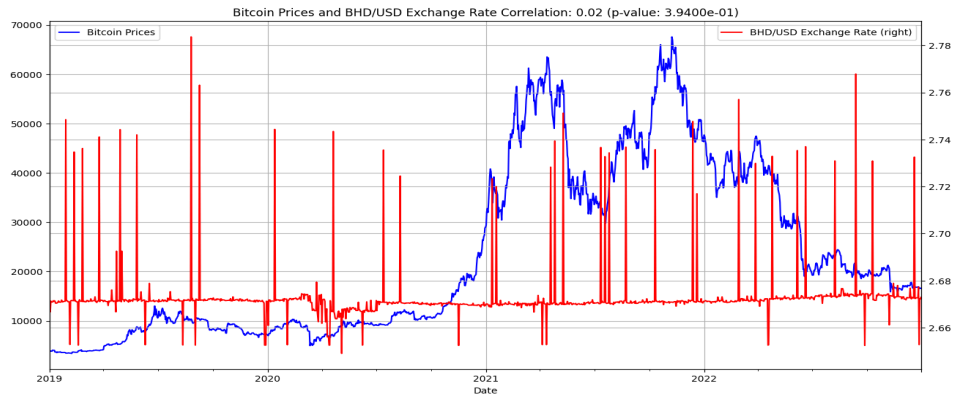
Figure 12: Bitcoin prices and BHD/USD exchange rates between 2019 - 2023

Data acquisition OMR:

The Omani Rial was formed in **1970** and is exclusively used in **Oman**. The currency is used by approximately **4.5 million (2022)** people and is valued at **2.6 USD(**May 2024). Our algorithm produced a correlation coefficient of **-0.03** and a probability value of **0.33813.** Based on the graph of OMR (Figure 13) showing **limited intersections**, a coefficient below 0.2, and a probability value **above 0.05** we concluded that the OMR exchange rate had a **very weak** relationship with Bitcoin prices. Upon conducting our **thematic analysis** we found crypto mining investment in Oman correlated with Bitcoin prices as both grew parallel to each other in 2023. Oman invested 1.1 billion dollars in Bitcoin mining infrastructure in August of 2023. Oman's licensed crypto-mining entity is predicted to go online within 2024. This investment decision in the crypto field was intended to reduce the economy's oil dependency. (Heaver, I, 2023) OMR pegged to USD did not allow for many fluctuations in currency value limiting the exchange rate correlation with Bitcoin prices. However, unlike Bahrain, Oman had some relevance to the cost of Bitcoin due to investments.
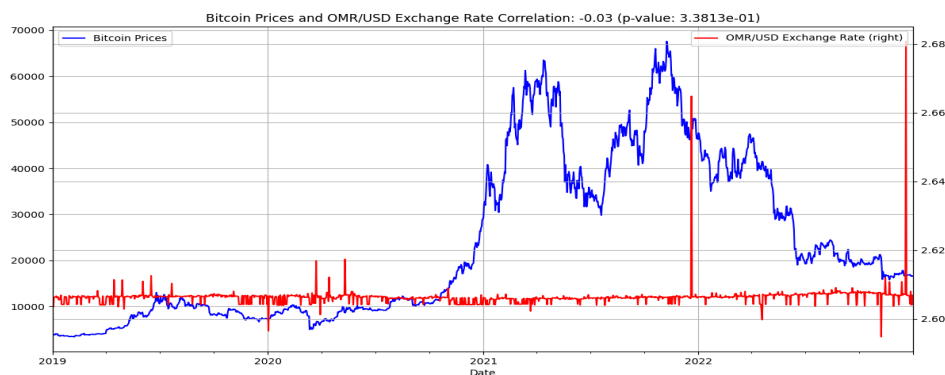

Figure 13: Bitcoin prices and OMR/USD exchange rates between 2019 - 2023

Data acquisition JOD:

The Jordanian dinar became the country's official currency and legal tender in **1950** and is currently used in **Jordan, Palestine, and Palestinian territories**. The JOD is used by about

16.3 million people as of 2022 and is valued at **1.41 USD** (May 2024). Our algorithm produced a correlation coefficient of **0.01** and a probability value of **0.75566.** The probability value higher than 0.05 shows the **lack** of statistical significance in the correlations. The coefficient below 0.2 and the graph showing very limited intersections of the two data sets allowed us to conclude that the JOD exchange rate and Bitcoin prices had a **very weak relationship**. The lack of fluctuation in JOD's value is shown in the graph as the currency's exchange rate is pegged to the USD. **Our thematic analysis** found the Central Bank of Jordan (CBJ) banned all cryptocurrency trading making Jordan irrelevant to the discussion of Bitcoin, nullifying the already weak results (Freeman Law, N.D.).
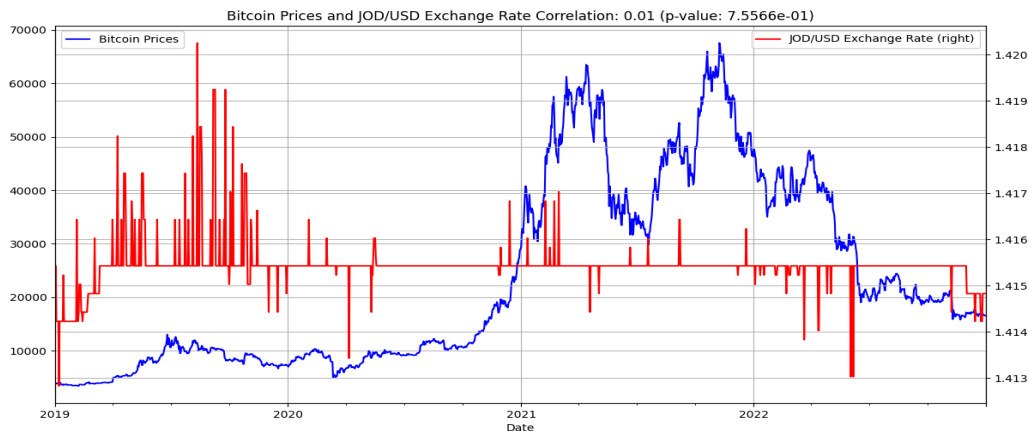
Figure 14: Bitcoin prices and JOD/USD exchange rates between 2019 - 2023

Quantitative Results:

Floating:

Country	Currency	Correlation Coefficient	Strength of Correlation
Kuwait	KWD	0.53	moderate
United Kingdom	GBP	0.57	moderate
Switzerland	CHF	0.62	strong
Eurozone	EUR	0.33	weak
Singapore	SGD	0.45	moderate
Canada	CAD	0.79	strong
Australia	AUD	0.66	strong

Control:

Country	Currency	Correlation Coefficient	Strength of Correlation
Bahrain	BHD	0.02	very weak
Oman	OMR	-0.03	very weak
Palestine Territories	JOD	0.01	very weak

Figure 15 - quantitative results

All floating currency **probability values** showed statistical significance (p-value below 0.05), while none of the pegged currencies' values did. These results confirmed our hypothesis that floating currencies' ability to fluctuate freely in global economics allowed for correlation with the rapidly changing Bitcoin prices, unlike the pegged currencies pinned to one value.

Discussion:

        The floating currency group (experimental group) had 3 currencies strongly correlating, 3 moderately, and one weakly as hypothesized. Our experimental group shows an overall moderate-strong correlation with Bitcoin prices conversely our control group shows a very weak relationship with no statistical significance. These findings contribute to our understanding that the global economy is interconnected: free fluctuating things always depend on factors like investor sentiment and supply/demand, unlike pegged currencies whose value is pinned down. This highlights the significance of global economics as we need to be cautious of the chain reaction problems occurring in society causing one economy to tumble after another. While investor sentiment and overall supply and demand are commonly discussed, specific factors like exchange rates have yet to be thoroughly examined for their impact on Bitcoin prices.

        Overall our research hypothesis was met, floating currencies showed a decent correlation with Bitcoin prices with statistical significance while pegged currencies did not contribute to our argument of interconnectedness in the global economy.

        Our study paves the way for further research on the pros and cons of pegging a national currency to the USD. Pegged currencies' stability prevents rapid exchange rate fluctuations, raising the question: Is it safer to peg or better to risk growth? Our study had two limitations in the analysis method. To avoid confusion we only used one testing function: the Pearsonr in Python. Though we used the probability value to highlight statistical significance, only one function usage may not resolve minuscule calculating errors. Another limitation is that we only analyzed the top ten currencies (value) which may cause some errors in generalization while discussing correlations as it may not transfer to Bitcoin relations in less affluent countries.

        Upon completing this study, we realized that economic decisions might rely on too many factors. Bitcoin prices, like housing and jewelry markets, depend on numerous variables. This interconnectedness has sparked past crises and may follow the same trend. Thus, we must ask: is this level of correlation beneficial or detrimental?

Source code:

```python
import yfinance as yf
import pandas as pd
import matplotlib.pyplot as plt
from scipy.stats import pearsonr


def fetch_data(symbol, start_date, end_date):
    """Fetch historical market data from Yahoo Finance."""
    try:
        data = yf.download(symbol, start=start_date, end=end_date)
        if 'Close' not in data.columns:
            raise ValueError("Fetched data does not contain 'Close' prices")
```

```python
        return data['Close']
    except Exception as e:
        print(f"Failed to download data for {symbol}: {e}")
        return pd.Series()

def check_data_completeness(data):
    """Check for any large gaps in the data and forward fill them."""
    if data.isna().any():
        print("Data contains missing values. Filling missing values...")
        data.fillna(method='ffill', inplace=True)
    return data

def calculate_correlation_and_p_value(data1, data2):
    """Calculate and return the correlation coefficient and the p-value between two datasets."""
    if data1.empty or data2.empty:
        print("One of the datasets is empty. Cannot compute correlation.")
        return None, None
    if not data1.index.equals(data2.index):
        print("Data indices do not match. Realigning data...")
        data1, data2 = data1.align(data2, join='inner')
    correlation, p_value = pearsonr(data1.dropna(), data2.dropna())
    return correlation, p_value

def plot_data(data1, data2, correlation, p_value):
    """Plot two datasets with the correlation and p-value in the title."""
    plt.figure(figsize=(14, 7))
    ax1 = data1.plot(color='blue', grid=True, label='Bitcoin Prices')
    ax2 = data2.plot(color='red', grid=True, secondary_y=True, label='JOD/USD Exchange Rate')

    ax1.legend(loc=2)
    ax2.legend(loc=1)

    title = 'Bitcoin Prices and JOD/USD Exchange Rate Correlation'
    if correlation is not None and p_value is not None:
        title += f': {correlation:.2f} (p-value: {p_value:.4e})'  # Changed p-value display to
scientific notation
    plt.title(title)
    plt.show()

def main():
```

```python
    btc_symbol = 'BTC-USD'
    forex_symbol = 'JODUSD=X'
    start_date = '2019-01-01'
    end_date = '2023-01-01'

    btc_data = fetch_data(btc_symbol, start_date, end_date)
    forex_data = fetch_data(forex_symbol, start_date, end_date)

    btc_data = check_data_completeness(btc_data)
    forex_data = check_data_completeness(forex_data.resample('D').ffill())  # Ensure daily
frequency for forex data

    correlation, p_value = calculate_correlation_and_p_value(btc_data, forex_data)
    if correlation is not None and p_value is not None:
        print(f'The correlation coefficient between Bitcoin prices and JOD/USD exchange rate is:
{correlation:.2%}')
        print(f'p-value: {p_value:.4e}')  # Use scientific notation for clarity on very small p-values

    plot_data(btc_data, forex_data, correlation, p_value)

if __name__ == '__main__':
    main()
```

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Yellow Face and Yellow Body: Rethinking Orientalism in the History of Hollywood By Wanjing Yasmine Shen

Abstract

In the history of theories, orientalism means cultural hegemony, which "seeks the West's spiritual and cultural control over the East" (Said). Under a Hollywood context presented in this essay, Orientalism points to a mechanism for describing Asia from a Western-centered perspective (How the West views the East). By citing Edward Said's definition of Orientalism, this essay explores Orientalism in Hollywood films throughout history in aspects of gendered characterizations and Techno-Orientalist imaginations. By specifically focusing on Orientalism in science-fiction films (such as *Cloud Atlas*), the essay summarizes and analyzes the characteristics of Asian elements in Hollywood sci-fi films. The author employs a methodology that includes both the generalization of several films and further detailed analyses of two films. It also values how Asian countries perceive the idea of Orientalism in Hollywood films nowadays. Eventually, the essay makes suggestions for Hollywood directors who wish to focus on Asian countries in their future films.

Introduction

Orientalism refers to fixed, fantasized, and fetishized view of a homogeneous Asia (especially East Asia) as ancient, mysterious, feminized, and backward. In today's globalization, cross-cultural communication has matured, and Hollywood films, as the leaders of the film industry, have long been infiltrating the spread of culture into their films. Western films have gradually opened up the Eastern market through the addition of Oriental elements, and shaped a series of films with their own cultural and spiritual kernel, which have been a great success in the global market (Li & Qu). However, nowadays Asian elements present certain stereotypes in western movies. "Manchuria," "lonesome," "barbaric," "cowardice," "Yellow skin, white heart" and other words that lead to the yellow peril theory are filled with semantic colors of violence and misery.

The Yellow Peril (also the Yellow Terror, the Yellow Menace and the Yellow Specter) is a racist metaphor that depicts the people of East and Southeast Asia as an existential danger to the Western world. In pre-World War II movies in Europe and America, "Asia" and "yellow peril" were inevitably linked together. In the 1890s, "yellow peril" was formally developed in Europe and gradually became a Western conception of the East. In the 1890s, the "yellow plague theory" was formalized in Europe and gradually became a Western discourse about the East. After the 1970s, Hollywood's Asian film themes have become more diverse and complex, with a large number of works on Christian salvation, love and conquest, social darkness and terrorism in Asian countries. However, under the influence of the Cold-War thinking, discrediting and vilifying Asia has always been the mainstream of Hollywood Asian-themed movies. Whether it is the cunning character Fu Manchu in the movie Dr. Fu Manchu, who is bent on taking over the West with ambitions and evil plans, or the great number of over-sexualized Asian women, it

seems that the image of Asians in the minds of the western public has already been framed in a bad light (Sun et al.). With the rise of cultural pluralism in the 21st century, these Asian images and elements are not the original Asian culture, and the Oriental elements are still unable to gain their own status, and must be subject to the domination and arrangement of the strong hegemonic culture.

Science fiction film *Cloud Atlas* (Lana & Lilly Wachowski, Tom Tykwer), released in 2013, counters rational totalization, focuses on individuality and self-concern against subjectivity and humanism, and replaces meta-discourse and grand narratives with uncertainty and mini-narratives. The cutting edge and acuity of its thought reflects the opposition to universalization and hierarchy, as well as the affirmation of difference and non-centrality. *Cloud Atlas* embodies an intellectual attitude that rejects essentialism and foundationalism, questions the myths of modernity, and exposes the inherent falsehood of rationality and humanism. In the dystopian future, the widening gap between the rich and the poor, coupled with the massive adoption of human cloning, makes it increasingly difficult for the poor to survive. Against this backdrop Sonmi-451, a clone waiter at the Song Kee restaurant in Shin-Seoul, joins the Resistance to resist the dirty clone production chain and the dark organization. But in the end, the plan falls apart, her lover is killed in action, and she herself is murdered.

In recent years, Techno-Orientalism has received increasing attention from researchers. Techno-Orientalism is one of the main metaphors representing Asia due to the rise of Japan in the 1980s and 1990s. The anti-utopian imagery was of an Asian-dominated future (a threat to white bourgeois heteronormativity and masculinity), with large corporations involved behind the scenes, represented by an evil extraterrestrial authority. This paper will analyze the representation of Orientalism and Techno-Orientalism in Hollywood films from 1950 to the present, locating and classifying the distorted Asian image with concrete examples.

I. Hollywood's distortion and prejudice towards Asian characters throughout the history

In his book *Orientalism*, Edward Said refers to "Orientalism" as part of his post-colonial cultural theory, and through a comprehensive study of Foucault's "discourse of power" and Gramsci's "cultural hegemony," he reveals that Orientalism is "a cultural hegemony that seeks the spiritual and cultural control of the West over the East" (Said).

In the twentieth century, the term Orientalism has been used to describe Western studies of the East in a negative sense, to the effect that scholars understand the Oriental world in the light of the imperialist views of the eighteenth and nineteenth-century Europe, or to refer to the old-fashioned and prejudiced understanding of Oriental cultures and humanities by outsiders. Orientalism is a mechanism for describing Asia from a Western-centered perspective, which is obviously not an objective view.

As early as the beginning of the 20th century, Asian characters have already been depicted in Hollywood movies. In the early portrayals of Asian/Asian American characters, most of them were described as dull and pedantic. In order to expand the difference between their own ethnic group and other images, these movies portrayed Asian characters in a negative light. *The*

Manchurian Candidate (John Frankenheimer, 1962), for instance, shows absolutely hostile North Korean soldiers in the movie. *The Killing Fields* (Roland Joffe, 1984) equally glorifies the invading team and makes the Vietnamese seem insignificant (Li & Qu).

In the history of Hollywood films, Asian characters in different historical periods have shown different and diverse character traits, but the mainstream ideological perspective is still attached to the inherent thinking and framework. In shaping and constructing the image of the East, "Orientalism" lingers. In Hollywood movies before World War II, "Orientalism" was inevitably associated with the "Yellow Peril Theory", which was formalized in Europe in the 1890s and gradually became a Western discourse towards the east. "Yellow Peril" viewed the yellow race as physically and psychologically weak and barbaric. The east was the representation of vulgar, violent, uncivilized, morally deficient, and childish. Under the continuation of this ideology, Hollywood was keen to imagine the Chinese as the "demonized other" who posed a threat to the white man. Scholars have argued that the yellow plague ideology is now re-configured in a techno-Orientalist imaginary, in which China is assumed to be the main enemy and threat, powerfully activates racial logic and racial influences, mediating multiple spheres of public health, technology and global trade (Siu & Chun).

1、Asian Male Characters

In order to make Western thoughts dominant, science is often used to support the knowledge of the ruling elite. Using the principles of biological determinism, the scholar J.P. Rushton claims in his article that penis size and sexual behavior are positively correlated with violence, and negatively related with intelligence (Sun et al.). In addition, there are significant racial differences: black males are the most sexualized, with the lowest IQs, and are prone to violence; Asian-Americans are the least sexualized, but the most intelligent, and the least violent; and white people are somewhere in the middle, as the most normal (Sun et al.).

Overall, Hollywood's historical positioning of Asian male characters has generally been about images that are more cunning, snobbish, and vulnerable, highlighting the powerlessness of Asian male characters. Two of the most recognizable Asian male figures in 20th century Hollywood films are Fu Manchu and Charlie Chan. As pointed out in "Fu Manchu and Charlie Chan: The Image of China in American Popular Culture" and "The Image of China in America," Fu Manchu is the embodiment of the "yellow peril" and the "evil dragon" of despotism, a criminal and a destroyer of social order (Fan). He has power and is the devil of Chinatown, but lacks sex appeal. This also fully demonstrates the position of Asian male identity in mainstream American society: Fu Manchu is a threat and an imaginary enemy that needs to be eradicated. According to JachinsonChan in his book *Chinese Masculinity - From Fu Manchu to Bruce Lee*, the powerful Fu Manchu is the de-empowering, lack of masculinity, cunning and snobbish man, and this feminization of Asian males is also a result of the Western strong and masculine culture's gender suppression and deprivation of ethnic minorities, gender suppression and dispossession (Chan).

During the Cold War and after, Hollywood has also made a number of movies narrating

Chinese characters as Cold War enemies, such as the first James Bond movie *Dr. No* (Terence Young) in 1962 and *Red Corner* (John Avnet) in 1997. In these movies, Asian male characters and China are still depicted as representatives of evil, despotism, and brutality.

Although the emergence of Asian actors such as Bruce Lee and Jackie Chan later seem to break the image of Asians as "thin, weak, and devious," Asian men are still perceived as lacking in sex appeal (Sun et al.).

2、Asian Female Characters

Generally speaking, throughout the history, Hollywood has over-sexualized Asian female characters. The image of Asian female characters is weak, reserved, withdrawn, easily controlled, who are protected by strong and masculine western male lover (Sun et al.).

If we say that Hollywood movies show Asian men only as "the outsider", then Hollywood movies' perspective towards Asian women is doubly "alien." In the representation of Asian female characters, Western movies have a strong Orientalist tendency in their portrayal. They are not only of low status, but also sexually seductive. Filmmakers tend to present Chinese women as "strange, subtle, soft, sensual and seductive playthings." (Sun et al.) They are strange and mysterious creatures that act to be kind and sacrificial. But this "goodness" is mainly expressed in the submissiveness to Western men: in the movie *Madame Butterfly* (Frederic Mitterrand, 1995), Cho Cho San, an Asian prostitute, gives birth to one child for her lover, Pinkerton, and then waits for Pinkerton's return. Years later, Pinkerton comes back to Japan with his wife, takes his sons away from Cho Cho San, and turns a deaf ear to her suffering.

The main reason for these stereotypes is that the creators of the film, under the influence of their times, insisted on using the East/West dichotomy as a starting point, resulting in a film that even though is less racist and insulting to the Orient than its contemporaries, is still a classic "Orientalist" film in our eyes today.

3、Narration towards the east.

The general narration of Asia as a whole in Western movies is backward and technologically underdeveloped. Asia's ignorance, backwardness, and repression were shown and exaggerated to the fullest extent (Rivera). Asian people in the movies at that time were even played by white people who dyed their skin yellow. Hollywood movies of the 70s and 80s imagined Asia as a depressing land, and the depiction of Asian people was quite stereotypical and simple. Westerners' imagination of Asia still largely remained in the imagination of the Cold War era, and the "Asian threat theory" remained largely dominant among the Western public opinion. Therefore, Hollywood movies reflecting the general views of the American or Western public presented a rather distorted and one-sided image of Asia.

While Hollywood films throughout the 20th century characterize Asian people in such a derogatory manner, the films produced in the 21st century point our attention to another aspect of orientalism that is ostensibly more positive — techno-orientalism.

II. Techno-Orientalism

1、Group-oriented

In Western science fiction movies, Asian characters are often thought to be group-oriented and collectivist, focusing more on interpersonal relationships than on individuals (Bergsten).

In collectivist societies represented by Asia, people hold a socially centered, interdependent self-concept in which individual interests and desires must be subordinated to social norms, duties, authority, and collective needs. This leads to a moral disposition characterized by acceptance of inequality, strict adherence to obligations and duties, and an embrace of authority. These various cultural dispositions are transmitted to individuals through society and constituting the general views of the world.

In collectivist groups, decision-making is impersonal and individual ingenuity is resisted. Individuality is based on relationships within the group, and a sense of "us" is developed. The values traditionally associated with Japanese culture are consistent with these collectivist characteristics. For example, the Japanese are known to be very concerned about their self-esteem, and they value interdependence, as well as the willingness to agree with the majority, or to follow organizational decisions.

Tracing back to its roots, Asian values are dominated by Confucianism. Confucianism emphasizes the maintenance of the existing inherently unequal social hierarchical structure, what anthropologist Fei Xiaotong calls the "differential order pattern," which is maintained by the traditional "rites" or "ceremonies". These units maintain this pattern of differential order.

Under the concept of collectivism, man and nature/ man and society can be regarded as a familial relationship, and the maintenance of the familial culture is the benevolence advocated by the Chinese people. The Chinese advocate the concept of benevolence, which means to love others. These Confucian principles have been profoundly elaborated and expressed in the sci-fi movie *2012* (Roland Emmerich, 2009). In *2012*, when the end of the world is approaching, people from all over the world are united, caring for and giving aid to each other, even sacrificing their lives. Specially, When a Tibetan old lady sees a fleeing family from the United States, she does not hesitate to ask her grandson to stop the car and save the American family, at the risk of being killed if she is delayed in boarding the ship. When the tsunami is about to hit the Ark, there are still many people from all over the world guarding the side of the boat instead of boarding. The people on the ship, after discussion, try to find a way to let all people get on board to share the same blessings and suffer the same hardships, rather than selfishly driving the boat away. This points to the Confucian concept of benevolence.

Further, *The 27th Day* (William Asher, 1957) depicts alien abductors testing the character of earthlings by providing five people with the ultimate weapon at the same time. There is a Chinese peasant woman who chooses to commit suicide in case she is used by the aliens. Her willingness to sacrifice her own life is in fact a choice that transcends race because she realizes that this is a matter of great importance to all the people of the world.

2、Asians are more likely to be controlled over

Western science fiction movies often assume that Asians are more easily controlled and weaker. Such prejudice is the result of multiple reasons.

The first reason is a historical one. In recent times, the vast majority of Asian countries with predominantly agrarian civilization have successively suffered from invasion or colonization by Western industrialized countries. Therefore, the West has a tradition of enslaving Asia, and in their consciousness, Asia is the object of enslavement. The second one is a cultural reason. The modernization of Asian countries is basically established by Western standards and models, which has caused Asians to look up to the West with a sense of frustration in their cultural psychology. Finally, it is the tradition. Most Asian countries and people oppose force and violence, advocate nonviolence and nonresistance, and tend to behave either as a moderate, or submissive and tolerant in front of the Western power (Huang).

Characters from one time period reincarnate into those of other times and different bodies throughout the six time periods covered in *Cloud Atlas*. With so many parallel storylines, a technologically advanced Asia makes an easy stand-in for the dystopian future (Nishime). Asian women clones who were created to work as waiters in a fast-food restaurant are the focus of the story. Their existence is pure slog. They consume the same box of liquid sustenance every day to sleep, work, and survive. Their lone ray of hope comes in the form of a yearly "exaltation" of a sort. The movie tells the tale of one clone, Sonmi-451 (Doona Bae), as she learns the true nature of her job, briefly flees from that constrained life, and ultimately consents to jail and execution.

Brightly colored tables and chairs in warm tones, an unrealistically clear blue sky, Asian-faced waiters with short hair, and the din of customers make up everything about Papa Song's restaurant. Underneath the futuristic backdrop, the customers treat the Asian-faced waitresses as sex slaves, scrutinizing them with dirty eyes, molesting them with words, even slapping their butts and laughing with disdain. Despite the waitresses' discomfort, they did not dare to resist, and abided by the first moral principle: "customer first". *Cloud Atlas* portrays a social logic that treats racialized bodies as prosthetic selves—disposable laboring avatars that inhibit white male subjectivity and must be abandoned for white females to transcend social barriers (Nishime).

Importantly, the Asian male protagonist Hae-joo Chang was played by a white actor, and at the end of this story, both Hae-joo Chang and Sonmi died. In another story which the two main white characters: Tild Ewing and Adam Ewing, were played by the same actors as Hae-joo Chang and Sonmi. However, this time, they play the role of a noble lady and an activist to save slaves, and end with happiness ever after.

By linking the final sequences of the two characters, the movie makes it impossible to avoid drawing comparisons between their outcomes. The scene changes between Tilda and Adam's encounter with Haskell and Sonmi-451's death in the final scene, which comes before the movie's brief epilogue. The movie cuts between different time periods to play Haskell's prediction that Tilda and Adam will be "spat on, beaten... lynched or crucified" over Sonmi-451's execution. She receives a shot to the neck , and the slow-motion process of her head falling back

is shown. When Sonmi-451 passes away, the camera cuts back to Tilda's face, allowing her fated Asian body to be reanimated as a white one.

Sonmi-451's racialized body is abused before being sacrificed in front of viewers. Tilda, on the other hand, experiences a more constrained type of liberation when she flees her father's oppression and follows her husband's ambitions. It seems as though the movie must reimagine the position through the body of a white lady since an Asian body cannot be imagined occupying a space of female empowerment.

Similarly, In *Wolverine 2* (James Mangold, 2013), Wolverine and Mariko lie calmly on a tatami mat in a Japanese-style room, with blue light, a symbol of lust, shining from the left side of the screen, a beautiful image that mirrors the picture of Sonmi-451 and Hae-joo Chang falling in love. At the same time, the pairing of "Western white male – Eastern yellow-skinned female" also adopts the same way of constructing racial and gendered power, with the male still taking the initiative in the narrative (Huang).

3、Cunning.

In Western science fiction movies, Asians are portrayed as cunning creatures based on the West's belief that the Asian race is inferior and disadvantageous compared to them.

In *Dune* (Denis Villeneuve, 2021), Yueh is a personal physician who serves the family of Atreides (similar to a Chinese herbalist or qigong physiotherapist). Dr. Yueh is a close and trusted teacher to the main character, Paul. However, inside his mind, Yueh is brooding, cold and cunning. Yueh makes five appearances in the movie. In the third time, Yueh appears to be delivering medicine and water to the young master Paul, but it is in fact sleeping pills, which leads to Paul's arrest by the enemy forces. In his fourth appearance, Yueh attacks his master, Leto, and carries out his devious plan. In order to save his beloved wife Wanna, Yueh betrayed the master Leto Duke, resulting in the destruction of almost the entire Atreides family. Being such a treacherous and selfish character, Yueh ultimately did not escape from the punishment of death.

Similarly, an Asian man in the elevator drinking Schwarzenegger's milk in *Transformers 3* (Michael Bay, 2011) left a deep impression on many viewers: wearing such archaic hairstyles, glasses, and pretentious bows; lewd expressions, misbehavior as well as cunning characteristics, in sharp contrast to the handsome, lanky, and tall European and American men in the film.

Conclusion

From Chinatown in LA to the samurai spirit (in the *Star War* series), Hollywood films have featured service robots in the restaurants, neon signs with Asian faces on and cold-blooded Asian killers. In the cyberpunk city, the audiences also saw how Asian culture has changed from yellow peril to a racial minority. Surprisingly, throughout the history of cinema, there have always been misinterpreted images of Asia and Asian people due to Western stereotypes of the East. This paper first lists and analyzes Orientalism in Hollywood films throughout the cinematic history, and its specific characteristics include: the cunningness and lack of sex appeal of Asian men; the

submissiveness of Asian women and the backwardness of Asia as a whole. Subsequently, going further into Techno-Orientalism, this paper discovers that Asian people in Hollywood science-fiction movies are mostly group-centered, easy to control, and cunning, which largely overlap with other genres produced in Hollywood. Such similarities show that the specific characteristics of Asian people are wrongly understood and presented by Hollywood movies as a whole. In addition, Asian elements in Hollywood science-fiction films are not only reflected in the movie itself, but also highly visible in Hollywood's remakes of Asian science fiction films, which is another area worthy of study. As people in Hollywood deepen their exploration of the Oriental culture, this mysterious land has produced unlimited reverie for them as they try to shift the point of view from the West to the East and localize the Asian films. However, the Western art is biased towards realism, while the Asian movies focus on something more abstract, such as the mood or the atmosphere. The forced fusion of the two cultures will only be counterproductive. Along with the declining innovation of science fictions, Hollywood producers began to adapt the science fictions from other countries, especially Japan (Zichuan). However, in the process of experimentation, a number of adapted sci-fi movies (such as the U.S. version of Godzilla, Ghost In The Shell, etc.) suffered a box-office fiasco. It has become difficult in the ways to inherit the ideas in Eastern sci-fi in a cross-cultural context and carry out the Western innovation, which is something that sci-fi movie producers in Hollywood need to ponder on. Meanwhile, the unsuccessful box office has also made Hollywood realize the commercial value that the Asian audiences can bring — Hollywood should not arbitrarily misinterpret Asian cultures. Now, the Asian people who have decided to recognize their identities will no longer tolerate Hollywood's stereotypical cameras on them.

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Ideal Human Trafficking Victims versus Reality: A Content Analysis of US-Based NGO Websites By Kaixuan Guo

Abstract

This project analyzes how a selection of United States (US)-based NGOs (non-governmental organizations) portray victims of human trafficking in the US by conducting a content analysis of their homepage photographs and key terms used to define victims of human trafficking. Content analyses of each NGO's materials are conducted to create individual victim profiles; they are then compared to a victim profile based on US federal human trafficking data from 2022, which approximates each profile's high-level accuracy in depicting the reality of human trafficking in the US.

This project finds that NGOs commonly depict the ideal victim as impoverished, undocumented, non-US citizen women who are involved in sex trafficking. Compared to federal data, these NGO representations align on victim gender and common vulnerabilities, but diverge regarding age, sexuality, citizenship, and trafficking type. These inconsistencies are most likely because federal data collection does not accurately represent all human trafficking experiences in the US, though there is the risk that inaccurate NGO portrayals are influencing how federal data is collected/categorized and vice versa.

This report concludes with the proposal that it may be productive to advocate for more fine-grained data collection on human trafficking victims beyond the limited scope of federal court cases to better assess the accuracy of NGO portrayals and suggest media revisions.

I. Introduction

Within Anthropology and Human Rights Studies, there are ongoing conversations as to how to best approach fundamental aspects of human trafficking. One debate is how to define the core concept of "the victim." In recent years, the topic of human trafficking has been receiving increasing attention in the United States (US). As non-governmental organizations (NGOs) are considered major actors within the realm of human rights work and key communicators with the public, it is essential to look at how they conceptualize human trafficking victims.

This project understands human trafficking as "a crime involving the exploitation of a person for labor, services, or commercial sex" ("Human Trafficking"). In 2000, the US federal government passed the Trafficking Victims Protection Act (TVPA), which emphasizes that "the recruitment, harboring, transportation, provision, or obtaining" as well as the "patronizing, or soliciting of a person" for the aforementioned purposes constitutes human trafficking "through the use of force, fraud, or coercion" ("Human Trafficking").

By conducting a content analysis of a selection of US-based NGOs' websites, this project analyzes how victims of human trafficking in the country are portrayed. Building on previous studies of human trafficking awareness campaigns conducted by scholars, including Erin O'Brien, this study looks at the definitional terminology and homepage images on the websites of three NGOs: Polaris Project, Freedom Network USA, and DeliverFund. Nils Christie's

analysis of the "ideal victim" (1986) and Judith Butler's framing of "grievability" (2021) are then applied to this data to establish each NGO's victim profile. These portrayals are then compared to a victim profile compiled from US human trafficking data from 2022 to approximate their accuracy.

As a preliminary investigation, this project finds that US-based NGOs tend to portray ideal victims of human trafficking as impoverished migrant women who are deceived into sex trafficking. Recent federal human trafficking data from 2022 indicate that human trafficking victims are equally minors and adults, female, trafficked for sex, and have common vulnerabilities such as being undocumented, living in unstable housing, and struggling with addiction. Comparing the ideal victim-type models, this study finds that NGO representations align with federal data when it comes to gender and victim vulnerabilities and diverge on age and legal status. Mapping the framing and representativeness of these NGOs' portrayals offers insight into whether NGOs should reconsider their communications. It also contributes to a clearer understanding of how victims are constructed as a social category and whether these constructions accurately reflect reality (Swedberg 186).

II. Background

Previous scholarship has begun to uncover problems in popular portrayals of human trafficking within the US. In their 2017 study on US media portrayals of human trafficking, Rachel Austin and Amy Farrell highlight a fundamental issue with how human trafficking is depicted. They argue that the US media misrepresents reality and that the impact of these misrepresentations is so extensive that it causes legislators and policymakers to propose less effective solutions to human trafficking issues (Austin and Farrell 1). This demonstrates one of the risks of incorrect popular framings of human trafficking. According to Austin and Farrell, due to the implementation of the TVPA and other laws, human trafficking is framed as a crime issue by the international community as opposed to a human rights issue. They propose that framing human trafficking as a crime issue that targets young white women resonates with the public and places attention on individual perpetrators, which ignores the complex reality that involves many other underlying problems such as "globalization, migration conditions, the status of women, and poverty" (4). Such overly simplistic depictions of human trafficking as a crime issue were less likely to encourage audiences to propose solutions, compared to depictions of it as a human rights issue, which encouraged better legislation and increased awareness (5).

It is important to acknowledge that, according to multiple studies, the goal of the popular media's framing of human trafficking as a crime issue is not to encourage the public to take action. Instead, the intention is to garner sympathy from the public. If a solution is proposed from this approach, it is usually related to law enforcement and crime control (Johnston, Friedman, and Shafer; Johnston, Friedman, and Sobel). Austin and Farrell argue that human trafficking is, in reality, a multifaceted issue that involves many factors that necessitate specific solutions (4-5). Whereas the aforementioned studies pay close attention to the popular media framing human trafficking as a crime issue, this project argues that US-based NGOs tend to

portray human trafficking as a human rights issue in their online publications, which engage in specific narratives about victimhood that have a unique history.

In *After Evil: A Politics of Human Rights,* political historian Robert Meister argues that there was a post-1989 normative shift towards ethics in political discourse. He asserts that ethics has replaced politics in the human rights discussion. The "nomos" of the Earth has become human rights discourse, which transcends politics and focuses on individual human suffering (Meister 1-2, 41). The rhetoric of preventing the suffering of victims and making human security the global priority emphasizes a domain of intervention that transcends any specific, regional politics and focuses on the international community. Therefore, a fundamental distinction can be made between NGO portrayals of human trafficking and those of the popular media. While NGOs are also participating in the mass media coverage of human trafficking, NGOs largely frame human trafficking as a human rights issue, not a crime issue. The main purpose of NGOs, according to political scientist Erin O'Brien, is to educate the public and allow them to gain a comprehensive understanding of the underlying issues behind the proliferation of human trafficking and incentivize them to take collective action through the use of human trafficking origin stories (1). This aligns with Austin and Farrell's argument that portrayals of human trafficking as a human rights problem more accurately cite the issue's root causes, which can also encourage more accurate solutions (5).

While the underlying intentions of framing human trafficking as a crime issue and a human rights issue are different, both framings rely on the creation of an "ideal" victim. This concept is defined by Nils Christie as "a person or a category of individuals who – when hit by crime – most readily are given the complete and legitimate status of being a victim" (12). Christie supplies a set of criteria that determines whether a person is granted this status: "The victim is weak," is "carrying out a respectable project" at a place they "could not possibly be blamed for being," and is "powerful enough to make [their] case known" after they are harmed (12,14). Erin O'Brien takes up Christie's ideal victim in her studies on human trafficking.

In O'Brien's 2013 study on human trafficking awareness campaigns, she observed that campaigns are often restricted to minimal space and must maximize text and images to efficiently capture viewers' attention. Common methods in static awareness campaigns include flyers, billboards, and social media posts. This poses a significant challenge for NGOs because these awareness campaigns are the primary method by which they educate the public about who the victims of human trafficking are (O'Brien 3). Although the text and images are perhaps effective in communicating the significance and severity of human trafficking, they do not have the room to capture the nuance and complexity of this prevalent global issue (2). Over time, a certain type of ideal victim image becomes commonly used for these awareness campaigns, and it is that image of human trafficking that becomes perpetually ingrained in the mind of the public and is considered most deserving of receiving attention and sympathy. While attempting to advocate for all victims of human trafficking, O'Brien finds that NGOs are either consciously or unconsciously placing victims on a hierarchy from most worthy to least worthy of protection, where victims in a certain sphere determined by their age, gender, class, and legal status are

deemed more important, while victims who do not fit within these categories are excluded (2-3). The main victim profile that O'Brien found through the studies is the portrayal of the "innocent and blameless" victim as a "young woman or girl" who is "trafficked for sexual exploitation" (3, 5, 8).

There is a wealth of similar studies to that of O'Brien's that show that the popular media and human trafficking prevention organizations commit most of their attention to female sex trafficking victims rather than other genders and trafficking types (Cockbain and Bowers 10); that victims in campaigns are women portrayed "as objects of male violence… positioned within the spaces of the home and the nation" (Andrijasevic 26); and that NGOs' categorizations of human trafficking victims do not align with legal categories used by the state, though they ought to (Andrijasevic and Anderson 153; Anderson and Davidson). This scholarship suggests that the ideal human trafficking victim is a highly gendered, moralized, and racialized category. These victims are curated in such a way in these campaigns in order to elicit maximum empathy and engagement from the public. A successful awareness campaign may, according to some researchers, be detrimental to preventing human trafficking.

In her 2015 study, Edith Kinney argues that the image of human trafficking presented in popular media creates expectations for how human trafficking should be handled and influences the way that government actors respond to human trafficking cases. For example, studies on victim identification indicate that when judges, prosecutors, and police encounter a person who does not fit the expected profile of a human trafficking victim, they are often hesitant to recognize these individuals as victims at all (Farrell, McDevitt, et al.; Farrell, Owens, et al.). This illustrates one of the negative effects of media framings of human trafficking.

The previously discussed research highlights a paradox within NGO anti-human trafficking campaigns: while these initiatives seek to inform and empower, they may inadvertently reinforce detrimental stereotypes and inaccurate representations of human trafficking victims. This study investigates whether current NGOs that are relevant to human trafficking discourse also perpetuate a similar ideal victim figure. Do US-based NGOs employ similar strategies in their anti-human trafficking initiatives? Are they unintentionally reinforcing harmful narratives about who human trafficking victims are?

This author seeks to answer these questions and to incorporate Judith Butler's concept of "grievable" life into what makes an ideal victim of human trafficking. Butler writes that people who are "valuable" in society are those who are depicted as "vulnerable," which makes them easy to grieve when they are harmed (Butler 177, 185–86). The loss of these people who are deemed "grievable" is hard to accept and would spark shock, anger, and outrage. If the "grievability" of these individuals were acknowledged while they are still alive, there would be policies created to protect them in efforts to prevent their potential loss because their lives are publicly regarded as more precious (186). This project proposes that the categorization of "grievable" connects to the "ideal victim" type. In the below analyses of NGOs' web content, this project considers how victim grievability is mobilized, à la Butler.

III. Methodology

This project examines the homepage photographs and key terms used to describe victims of human trafficking and vulnerable populations of three different US-based NGOs' websites. The materials analyzed include content from Polaris Project, Freedom Network USA, and DeliverFund because they are the leading organizations that appear in Google search engine results for "US anti-human trafficking NGO" as of February 2024. Since these websites have a more immediate online presence, this project illustrates that they have a comparatively greater chance of being accessed by the US public and, thus, have a larger influence on public understanding of human trafficking.

Content analyses of these digital materials are conducted in order to understand how each organization defines victimhood and the implicit assumptions about the ideal victim type they create. The content analyzed consists of textual and visual depictions of victims. In order to compare similar data, this project focuses on home page imagery and written information on each NGO's tabs that can be generally categorized as offering descriptions of human trafficking and victim types (e.g., "About Human Trafficking" or "Defining Human Trafficking" articles). The homepage imagery is exclusively analyzed because these pages serve as the initial visual stimuli that viewers are exposed to when they first open the website.

Key commonalities across the depictions of age, gender, race, vulnerabilities, legal status, and trafficking type are observed, indicating the construction of an ideal victim type in each NGO. These ideal victim types are then compared to a 'baseline' human trafficking victim that was created from 2022 US human trafficking data. These comparisons are done in order to assess the approximate accuracy of each NGO's portrayal of victimhood.

IV. NGO Content Analysis

IV.I. Polaris Project
Key Terms and Description

The Polaris Project (referred to as Polaris moving forward) splits its "Understanding Human Trafficking" webpage into two parts: the first section addresses the victims of sex trafficking, and the second addresses victims of labor trafficking (*Understanding Human Trafficking - Polaris*). When referring to both labor and sex trafficking, Polaris states that "anyone can be trafficked," but adds that there is an added degree of susceptibility for certain types of people because they have specific vulnerabilities (*Understanding Human Trafficking - Polaris*). The page subsections "Sex Trafficking: the Basics" and "Labor Trafficking: The Basics" detail that people might be at risk of being trafficked if they: have "unstable housing," experience domestic violence, have a caregiver or family member with a substance abuse issue, are runaways, involved in the juvenile justice system, or the foster care system, are undocumented migrants, are facing poverty or are in need economically, have experienced sexual abuse, or are addicted to drugs or alcohol.

Polaris's "Myths, Facts, and Statistics" page discusses popular assumptions about populations that are vulnerable to being trafficked, combating "myths" with "reality" statements.

For example, the myth "Only women and girls can be victims and survivors of sex trafficking" is followed with the reality statement "LGBTQ boys and young men are seen as particularly vulnerable to trafficking." Whereas the textual content complicates victim descriptions, Polaris's landing page imagery seems to undermine this approach.

Home Page Image(s)

　　　At the time of this analysis (December 2023), the homepage of the website features a singular, large, full-screen image depicting a young, ethnically ambiguous woman wearing an ethereal white dress (see Figure 1). She is walking alone on a path confined between two walls, and the image filter is dark and heavily saturated, conveying an ominous story of a pathway with no exit.

General Victim Profile

　　　Based on the terms and images used by Polaris to characterize victims, the people who are prone to be trafficked are generally framed as members of minority groups. As stated by Polaris, the groups of people who are "most vulnerable" include "people living in poverty or in unstable housing situations, people with a history of trauma or addiction, [...] people of color, immigrants, people who identify as LGBTQ+, [...], people involved in the child welfare system and being a runaway or homeless youth" (*Understanding Human Trafficking - Polaris*). While Polaris makes an effort to debunk the myth that victims of human trafficking are always female, the usage of the term "particularly vulnerable" to describe "LGBTQ boys and young men" suggests that there is another group of people that fits within Polaris's categorization of what constitutes the ideal victim type. This categorization demonstrates the perpetuation of the notion that minors and younger people are the victims of human trafficking. The statement that human trafficking victims are not always female juxtaposes the image of a woman wearing a dress that encompasses the entirety of the website's homepage. If women and girls are not the only victims of human trafficking, why is the first image that viewers see on an anti-human trafficking website the image of one singular woman? According to this author, such an image communicates stereotypical conceptions of femininity, youth, beauty, and delicateness that align closely with ideal victim types, as found in previous studies.

Polaris Project Ideal Victim Type Summary	
Age	Young
Gender	Female
Sexuality	LGBTQ+
Ethnicity	People of Color
Legal Status	Undocumented Migrant; Non-US Citizen
Economic Group	Low-Income
Grievability Factors	Prior Abuse; Addiction; Unstable Housing
Most-Discussed Trafficking Type	Equal Sex and Labor Trafficking Split

Table 1

IV.II. Freedom Network USA

<u>Key Terms and Description</u>

On its page "The Issue," Freedom Network USA provides detailed descriptions of what both sex and labor trafficking may look like, rather than offering rigid definitions. Because of this open-ended approach, the information provided directly by the NGO is vague and generalizable. In response to the overarching question, "Who are victims of human trafficking?" Freedom Network USA reiterates that all people can be trafficked no matter what population they belong to, including non-stereotypical groups like "men, boys, older persons, and US citizens." The webpage then obliquely says that certain categories of people are "made disproportionately vulnerable" to being trafficked due to discrimination and stigmatization for being LGBTQ youth, being disabled, having an "unlawful immigration status," experiencing poverty, and having undergone violence before, such as child abuse and sexual assault ("The Issue: What Are the Signs of Human Trafficking?").

The subheading "Labor trafficking may look like…" describes the situation as follows: "When workers are trapped and feeling like they have to keep working for someone even if they don't want to" ("The Issue: What Are the Signs of Human Trafficking?"). In addition, the site qualifies that various situations involve labor trafficking, and the circumstances surrounding the trafficked victim are different for all victims. To further elaborate on the situation faced by labor trafficking victims, Freedom Network USA states that they "can be working alongside non-trafficked workers in legal jobs, work under the table or for no pay in legal businesses, or be forced to commit criminal acts that benefit someone else" ("The Issue: What Are the Signs of Human Trafficking?").

According to the Freedom Network USA, these populations primarily consist of immigrants regardless of legal status, but certain US citizens are also vulnerable ("The Issue: What Are the Signs of Human Trafficking?"). The website does not specify who constitutes "vulnerable US Citizens," but is it presumed to be people who exhibit the signs or "common red flags" of human trafficking (as provided on the website): "signs of abuse, malnourishment, exhaustion, or fearfulness;" "not being paid, being paid very little, or is working excessive hours or in dangerous work conditions;" "not allowed to leave home or premises or is closely supervised and restricted in movement;" "does not have access to personal documents such as ID, passport, visa, or social security card;" "under 18 and is working in the commercial sex industry" ("The Issue: What Are the Signs of Human Trafficking?").

For the definition of sex trafficking, the website highlights that "When a minor (under 18) is given anything in exchange for any sex act OR when an adult (over 18) is trapped or forced into commercial sex by someone else," it is a form of trafficking ("The Issue: What Are the Signs of Human Trafficking?"). The website indicates that due to sex work being illegal in the United States, victims often refuse help and protection and that both immigrants and US Citizens are equally as likely to be the victims of sex trafficking.

Whereas the NGO consistently uses generalizable language and does not commit to a firm categorization of victimhood, the content it includes from third-party sources reveals

underlying assumptions about victim identity. Under the definitions of labor and sex trafficking, there are examples of human trafficking cases in the form of articles published by news outlets such as *PBS* and *The Counter*, as well as government sites like the U.S. Department of Justice (see Figures 2 and 3). The keywords mentioned in the titles of these articles about labor trafficking demonstrate clear identity categories, such as: young (age), immigrants (legal status), non-citizen (legal status), adult (age), and woman (gender) (see Figure 2). As for the articles about sex trafficking, keywords featured include the following: minors exploited/sex trafficking of minors (age), women (gender), and substance addiction (disorder) (see Figure 3).

Additionally, Freedom Network USA exhibits a set of charts titled "Trafficking by Gender and Type" (see Figure 4) with data collected from the *2022 Freedom Network Member Report*. The demographics of the trafficked individuals presented indicate that labor and sex trafficking cases are almost equally prevalent, accounting for 37% and 42%, respectively. Additionally, the majority of victims are adults as opposed to minors. Lastly, the statistics show a significant gender disparity, with 74% of females trafficked compared to only 22% of males ("The Issue: What Are the Signs of Human Trafficking?").

Home Page Image(s)

The homepage of the Freedom Network USA (see Figure 5) includes a large image featuring four women of different ethnicities and ages dressed in business clothing and holding signs that say, "Every Survivor Counts" and "Justice. Safety. Opportunity" while smiling. Given the page's accompanying information promoting attendance for its 2024 professional conference, it is likely that the photograph is of past conference attendees. This imagery suggests that the NGO is drawing attention to creating an ideal type of anti-human trafficking advocate on its main page, which is markedly gendered and professionalized, rather than communicating what victimhood looks like.

Due to the lack of victim-associated imagery on the home page, this author analyzed the only image included in the context of victim descriptions on its "About Human Trafficking" page (see Figure 6). In line with the web page's noncommittal textual content, this photograph depicts agricultural laborers working who cannot be easily categorized by age, race, or ethnicity, though two workers whose faces are visible appear to be male. By choosing to depict labor trafficking and using a photo in which victim identities are ambiguous and open to interpretation, Freedom Network USA reiterates its overarching message that anyone can be trafficked and gently goes against classic trafficking victim stereotypes.

General Victim Profile

Though Freedom Network USA overarchingly avoids strong commitments to a victim type, through its inclusion of certain news sources and statistical data, it is possible to determine a general victim profile to which it subtly commits more attention. The victims that Freedom Network USA most often presents to the viewer are young, females, immigrants, non-citizens,

vulnerable due to previous addiction or economic instability, and nearly equally trafficked for sex and labor.

Freedom Network USA Ideal Victim Type Summary	
Age	Young
Gender	Female
Sexuality	LGBTQ+
Ethnicity	N/A
Legal Status	Undocumented Migrant; Non-US Citizen
Economic Group	Low-Income
Grievability Factors	Prior Abuse; Addiction; Disability
Most-Discussed Trafficking Type	Equal Sex and Labor Trafficking Split

Table 2

IV.III. DeliverFund

Key Terms and Description

The "Human Trafficking Awareness" page of the DeliverFund website provides statistics about the percentage of human trafficking victims who are children compared to adults. This fact aims to debunk the myth that children are the main targets of human trafficking. According to the website, only 25% of all human trafficking involves children out of the 40 million victims globally. Conversely, the website states that data sourced from the *2020 Federal Human Trafficking Report* has shown that the number of child victims of sex trafficking cases in the United States rose significantly over the course of a year and has surpassed the number of adult victims ("DeliverFund | Together, We Can End Human Trafficking in the US").

On the homepage, a subheading encourages the viewer to "Join our community to protect women and children," indicating that the organization believes the women and children are the victims of human trafficking, a belief that is further reinforced by statements such as "96% of trafficked victims are female" and the majority [trafficking victims] are females, trafficked for sexual exploitation" ("DeliverFund | Together, We Can End Human Trafficking in the US"). DeliverFund urges the reader to "recognize red flags and possible indicators" of human trafficking such as signs of abuse and poor living conditions. DeliverFund also states that victims of child trafficking are likely to have run away from their homes or are currently situated within the foster care system.

While DeliverFund asserts anyone can be trafficked, it underlines that certain groups of people make up the majority of human trafficking cases. The NGO lists the following groups as at higher risk of being trafficked: homeless youths and runaways, youths in and out of foster care/juvenile facilities, people struggling with substance abuse or mental illness, recent migrants (especially those who do not speak the local language), survivors of violence, and those "with little to no recognized or upheld civil rights" ("Know the Signs of Human Trafficking").

Home Page Image(s)

The homepage of the DeliverFund website (see Figure 7) features icons to represent the usage of technology to track down human traffickers. The background features an out-of-focus image of a person in handcuffs. By depicting a vague perpetrator rather than a victim on the main page, DeliverFund conveys a message to site visitors that there is a need to pay attention to traffickers and more clearly reveals the ambiguous danger.

Due to the lack of victim-associated imagery on the NGO's main page, this study includes the main image from the secondary page, "Stories from Survivors" (see Figure 8). At the center of the page, there is what seems to be a teenage girl hunched on a bench in a light-colored, youthful dress. Her long dark hair covers most of her downcast face, but the blue filter and her shrunken posture communicate vulnerability and somberness.

General Victim Profile

While the images on the home page of the DeliverFund website do not provide information regarding the types of individuals that the organization believes to be victims of human trafficking, the statistics supplied by the organization, the characteristics of the described victims, and the signs of human trafficking all pertain to a particular victim type. The human trafficking victim that DeliverFund portrays is a poor female migrant who has been subjected to unstable housing, has a mental illness and/or struggles with substance addiction, and has undergone past abuse.

DeliverFund Ideal Victim Type Summary	
Age	Equally Youths and Adults
Gender	Female
Sexuality	N/A
Ethnicity	N/A
Legal Status	Undocumented Migrant; Non-US Citizen
Economic Group	Low-Income
Grievability Factors	Prior Abuse; Addiction; Disability; Unstable Housing; Mental Illness
Most-Discussed Trafficking Type	Sex Trafficking

Table 3

V. NGO-US Data Comparative Analysis

United States (US) human trafficking data was used in comparison with the victim profiles demonstrated on the websites of the three NGOs to assess the accuracy of victim portrayals. While the data is sourced from the most recent *2022 Federal Human Trafficking Report* (FTHR) provided by The Human Trafficking Institute, an organization associated with the US government, it is crucial to address the many limitations associated with the use of this data. Firstly, the data shown by this report only reveals public information "relating to human trafficking cases filed in the federal court system" (*2022 Federal Human Trafficking Report* 50). Due to this limitation, the 2022 FHTR explicitly states that "like all the data presented in the FHTR, it is inaccurate to use the following information as a reflection of the prevalence of

victims in the United States or to extrapolate demographic trends to victims beyond those named in federal prosecutions" (34). As a result, the data range does not represent the number of people who were trafficked during the year 2022, only the number of cases filed in federal court.

It is important to note that there is a difference between how human trafficking victims are popularly defined by different NGOs to inform the public and how they are differentially defined as an "administrative category" in legal actions by the US government (Andrijasevic and Anderson 153). This could further accentuate the discrepancy between who NGOs perceive to be a victim of trafficking and what is depicted in government data. Therefore, when comparing NGO victim profiles and US federal human trafficking cases, it is essential to recognize that the data presented as well as the categorization of victims are potentially not perfectly aligned with how NGOs categorize and qualify an individual as a victim of human trafficking. The NGO victim profiles created are only compared with the most recent FHTR from The Human Trafficking Institute. All NGO data used to create each victim profile are not separated by source or year of publication, as all data are currently published on each NGO's websites as of the time of this project's analysis.

With the limitations of this comparative analysis in mind, the identity categories indicated in the 2022 FHTR were compared to the same categories present in NGO victim profiles. Due to the small sample size, the data is not statistically significant, leading to multiple categories having inconclusive results. For example, for age, out of the 363 new cases of human trafficking filed in 2022, 34% (122) of the victims were minors, 39% (141) of the victims were adults, and the age of the remaining 28% (100) of victims is unknown. As for gender, females comprise 66% (238), males comprise 4% (13), and 31% (112) are unknown (*2022 Federal Human Trafficking Report* 35). However, even though the gender of 112 victims is unknown, assuming that all 112 are male, it is nevertheless a smaller number than the 238 females. Therefore, it can be assumed that female trafficking victims make up a larger portion of overall legal cases filed.

The 2022 FHTR provides data regarding victim vulnerabilities. Out of all total vulnerabilities, unstable housing (runaway, foster care, homeless), addiction, and lack of legal status are stated as the most prevalent (*2022 Federal Human Trafficking Report* 43). For additional context, the victim vulnerabilities were collected from 13% (16 of 122) of minor victims and 13% (18 of 141) of adult victims (*2022 Federal Human Trafficking Report* 42). As for legal status, there was not enough information given to know for certain the nationalities of the victims. The category of U.S Citizens or Nationality Unknown constituted 93% of all victims, while known Foreign Nationals comprised only 7% of victims (50).

Lastly, in the new human trafficking cases of 2022, 96-97% of cases were sex trafficking cases while only 3-4% were labor trafficking cases, clearly indicating that prosecuted sex trafficking cases outnumber labor trafficking cases. Due to the sample size, there is not enough data to confidently provide an accurate depiction of human trafficking demographics in the United States, using the federal court cases filed (35). Hence, because no other sources of government human trafficking data are made available to the public, this study must utilize the given dataset.

Acknowledging the disparity between sex and labor trafficking data, the report offers an explanation: "Since the enactment of the TVPA in 2000, only 6% of the cases filed were for forced labor. The ratio of sex trafficking and forced labor cases in new cases filed has varied only slightly since 2017" (15). The report provides further reasons as to why there appear to be significantly fewer prosecuted labor trafficking cases compared to sex trafficking, including the following: "sex trafficking is often more visible than forced labor," "many victims of forced labor may fail to recognize that they are being exploited by a trafficker," and "forced labor investigations and prosecutions can be incredibly complex and difficult to prove" (15). The Human Trafficking Institute also warns that while there seem to be significantly fewer cases of labor trafficking compared to sex trafficking, it does not indicate that forced labor is any less prevalent than sex trafficking in the United States (15).

Recognizing the above-discussed limits of the available dataset, the table below (Table 4) lists each NGO victim profile and compares them to the profile compiled from the strongest US human trafficking legal cases data analyses.

NGO Trafficking Victim Profiles versus US Trafficking Victim Data-Based Profile				
	2022 FHTR	**Polaris Project**	**Freedom Network USA**	**DeliverFund**
Age	N/A	*Young*	*Young*	Equally Youths and Adults
Gender	Female	Female	Female	Female
Sexuality	N/A	*LGBTQ+*	*LGBTQ+*	N/A
Race and Ethnicity	N/A	*People of Color*	N/A	N/A
Legal Status	Undocumented	Undocumented; *non-US Citizen*	Undocumented; *non-US Citizen*	Undocumented; *non-US Citizen*
Economic Group	Low-Income	Low-Income	Low-Income	Low-Income
Grievability Factors	Addiction; Unstable Housing	Prior Abuse; Addiction; Unstable Housing	Prior Abuse; Addiction; Disability	Prior Abuse; Addiction; Disability; Unstable Housing; Mental Illness
Most-Discussed Trafficking Type	Sex Trafficking	*Equal Sex and Labor Trafficking Split*	*Equal Sex and Labor Trafficking Split*	Sex Trafficking
*Note: Victim attributes that differ from FHTR data are *highlighted and italicized* for readability				

Table 4

Profile Alignments: All NGOs

All sources depict human trafficking victims most often as female, having an undocumented legal status, of a low-income group, and likely (directly or indirectly) experiencing addiction. While each NGO varies slightly in the common vulnerabilities that they consider as primary risks, all factors listed in the tables above appear in the FHTR and are considered generally aligned in this report. DeliverFund is closest to the FHTR profile since it makes the fewest definitive claims as to common victim characteristics and because it considers sex trafficking to be the most common type of human trafficking.

Profile Divergences: All NGOs

Most NGO victim profile deviations can be largely attributed to the limited information available in the FHTR, which generates multiple inconclusive identity categories, such as age, sexuality, race and ethnicity, and citizenship. Therefore, it is not possible to determine the accuracy of these aspects of the NGO profiles at this time. However, this report calls attention to where NGO descriptions diverge from one another in these categories, where applicable.

Profile Divergences: Polaris Project

Polaris lists sociodemographic categories for human trafficking victims that are too fine-grained to be verifiable by a limited US government dataset. It describes victims as commonly young, of the LGBTQ+ community, people of color, and non-US citizens. It is important to highlight that other NGO explicitly speaks to victims' race and ethnicity. Polaris also says that labor and sex trafficking are equally prevalent, but this conflicts with the FHTR findings that sex trafficking is most common.

Profile Divergences: Freedom Network USA

Freedom Network USA equally discusses the trafficking of adults and minors. However, due to the lack of certainty within government data, the ratio of minor victims to adult victims cannot be approximated. Thus, no conclusion as to correctness can be made regarding this specific category. Like Polaris, Freedom Network USA mentions that LGBTQ+ community members are more vulnerable to being trafficked, though the data cited on their webpage do not directly offer information on LGBTQ+ victims at all. Additionally, Freedom Network USA's discussion of sex and labor trafficking prevalence as equal conflicts with the FHTR data that indicate sex trafficking is the most common.

Profile Divergences: DeliverFund

DeliverFund's victim profile is most closely aligned with the federal human trafficking data, which is likely due to the fact that it frequently cites the report's findings. For example, the victim vulnerabilities listed are precisely the same as those in the 2022 FHTR. However, DeliverFund draws attention to the equal trafficking of minors and adults, which cannot be corroborated by the available data. Like Polaris and Freedom Network, DeliverFund also includes refugees and immigrants among legal statuses associated with increased vulnerability to trafficking. However, the accuracy of this claim cannot be evaluated due to data constraints.

VI. Discussion

        Having reviewed the different ideal human trafficking victim types across three major US-based NGOs and compared findings to available human trafficking court case data, this study finds that the framing of human trafficking primarily as a crime issue (rather than a human rights issue, as discussed by Austin and Farrell) and the enforcement of the TVPA likely contributes to the lack of documented labor trafficking cases. The crime framing of human trafficking perpetuates the idea that only violent acts toward an individual constitute human trafficking. This leads to labor trafficking being challenging to identify for law enforcement, the public, and even the trafficked individuals themselves. The unclear distinctions between what is considered administrative labor violations and what is considered forced labor, as well as the TVPA framing of human trafficking as a crime issue, all contribute to the lack of labor trafficking cases filed and prosecuted. Sex trafficking, on the other hand, has gained a lot of media coverage, resulting in the public gaining increasingly more awareness about this specific aspect of human trafficking, leading to the emergence of the "ideal victim."

        The reason why sex trafficking has received widespread attention can be explained through Butler's concept of grievability: if a population is viewed as grievable from society's point-of-view, they are the victims whom the majority associate with when a violation of human rights occurs. Hence, they are more likely to receive greater attention and care if they become victims. In the United States, the lives of marginalized and underprivileged communities are becoming increasingly recognized and valued within society, making them more grievable.

        Based on the comparative analysis, the grievable population in the case of human trafficking are undocumented migrants and refugees. While the data do not state that immigrants and refugees are more likely to be trafficked, when presented with data that leaves room for interpretation, it appears that NGOs tend to assume that certain populations of people are the ones who are victims of trafficking. This relates back to Christie's concept of the "ideal victim." The ideal victim of human trafficking is most often an impoverished young woman or girl, who is an undocumented immigrant trafficked for sex. Due to this hierarchy of perceived victimhood (O'Brien 2), men who have a stable income, who are American citizens, and who are trafficked for labor are most directly left out of this specific categorization.

        A consistent framing of victim vulnerabilities was observed across all the analyzed NGOs. These framings also happen to align perfectly with the federal report. A possible explanation can be that these vulnerabilities are listed instead of represented through percentages, making it easier for NGOs to present the information on their respective websites. On the other hand, NGOs diverge from one another and from the data for the age of victims. The data shown in the report had a large uncertainty that made it impossible to determine if more minors were trafficked, if more adults were trafficked, or if they were equally as likely to be trafficked. Both DeliverFund and Freedom United USA framed both minors and adults as equally vulnerable to being trafficked, while the Polaris Project highlighted minors as the main victims of trafficking.

For legal status, the data in the federal report stated that 93% of victims were U.S. citizens or of unknown nationalities. This demonstrates that the nationalities of the majority of victims are unknown, and there are no significant results that can be drawn from this statistic. However, surprisingly, all three NGOs communicated that undocumented immigrants and refugees were more likely to be trafficked as opposed to American citizens. Finally, for the most common trafficking type, results were mixed. Both Polaris and Freedom Network equally emphasized sex and labor trafficking, while DeliverFund frames sex trafficking as the predominant type of trafficking, stating that: "96% of trafficked victims are female", a statistic that is listed as sourced from a past report from the Human Trafficking Institute. This indicates that some NGOs are gathering human trafficking statistics from the Human Trafficking Institute and using the data to create a specific victim type. This could imply that NGOs diverge from the 2022 Federal Human Trafficking Report's inconclusive results and create their own conclusions for socio-demographic categories that include large uncertainties. There is also not enough information to determine the accuracy of these depictions of human trafficking victims.

Due to the instances of divergence between human trafficking data and NGO portrayals, perhaps the ideal victim-type framed by NGOs is not based on what is legally recognized as human trafficking by the federal government, but on what the majority believe are characteristics that constitute a victim. This connects with Andrijasevic and Anderson's findings 2009, where a difference is distinguished between the use of the term "Victim of Trafficking (VoT)" used descriptively by NGOs, the media, and civil society to describe individuals who have experienced certain situations (though there is a disagreement on what exactly qualifies) and as an "administrative category" that requires legal action from the state (Andrijasevic and Anderson 153).

Something that stands out is that the information about the most vulnerable victims of each socio-demographic category closely aligns with those of the NGOs, even though the populations are too small to be statistically influential, and the "unknown" category renders some of the data unusable. There appears to be a correlation between the data provided by the Human Trafficking Institute and the victim profile of each NGO, suggesting the Human Trafficking Institute and NGOs mutually influence one another. Information displayed on NGO websites could influence how data is recorded in new human trafficking cases, and this could, in turn, guide how NGOs speak to the public about victim awareness. Additionally, both DeliverFund and Freedom Network include information sourced from the Polaris Project. It is probable that NGOs collect information about human trafficking from other sources instead of solely using data provided by the Human Trafficking Institute. Future data research is required to confirm this claim. A study of all US legal cases and transcripts is required to create a more complete archive of human trafficking cases.

Meister claims that in human rights, individual suffering and global victims are the focus instead of political issues in specific regions that the victims are within. This paper contends that while political issues are no longer the explicit focus of human rights and human trafficking, the focus is instead placed on the categories that the victim belongs to, thereby causing human rights

to become disconnected from the reality and individual suffering of the victims. There is an excessive emphasis being placed on vulnerable populations, leading NGOs, the government, and the public to overlook other potential victims that do not fit the norm. The ideal victim broadcasted by the media is an individual who fits within all stereotypical descriptions of a trafficking victim and has undergone the worst possible scenarios that a victim could face. If the victim in question is someone who is slightly different from this artificially constructed reality, they are often not seen as a victim at all (Farrell, McDevitt, et al.; Farrell, Owens, et al.). Currently, society is heavily biased based on preconceived notions of victimhood, that it fails to account for what the reality of the situation actually is. Due to the occurrence of this phenomenon, human trafficking NGOs need to change their portrayals of human trafficking victims and "confront the ideal type with reality" (Swedberg 188). The ideal type could be "changed or adjusted" to better align with reality, but first, it is important to uncover what the reality is (188).

VII. Conclusion

There is a paradox in NGO anti-human trafficking campaigns. While these initiatives aim to educate and empower the public, they may unintentionally perpetuate stereotypes and create harmfully inaccurate portrayals of human trafficking victims. The NGOs studied in this project promote an image of the "ideal victim" of human trafficking through the textual and photographic content of their websites. To better map out the landscape of human trafficking victims, more accurate data regarding human trafficking in the United States must be obtained. For example, it may be productive to lobby the federal government to record more fine-grained information about human trafficking victims outside of the limited scope of federal court cases, so as to create a more representative dataset.

Moreover, based on the comparison conducted in this paper, there appears to be a correlation between the identity categories of trafficking victims framed on NGO websites and data from the 2022 FHTR compiled by the Human Trafficking Institute. It was found that NGOs frame victims as predominantly foreign women experiencing poverty who become victims of sex trafficking.

It is important to note that while this paper utilizes the 2022 Federal Human Trafficking Report as representative of human trafficking cases in the United States, the data only comprise a small portion of human trafficking cases, namely those that have been filed and prosecuted in federal court. Additionally, this paper assumes that human trafficking NGOs are only influencing federal human trafficking data and vice versa, not taking into account other factors that could influence how NGOs portray trafficking victims.

Returning to Nils Christie's framework of the ideal victim, it is imperative that depictions of trafficking victims by anti-human trafficking NGOs align with reality to prevent biases based on the identity categories to which the victim belongs. The perpetuation of ideal victims extends to many areas of human rights and crime. This raises many questions such as, are the persistence of the ideal victim framings more harmful than helpful? Is an ideal victim a necessary

component required to raise awareness and rally the public for a specific cause? And what are the possible implications of assuming that all people are equally as likely to be the victims of crime? These questions are beyond the scope of this paper and require further research. Presently, understanding the current landscape of human trafficking is vital for developing effective prevention and intervention strategies to combat human trafficking whilst supporting trafficking victims.

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Revolutionizing Healthcare: Exploring the Impact of Artificial Intelligence across Diverse Domains By Mourya Vemuganti

Abstract

Artificial Intelligence (A.I) is a branch of computer science that focuses on creating intelligent systems capable of performing tasks that typically require human intelligence. Through A.I, machines can mimic and automate human-like cognitive processes, enabling them to perform complex tasks and make informed decisions. Over the past decade, A.I has experienced a remarkable evolution, fueling its rise across various domains. Advances in deep learning algorithms, increased computing power, and the availability of vast amounts of data have propelled A.I forward. The use of A.I has skyrocketed over the past decade due to these advancements. This integration of A.I into everyday life has been transformative, leading to improved efficiency, personalized experiences, and exciting possibilities for future innovations. One field that A.I usage has risen and will continue to rise is healthcare. A.I has transformed healthcare by enhancing diagnostic accuracy, enabling personalized treatments, accelerating drug discovery, facilitating remote monitoring, improving administrative efficiency, and supporting population health. These advancements have the potential to enhance patient care, optimize healthcare delivery, and ultimately save lives. However, it is important to note that healthcare professionals are not ready to adopt A.I fully into healthcare just yet due to ethical concerns. This paper will look at A.I impact across different domains of healthcare and analyze several studies to show its applications in those domains while also diving into the ethical concerns of A.I in healthcare, showing why there is a risk of adopting A.I fully.

Introduction

The term "Artificial Intelligence (A.I)" refers to computer systems that simulate or exhibit a specific aspect of human intelligence such as reasoning, learning, and problem solving (Chen and Decary). A.I is not a single technology but rather a range of different technological processes and behaviors generated by different algorithms (Chen and Decary). Different A.I technologies have distinct roles in our society. Two of the most impactful A.I in many professions, including healthcare, are Machine Learning and Natural Language Processing (NLP). Machine Learning is a statistical technique for fitting models to data and to 'learn' by training models with data (Davenport and Kalakota). In a 2018 Deloitte survey, 1,100 US managers who were already pursuing A.I in their organization, were questioned about their use of machine learning in their businesses. According to the survey, 63% of managers surveyed were employing machine learning in their companies. NLP is a branch of A.I that is used to make sense of the human language so that they can perform tasks (Davenport and Kalakota). This includes speed recognition, text analysis, and translation (Davenport and Kalakota). Although it may seem that A.I has impacted businesses for a while now, most usage of A.I has not started until recently. A.I has undergone significant evolution over the past decade due to the advancement of computational powers. In the past, scientists were unable to identify the

potential of A.I due to limitations in data, computing power, and funding. However, now with all these recent advancements, scientists are looking at a more optimistic picture for the applications of A.I in the near future.

Healthcare is one field of profession that A.I is already being implemented in and will hopefully continue to do so. Healthcare simply refers to the system that helps people stay healthy, treats them when they are sick or injured, and takes care of their overall well-being. Over the past few years, the use of A.I has revolutionized Healthcare to greater heights, addressing some key problems within the Healthcare system such as dealing with high numbers of patients. A.I has led to better care outcomes and improved productivity and efficiency of care delivery (Spatharou et al.). While assisting with different tasks, A.I is also used to improve the day-to-day life of healthcare practitioners, letting them spend more time looking after patients resulting in increased staff morale and retention (Spatharou et al.). However, it is still unclear whether A.I will replace human clinicians on a large scale or simply just augment their efforts to care for patients. While future implications of A.I in healthcare are still unknown, the transformative impact that it has already had on healthcare cannot be ignored. A.I has enabled more accurate diagnostics through image recognition and analysis, improved patient outcomes through predictive analytics and personalized medicine, enhanced drug discovery processes, and empowered virtual healthcare assistants. A.I in healthcare has improved accuracy and patient care while reducing costs. To better understand how A.I has impacted all these different components of healthcare, it is necessary to dig deeper to look at the role of A.I in different subsections of healthcare.

Diagnostics and Imaging Advancements

In healthcare, diagnostics refers to the process of identifying and assessing diseases, conditions, or disorders in patients. It involves the use of medical tests, examinations, and procedures to gather information about the patient's symptoms, medical history, and physical findings. The diagnostic process aims to determine the underlying cause of the patient's symptoms or health concerns, leading to an accurate diagnosis. This enables healthcare professionals to develop appropriate treatment plans and interventions tailored to the patient's specific condition, ultimately improving patient outcomes, and guiding further medical management. A.I based systems are now currently being implemented in diagnostics to improve accuracy and efficiency across various specializations (Ahuja). For instance, A.I are now assisting physicists by diagnosing diseases using "complex algorithms, hundreds of biomarkers, imaging results from millions of patients, aggregated published clinical research, and thousands of physician's notes from EMR's" (Ahuja). While it may be true that humans can replicate everything or most things A.I do relating to healthcare, the truth is A.I do it at a much faster rate than humans allowing a more efficient diagnosis. The use of A.I in diagnostics can not only speed up the process, but also provide an accurate diagnosis for any health condition. In fact, research shows the accuracy of A.I in diagnostics is similar to or above that of humans in related fields. A study by Lakhani & Sundaram (2017) used different models of Deep Learning (DL)

algorithms, a type of A.I, to accurately diagnose tuberculosis (TB) (Ahuja). The researchers obtained 1,007 x-rays of patients with and without TB (Ahuja). The models of A.I were trained using different TB cases (Ahuja). The models' accuracy was tested on 150 different cases excluded from the training and the best performing A.I model achieved a net accuracy of 96 percent, which is similar to the accuracy of humans (Ahuja). It is also likely that with additional training, that number will go up (Ahuja). A.I models have achieved similar accuracy compared to humans' while performing at a much faster rate. With more training, A.I technologies can become so advanced that their accuracy will go levels above humans and their efficiency will become even greater.

Imaging is a prime example of how efficient A.I models are and can be in the future. Medical Imaging refers to the use of various imaging techniques to create visual representations of the internal structures and processes of the human body. These images assist healthcare professionals in diagnosing and treating medical conditions. A.I algorithms can analyze medical images (e.g., X-rays, MRIs, ultrasounds, CT scans, and DXAs) to assist healthcare providers in identifying and diagnosing these medical conditions more accurately and quickly (Al-Antari). A.I can analyze immense amounts of patient data, including 2D/3D imaging, bio-signals, vital signs, demographic information, medical history, and laboratory test results (Al-Antari). With all this information, A.I can provide accurate prediction results. Healthcare providers simply do not have enough time to look at all this information for millions of patients so usage of A.I might be necessary. Historically, trained physicians would visually assess medical images for detection of diseases. Now, A.I methods excel at automatically recognizing complex patterns in imaging data which allows for a quicker and more accurate diagnosis (Hosny et al.). An example of this would be screening of Lung cancer. Lung cancer is one of the most common and deadly tumors and can be avoided through screening that can help identify pulmonary nodules, with early detection being lifesaving in many patients (Hosny et al.). A.I can automatically identify these nodules and categorize them as benign or malignant, saving countless lives. The impact that A.I will continue to have on diagnosis is prevalent in today's age.

Without the use of A.I, it is impossible for healthcare professionals to diagnose diseases early and tailor a personalized treatment plan. Diagnosing diseases early is crucial because it can result in much better treatment outcomes and health impact. A.I is the best way to maximize early detection of diseases because of how they can recognize complex patterns. A.I models have become so advanced that they can identify any diseases in their initial stages (Al-Antari)). For example, Covid-19. A.I can quickly analyze irregular symptoms and other 'red flags' and thus alarm the patients and healthcare authorities, providing faster decision making and a quicker diagnosis (Hosny et al.). A.I can also use different medical imaging technologies to diagnose Covid. By analyzing large volumes of patient data, through imaging scans, A.I can make quick and accurate diagnosis about the patient. This can help Healthcare professionals allocate their resources efficiently and make timely treatment decisions to better patient outcome and reduce effects of Covid-19. A.I can also play a key role in personalized treatment planning tailored to specific patients. Tailoring a personalized treatment plan to specific patients often requires a deep

understanding of the patients' conditions and circumstances resulting in the extensive use of sophisticated assays that generate massive amounts of data (Kumar et al.). A.I can have a special role in this process because of the different models' ability to navigate through copious amounts of data. This role of A.I in treatment planning is no different than its role in diagnostics where A.I scans a bunch of complex images to diagnose a disease. The only difference is now, A.I is scanning through different assays for the creation of personalized medicine. Once again, A.I main job is to improve the efficiency of the task compared to humans.

In the future, A.I might play an even more pivotal role in diagnostics along with imaging advancements. A.I algorithms have the potential to revolutionize the field by offering faster and more accurate analysis of medical images, enabling early detection of diseases and conditions. With access to vast amounts of data, A.I systems can be trained to recognize patterns and anomalies that may be imperceptible to the human eye. By leveraging these deep learning and machine learning techniques, A.I can assist pathologists and other healthcare professionals in making more informed decisions, improving patient outcomes, and reducing diagnostic errors. With further development and integration, A.I-powered diagnostics and imaging systems have the potential to enhance the efficiency and effectiveness of healthcare, leading to better and more personalized patient care.

Predictive analytics to Identify High Risk patients and Patient Monitoring

Predictive Analytics refers to using different data analysis techniques and statistical models to predict future events or outcomes of patients. Usually, this process involves analyzing large sets of patient data, including medical imaging, genetic information, and Electronic Health Records (EHR) to identify patterns and relationships that can help predict patient outcomes. Predictive analytics goes hand and hand with Diagnostics but there are a lot more uses for Predictive analytics other than disease detection. For example, Predictive Analytics can also be used to identify patients at elevated risk for developing certain diseases, allowing healthcare professionals to take drastic measures and intervene early to prevent these adverse outcomes. A.I can leverage Predictive analytics to diagnose diseases like talked about above, but it can also use Predictive analytics to identify high risk patients for diseases. A.I can analyze the large volumes of data to identify different risk factors that could potentially lead to certain health conditions or complications. The benefit of this approach rather than human pathologist is that A.I can predict high risk patients a lot faster than humans can, allowing more time to take measures which can result in better patient outcome. One recent study involved using Artificial Intelligence to identify high risk Covid-19 patients. All the patients were divided into four stages (Quiroz-Juárez et al.). Patients in stage 1 are those who are in the process of receiving initial medical assessment and care (Quiroz-Juárez et al.). Patients in stage 2 are comprised of those who already have a known Covid-19 status (Quiroz-Juárez et al.). Patients in stage 3 are those for whom a decision has been reached, whether to be admitted to a hospital or taken back home (Quiroz-Juárez et al.). Finally, patients in stage 4 are those who in addition to being hospitalized, have either been intubated or admitted to an intensive care unit (Quiroz-Juárez et al.). The study consisted of

using a Machine Learning algorithm (ML algorithm) to identify whether patients, infected or suspected to be infected with the virus, are more likely to survive or die (Quiroz-Juárez et al.). This algorithm was trained with historical data, including medical history, demographic data, and any Covid-19 related information (Quiroz-Juárez et al.). After training was completed, it was time to test if the ML algorithm can predict with high accuracy whether a given patient with known characteristics belongs in class 1 (more likely to survive) or class 2 (more likely to die) (Quiroz-Juárez et al.). The results were astonishing to say the least. Across all four clinical stages, the newly trained algorithm exhibited an accuracy greater than 84% and since more information becomes available for successive clinical stages, it is only natural that the accuracy improved when progressing from one stage to the next (Quiroz-Juárez et al.). The accuracy of the ML algorithm was compared to that of three different A.I algorithms and the results stayed consistent. Achieving high accuracy in more efficient ways, A.I algorithms have the potential to improve so many patient lives and improve healthcare professionals' lives.

Table 1. Accuracy obtained by Machine Learning (ML), Logistic Regression (LR), Support Vector Medicine (SVR), and k-Nearest (kNN) algorithms, for each of the four clinical stages.

Stage	*Algorithm*	*Accuracy*
1	Machine Learning (ML)	84.3%
	Logistic Regression (LR)	82%
	Support Vector Medicine (SVR)	84%
	k-Nearest (KNN)	81%
2	Machine Learning (ML)	90.5%
	Logistic Regression (LR)	88%
	Support Vector Medicine (SVR)	88%
	k-Nearest (KNN)	85%
3	Machine Learning (ML)	93.1%
	Logistic Regression (LR)	92%
	Support Vector Medicine (SVR)	91.8%
	k-Nearest (KNN)	89.1%
4	Machine Learning (ML)	93.5%
	Logistic Regression (LR)	92.1%
	Support Vector Medicine (SVR)	92.5%
	k-Nearest (KNN)	89.3%

Healthcare professionals have also been using the integration of A.I to monitor patients remotely to improve patient outcome (Inc). Remote patient monitoring (RPM) is a healthcare practice that allows healthcare professionals to monitor a patients' health remotely outside of traditional healthcare settings. It involves the use of various medical devices, sensors, and communication technologies to collect patient data and transmit it to healthcare providers for analysis and intervention. A.I algorithms play a crucial role in implementing RPM. A. I can analyze the large amounts of data collected from patients, such as vital signs, activity levels, and medication adherence, to provide valuable insights and alerts to healthcare professionals. A.I-powered RPM systems can continuously monitor patients' health parameters, enabling real-time tracking and proactive intervention. An example of this is A.I algorithms can flag abnormal vital signs or variations from baseline readings, prompting healthcare professionals to take timely actions, such as adjusting medications or scheduling an in-person appointment. A benefit of A.I-powered RPM systems is that it can lead to an early detection of potential health issues and can detect high risk patients just like predictive analytics (Inc). Overall, this system leads to better patient outcomes and improves efficiency in the workforce.

Drug Discovery and Development

Drug discovery is of paramount importance in healthcare as it serves as a catalyst for advancing medical treatments and improving patient outcomes. The process of discovering new drugs allows for the identification and development of new innovative therapies that can effectively target and treat a wide range of diseases and conditions. Drug discovery enables the exploration of new therapeutic targets, the understanding of disease mechanisms, and the creation of novel drug candidates through rigorous research and development efforts. These advancements not only offer hope to patients by providing effective treatment options, but they also contribute to the overall progress of medical science, pushing the boundaries of our understanding and capabilities in combating diseases. However, it must be said that the process of discovering new drugs can be quite expensive for healthcare professionals and can take an average of 12 years to be complete (Chan et al.). The process is also very complex. In fact, the process requires navigating a combinatorial space of more than 10^{60} molecules to find a suitable drug candidate (Lou and Wu). This is obviously not ideal, so healthcare professionals started implementing A.I technologies to speed up the process while also reducing the cost and complexity of it too. An example is A.I technologies excel at looking at vast amounts of data to find patterns and trends as talked about already. This can be used to scan through the data needed to find a suitable drug target much faster than the speed of humans. Drug targets refer to a specific molecule or biological structure within the body that is intended to be affected or modulated by a therapeutic drug. To identify a good drug target, traditionally, domain experts had to collect information from a large amount of biomedical literature and clinical trial data (Craig et al.). Now, with A.I, we can collect evidence by examining the entire biomedical literature along with the entire clinical trial data to find a suitable drug target (Craig et al.). The role of A.I in this field does not stop there. Once we find a suitable drug target, A.I can be used

to find a good drug candidate as well. A.I can predict protein structures accurately and are making quick progress on protein-ligand, protein-protein, and antigen-antibody complex structure predictions (Craig et al.). Such progress allows us to design molecules binding to the protein target, and we can at the same time predict the developability of designed molecules (Craig et al.). All these techniques will empower a drug discovery process that is faster and with a higher success rate (Craig et al.). The implementation of A.I in drug discovery can also reduce the cost of making the drug, which can be just as beneficial to healthcare practitioners as the time issue. The typical drug discovery process costs around 2.6 billion USD and this money goes toward various steps, all which A.I can control. For example, A.I algorithms can help identify potential drug candidates through virtual screening which eliminates the cost of extensive experimental screening. Another example is A.I can identify viable drug targets through analyzing biological data, avoiding costly pursuits of less promising options. Overall, the implementation of A.I in drug discovery has allowed for a more time-efficient process and a higher success rate while also being more cost-effective.

Clinical Trials (CTs) are scientific studies conducted to evaluate the safety, efficacy, and potential benefits of medical treatments, interventions, or therapies in human subjects. These trials are an essential step in the process of developing and testing new drugs, medical devices, vaccines, or other medical products. CTs are also conducted to explore new uses for existing treatments or to compare different treatment approaches. Steps for a successful CT are pre-Clinical research, Design, Recruitment, Conduct, and Analysis (Askin et al.). CTs remain the foundation of safe and effective drug development (Askin et al.). With A.I being recognized as a pathway towards sustainable and optimized drug development, multiple applications in CTs are being discussed and beginning to be explored in practice (Askin et al.). To see how much A.I is being implemented in the CT process, a study was done to gather publications tackling the use of A.I and ML in CTs from the past 5 years in the US and Europe (Askin et al.). The search for publication was performed on PubMed, SCOPUS, International Pharmaceutical Abstracts, and Google Scholar databases using broad terms such as "artificial intelligence" or "machine learning" with the term "clinical trials (Askin et al.)." The searches were performed between 7th October 2021 and 14th October 2021, with results being downloaded into a single excel file (Askin et al.). Any publications prior to 2017, as well as those not relevant to EU or US and any duplicates were removed (Askin et al.). The search wielded 48 publications and they were reviewed and categorized based on the research activity where A.I was applied: pre-clinical research, Design, Recruitment, Conduct, and Analysis (Askin et al.). Table 2 provides uses of A.I for each of these category labels (Askin et al.).

Table 2. Definitions of research activities considered for categorization of papers based on use of A.I

Pre-clinical research	*Early use of AI in pre-clinical research, impacting subsequent CTs*
Design	*Use of AI enabling prediction of outcomes*

	and disease progression to shape or improve Design of CTs
Recruitment	*Use of AI in Recruitment, which includes Enrollment, defined as the identification of eligible participants and onboarding them into suitable CTs.*
Conduct	*Use of AI in Conduct refers to the period following a participant's enrollment into the trial, up to the trial database lock, prior to statistical analysis.*
Analysis	*Use of AI in Analysis relates to activities performed by statisticians after a trial has achieved database lock, as part of statistical analysis for the trial.*

The research indicates that potential applications of AI across CTs is broad, however recruitment is clearly a key area of interest (Askin et al.). Over 50% of the papers reviewed address recruitment, which is over double that of trial design and nearly 3 times the number of papers discussing analysis, which were also commonly identified (Askin et al.). Figure 1 shows the number of publications referring to AI applications, per CT activity (Askin et al.).
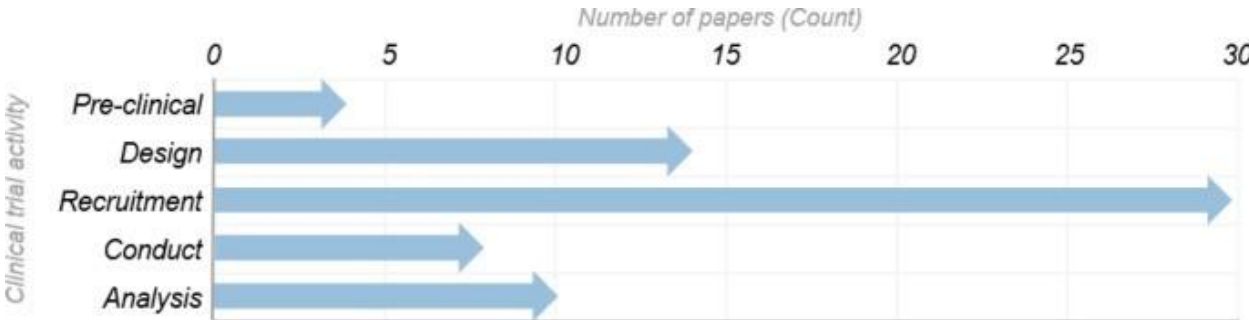

Figure 1. Number of papers referring to A.I applications, per categorized CT activity
Implementation of A.I in clinical trials is trending in a positive direction and will be used to advance drug development in the future, making it a safer and more efficient process.

Precision Medicine and Genomics

Genomics has become a more interesting topic of use in healthcare facilities, especially when treating different patients with diseases. Genomics refers to the study of an individual's genetic information. Healthcare practitioners do this to understand how different diseases are more susceptible to different humans. This study involves analyzing an individual's DNA to

identify genetic variations, mutations, and predispositions to certain diseases. Genomics has become increasingly overused in the past decade due to it being clear that human diseases and disease susceptibility are not only a consequence of a particular gene disfunction, but also a result of genetic variations in the genome (Xu et al.). With the widespread use of Genomics, it is only natural that healthcare practitioners are trying to integrate A.I into this process as well to improve accuracy and speed. A.I systems, with their ability to capture and interpret humongous data sets, can be integrated very effectively into this process to diagnose diseases among patients (Xu et al.). To accurately diagnose diseases among patients, A.I systems need to be in the non-coding regions of the genome since that is where most genetic variations associated with diseases are located (Xu et al.). A.I systems are necessary for this process because interpreting non-coding regions is not a simple task and can take a while to finish. This process of interpreting non-coding regions requires a lot more than traditional data analysis which is all that is needed in other parts of the genome (Xu et al.). That being said, rapid development of A.I systems helps healthcare officials' case a little more here. An A.I model (DeepC) has been accurately shown to predict the topologically associated domain (TADs) within a genome (Xu et al.). TADs are essentially fundamental units of the 3D nuclear organization of the Genome that contribute to gene expression (Xu et al.). Predicting these TADs can allow for prediction of how variations in the primary sequence can impact the 3D genomic structure (Xu et al.). This, in turn with analyzing the data of the genome, can help healthcare practitioners accurately predict human diseases and rare symptoms.

  A.I can identify all human diseases by just looking at the human genome, but they also can personalize different treatment plans for everyone based on their genetic profile. An example of this is shown in the study of Cancer genomics. The key to predicting human diseases and analyzing genomic data is Next-Generation Sequencing (NGS). NGS refers to the modern techniques used in DNA sequencing. NGS methods allow for the parallel sequencing of millions of DNA fragments, generating vast amounts of sequencing data in a single run. This technology helps identify genetic variation which is key for prediction of human diseases. With precision medicine and the advancement of NGS, patient's genetic profiles have been increasingly used to diagnose diseases and develop guide targeted therapies (Dahle). A.I use algorithms to analyze the vast amounts of genomic data from tumors and patients. By identifying patterns in this data, A.I helps personalize treatment plans by predicting which therapies might be most effective for specific types of cancer based on the genetic profile of the tumor. This allows for more tailored and targeted treatments, improving patient outcomes and reducing adverse effects for the patients. There are a few steps in the process of analyzing genomic data with A.I. To personalize treatment plans for specific individuals, Healthcare practitioners needs to know which disease is present in the genome. To do this, Healthcare practitioners have started adopting A.I in the first step: Variant calling. Variant calling is the process to identify variants in NGS data (Yin et al.). NGS data usually includes millions of DNA fragments which take time to analyze when using traditional variant callers. Additionally, the accuracy is not ideal (Dahle). Often, users of the variant caller need to heuristically tune parameters and apply multiple customized filters to

remove false positives before an acceptable accuracy is reached (Dahle)). This process is very time consuming, so different groups have now started leveraging ML algorithms to improve the performance of variant calling (Dahle)). While traditional variant callers cannot detect Sub-clonal variants (present in only a few cells), ML algorithms can detect alleles with very low frequencies (Dahle)). For example, a study performed by Hill et al. used an ML algorithm called convolutional neural network (CNN) model to predict variants (Dahle). The model achieved an F1 score (an accuracy measure) of 0.96 and was able to reach variants with allele frequencies as low as 0.0001 (Dahle)). In another study, a Random forest-based ML approach (Cerebro) showed an improved F1 score in the identification of a Tumor mutation when compared to existing variant calling programs such as MuTect1, MuTect2, SomaticSniper, Strelka, VarDict, and VarScan2 (Dahle)). While their recall values were similar, Cerebro showed increased precision values compared to the existing Variant callers (Dahle)). The next step to personalize treatment plans is to interpret these Variants. It is crucial to determine whether a mutation is benign or disease causing. Several ML algorithms are being used and trained to improve the accuracy of variant classification. Once ML algorithms have successfully interpreted each variant, the next step is Entity extraction. Entity extraction is an NLP technique used to identify and extract specific pieces of information. In precision medicine, and specifically cancer genomics, NLP tools have been used for automated extraction of entities such as genes, genetic variants, treatments, and conditions from patient records or scientific literature. Once the relevant information has been extracted, NLP can extract relationships or connections between entities mentioned in the text. This is called Relationship extraction. This is very important in precision medicine because it can identify connections between specific genes and diseases. By extracting these relationships, it becomes possible for healthcare officials to build structured databases that capture valuable insights about connections between various entities, aiding in personalized medicine plans. Overall, A.I can be used to improve accuracy and efficiency of analyzing genomic data which can help Healthcare officials to diagnose diseases and personalize treatment for individual patients to target specific gene mutations and proteins that are involved in the growth of tumor cells (Yin et al.).

Ethical and Regulatory Considerations

As shown, the integration of A.I in healthcare holds immense potential for improving patient outcomes, enhancing efficiency, and transforming the delivery of healthcare services. However, this advancement also presents several ethical challenges that must be carefully addressed to ensure responsible implementation. These challenges include privacy and confidentiality issues due to vast amounts of personal health data required, and the potential for bias in A.I algorithms that can lead to unfair treatment of certain groups. Additionally, there are concerns about the transparency and accountability of A.I decision-making processes and the challenges in ensuring informed consent from patients. These issues, while in many ways interconnected, pose a threat that cannot be ignored (Murphy et al.). Given that these A.I systems must be trained with a sizable amount of personal health information, it should come as no shock

that issues of privacy and data security have been raised (Murphy et al.). One concern involving this is that A.I systems may use patient data in ways that may be unbeknownst to the patient or individual from whom the information was collected (Murphy et al.). Another concern is that there is potential for information collected by and for A.I systems to be hacked (Murphy et al.). This is because A.I systems require large volumes of sensitive health information that are vulnerable to breaches and cyberattacks. An example of this occurred in Mumbai back in 2016 (Murphy et al.). A diagnostic laboratory database was hacked, during which 35,000 patient medical records were leaked, inclusive of patient HIV status, with many patients never informed of the incident (Murphy et al.). Even anonymized data can be at risk of re-identification, where individuals are identified by cross-referencing datasets, compromising privacy. A study by Na et al., for example, found that an algorithm could be used to re-identify 85.6% of adults and 69.8% of children in a physical activity cohort study, "despite data aggregation and removal of protected health information (Murdoch)." Another study in 2018 concluded that data collected by ancestry companies could be used to identify approximately 60% of Americans or European ancestry and that, in the near future, the percentage is likely to increase substantially (Murdoch). Furthermore, a 2019 study successfully used a "linkage attack framework" - that is, an algorithm aimed at re-identifying anonymous health information – that can link online health data to real world people, demonstrating "the vulnerability of existing online health data (Murdoch)." Additionally, informed consent is often insufficient, as patients may not fully understand how their data will be used, shared, or stored by A.I systems. The complexity and opacity of these systems along with patients not being adequately informed about the potential privacy concerns associated with A.I lead to consent that is not justified. Addressing these concerns requires collaborations among policymakers, technologists, and ethicists to foster an environment where A.I enhances healthcare delivery while upholding ethical standards and regulatory compliance.

Conclusion

        The integration of artificial intelligence into healthcare holds immense promise, revolutionizing diagnosis, treatment, and patient care. A.I-powered tools can analyze vast amounts of medical data with unprecedented speed and accuracy, leading to earlier detection of diseases, more personalized treatment plans, and improved patient outcomes. Moreover, A.I-driven predictive analytics can help healthcare providers anticipate potential health issues, enabling proactive interventions and reducing healthcare costs. However, alongside these benefits come significant challenges and ethical considerations. A.I systems can inadvertently perpetuate biases present in training data, leading to disparities in healthcare delivery and exacerbating existing inequalities. Moreover, the opacity of A.I algorithms can undermine transparency and trust, raising concerns about accountability and patient autonomy. Safeguarding patient privacy and data security is crucial, as is ensuring that A.I technologies adhere to robust ethical standards and regulatory frameworks. Despite these challenges, with careful consideration and collaboration among stakeholders, A.I has the potential to revolutionize healthcare, ushering in a new era of precision medicine and improved patient care.

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Flight: Community or Individual… or Both? By Alexander Sabat

  In *Song of Solomon*, Toni Morrison's central narrative concerns Milkman's quest to acquire his sense of self and find his true identity. Essential to Milkman's discovery of his roots are African culture and folklore, specifically the "flying African" tale, a generations-old African myth in which an enslaved African flies back to his homeland. This legend, with its corresponding symbol of flight, became a beacon of hope, escape, and freedom for enslaved people. Similarly, in Morrison's *Song of Solomon,* the motif of flight appears in various forms and often represents different aspects of escape, freedom, and self-discovery. The first flight takes place on the roof of Mercy Hospital. Robert Smith, an insurance agent, leaps off the building hoping to "fly away on [his] own wings," as a means of escaping the confines of his life (3). Later in the novel, the story of Milkman's ancestor Solomon is revealed. Solomon escaped the confines of slavery, achieved freedom, and flew back home to Africa. Like his great-grandfather, Milkman's journey of self-discovery ends as he leaps off the cliff and takes flight at the end of the novel. Critics debate whether the novel's final image of Milkman in flight and his discovery of his sense of self is communal and ancestral, or individual. Does Milkman become one with his community and ancestors, or does he remain individualistic and self-reliant? While critics debate the meaning of flight in the novel*,* they all define the term as either individualistic or selfless and communal. However, in applying a singular definition to the motif, critics overlook Morrison's intent in exploring the evolution of flight in *Song of Solomon.* Milkman's final flight is revolutionary, changing the meaning of flight in *Song of Solomon* from something individualistic to something communal and ancestral.

  In "All God's Children Had Wings: The Flying African in History, Literature, and Lore," Jason R. Young interprets Milkman's flight at the end of the novel as a leap of faith, "crystalliz[ing] his connection with the folklore of his ancestors" (Young 64). Young then compares this flight with Robert Smith's attempted flight, as depicted at the beginning of *Song of Solomon*. He claims that Robert Smith's attempted flight ends in his death, as he was "too far removed from his heritage," while Milkman's flight ends in triumph as he could "claim his past, his family history, and a sense of the sacred up through generations and into the present" (Young 64). By contrasting the results of these two attempted flights, Young emphasizes the importance of cultural connection and heritage. Young's perspective of Milkman's discovery and flight is straightforward–Milkman obtains a communal and ancestral identity and sense of self.

  However, in "Folklore and Community in *Song of Solomon,"* Susan L. Blake has a more nuanced perspective on Milkman's quest; she introduces the idea that Milkman's discovery is not just a discovery of his roots, but something more self-serving and individualistic. Blake claims that "as the object of Milkman's quest," the flying African folktale "suggests a multi-leveled equivalence between individual identity and community" (Blake 78). She discusses Milkman's quest as a parallel to Solomon's flight back to Africa, as they represent a return to their community. Blake suggests that Pilate represents the spirit of community, while Macon Dead Jr. on the other hand represents a more selfish sense of individuality. Pilate lives without a desire for

money, electricity, or fancy clothes, and she has poor manners, but she values human relationships more than anything (Blake 78). She speaks to her father's ghost and carries around his bones (though unknowingly), and sings the song of Solomon, indicating her strong relationship with her ancestry and community. However, Macon exemplifies individualistic values, as he is only motivated by his desire for wealth and materialism, at the cost of neglecting his cultural and familial roots. Blake compellingly argues that Milkman begins his quest intending to seek gold, his father's materialistic values, but then adopts Pilates communal values, and ends up seeking community and his family (Blake 78). Like Young, she argues that Milkman accomplishes his quest for his sense of self through his community. However, contrary to Young's belief that Milkman's discovery is communal, Blake argues that the identity he achieves is individualistic. She argues that Milkman's flight is not the typical flying African tale, but a "solitary leap into the void" (Blake 79). Blake argues that Solomon's flight is also individualistic, as he abandons his family (Blake 80). This nuanced perspective on Milkman's quest establishes a paradoxical relationship in Milkman's discovery–Milkman accomplishes his sense of self through community, but his leap is individualistic.

In "The Quest for and Discovery of Identity in Toni Morrison's *Song of Solomon*," Valerie Smith discusses the importance of "communal and mythical values" over "individualism and materialism" in Milkman's ancestor's world (38). Milkman is only admitted into the Shalimar community "when he ceases to flaunt his wealth," indicating the community's lack of individualism and materialism. Similar to Young, Smith underscores the importance of community in Milkman's discovery. Like Blake, Smith suggests that Milkman's father represents individualistic values. She argues that Milkman has taken after his father's materialistic and individualistic qualities, evident when Milkman goes on the quest for the gold with the primary intent of just getting money (Smith 37). However, finding the gold will not free him; Milkman can only acquire his sense of self by changing his objective and discovering his roots. Smith concludes by stating "Knowing oneself derives from learning to reach back into history" (Smith 40). When Milkman immerses himself in his ancestral past, he escapes his father's individualism and accepts community.

When it comes to determining the meaning of flight in *Song of Solomon*, critics tend to interpret flight through a singular perspective; critics overlook the fact that the meaning of a motif or symbol can change throughout the novel. Some critics define flight with a negative connotation, as an individualistic and selfish action, while others give flight a more positive interpretation, a sense of community and ancestry. In Toni Morrison's *Song of Solomon,* Milkman's leap changes the meaning of flight from self-serving to selfless and communal.

Through the character of Macon Dead Jr., Morrison illustrates that individualism and selfishness can prevent someone from achieving flight. Macon Dead Jr. is a materialistic man–he strives for social status and prioritizes financial success. Macon is ruthless and unsympathetic with his tenants, demonstrating his greed for money and lack of empathy. This is seen when Mrs. Bains asks Macon to defer her rent payment, so she can feed her baby grandchildren that Cency had just left with her. Macon harshly refuses this request, threatening to kick them out if the rent

is not paid by Saturday. While Macon is financially successful, he prioritizes himself over the well-being of others. As a result of this, Macon's relationships with his family members are strained. Macon neglects his family; he avoids and holds great disdain for his sister, Pilate, and he rejects his past. However, this approach to life is unsuccessful for him, as he is restricted by societal norms, and ultimately isn't living freely. When Milkman and Guitar are plotting to steal the gold from Pilate, they spot a peacock sitting in the parking lot. After seeing that the peacock is unable to fly, Guitar says "All that jewelry weighs it down. Like vanity. Can't nobody fly with all that shit. Wanna fly, you got to give up the shit that weighs you down" (179). This peacock is a direct metaphor for Macon Dead Jr., who is held down by his materialistic values and desire for money, just like the peacock is weighed down by its jewelry. Guitar's statement about the peacock is also indicative of Milkman's situation. At this point, Milkman's only desire is to find the gold, and he is restricted by this materialistic view, just like his father. This foreshadows Milkman's quest, as he later switches his goal from just finding the gold to discovering his community. In order for Milkman to fly and be free, he must "give up the shit that weighs [him] down" (179).

At the beginning of the novel, flight is portrayed as individualistic and selfish. Robert Smith leaps with hopes to "fly away on [his] own wings," while Solomon flies back home to Africa to escape slavery (3). Smith flies to escape the confines of his own life, and Solomon leaps for personal freedom. Solomon selfishly leaves behind his twenty-one kids and his wife to chase his own needs. Both Robert Smith and Solomon attempt flight as a means to escape their current situation, an act of individualism.

While Blake argues that Milkman's discovery and flight at the end of the novel is individualistic, it is actually one in which Milkman achieves a sense of community and ancestry. Blake's argument of Milkman's individualistic jump lacks a deep analysis of Milkman and Pilate's profound connection. Milkman's relationship with Pilate is essential to his discovery and connection with his community and familial roots. Upon hearing children in Shalimar sing the song of Solomon, the song Pilate used to sing, Milkman smiles: "He was homesick for her, for her house, for the very people he had been hell-bent to leave" (300). Morrison's use of the word "homesick" is interesting here. "Homesick" has connotations of nostalgia, sadness, longing, sickness, and homecoming. However, in this case, "homesick" does not make much sense, as one isn't "homesick" for another person; one is homesick for a home. The word "yearning" would seem to make more sense in this passage, "he was [yearning] for her, for her house, for the very people he had been hell-bent to leave." "Yearning" better connotes a sense of desire and longing for a person and makes sense in this passage, as Milkman desires and longs to return to Pilate. The use of "homesick" indicates a stronger connection towards Pilate, as he is sick of not being around her, not just yearning for her. Toni Morrison uses "homesick" to convey Milkman's feelings of strong nostalgia and connection towards Pilate. This use of "homesick" would only make sense if Milkman considers Pilate to be "home." This affiliation between Pilate and home for Milkman is very important. Home is the place where one has their strongest connection with, a place where they feel safe. The word "homesick" is most powerful here because of its

connotations of home and homecoming, as homecoming is one of *Song of Solomon's* central themes. Throughout most of the novel, Milkman has no goals, desires, or hunger. He is just living without a point or purpose. Once he learns about the opportunity to find the gold, Milkman has a desire to strive for something more in his life. However, while on this journey, his focus shifts from finding the gold to learning about his family's heritage. Milkman finally finds a purpose in life, a homecoming, to find his family's origin. To find his true home.

For Milkman, home is not a place; his family is his true home. One reason Milkman is strongly connected to Pilate is because she sings the song of Solomon. The song represents the powerful connection Pilate has to her ancestral roots, to Solomon. Whenever Pilate sings the song, she remembers her ancestral roots: her mother, Sing; her father who she thinks is telling her to sing, although he is just calling his wife's name; and Solomon, whom the song is named after. The song is a metaphor for finding one's home through their heritage and past. Pilate also has a strong connection with her roots because her ancestry literally lives with her. Unlike Macon Dead Jr., who is assimilated into modern white culture, Pilate keeps her name in her ear, always carrying her family with her. She also literally carries her family with her, though unknowingly, by carrying her father's bones in her green sack. Because of Pilate's deep connection to her roots, Milkman was able to connect with his family's past and find belonging. Finding his heritage shapes his new identity, as he finally has a purpose: recovering his ancestry.

After discovering his roots, Milkman seems to have achieved his homecoming. He knows what Shalimar knew: "If you surrendered to the air, you could *ride* it" (337). When Milkman is being held at gunpoint by Guitar on the cliff, "he leaped." After finding out his ancestry and past, he flies away to his home: his heritage. However, Blake argues that Milkman's leap is a "solitary leap into the void," because Pilate has been his strongest connection to his heritage, and she is dead by this point in the novel (Blake 79). He claims that Milkman's flight is an "individualistic variant" of the flying African tale, and states that Milkman "does not so much unite with her as succeed her" (Blake 79.) However, Blake's argument does not prove that Milkman's leap is individualistic, it actually proves the opposite: his leap is for community. Pilate is emblematic of a strong connection with one's past and heritage, representing the importance of family and community. Pilate is Milkman's connection to his heritage and when Pilate dies, he does not lose connection with his ancestors, he "succeeds" her, and becomes the direct connection with his heritage. After Milkman succeeds Pilate as the connector to his roots and ultimately embraces his roots, he is able to live carefree. When Milkman takes his leap, the meaning of flight in *Song of Solomon* changes from escape to surrender and embracement. Milkman's flight was the first communal leap of the novel. While Smith and Solomon's flights are for individual escape, Milkman is not escaping, he is surrendering to the air, embracing his ancestry.

At the end of the novel, Milkman achieves his self-discovery; he is part of a whole, his ancestry. Morrison uses Milkman's leap to illustrate that if one stops resisting, surrenders to the air, and embraces their ancestry, one can navigate life's journey like a rollercoaster, allowing oneself to be carried wherever it leads. If one surrenders they will be free, not restricted like Macon Dead Jr. Pilate is more happy and carefree than Macon because she surrenders, doesn't

adapt to modernism, and accepts and embraces her true identity, her culture. Because Pilate embraces her culture, she has more autonomy than Macon, who is restricted by societal norms, so she can ride life to the fullest. Milkman's flight evolves the meaning of flight from an escape to a surrender, a journey of self-discovery, embracing one's roots, and becoming free.

The concept of flight and the "flying African" tale are very nuanced and can be interpreted as either communal or individualistic. In *Song of Solomon,* Toni Morrison intends the meaning of flight to change from individualistic to selfless and communal. The "flying African" tale is a cultural symbol passed down through generations of enslaved people, giving hope of escape and liberation. It is a shared dream that brings the community closer together, representing the communal aspiration of returning to one's roots. Milkman's leap exemplifies the communal nature of flight in the novel. Milkman's flight is not a "solitary leap into the void;" he carries the legacy of his ancestors, acknowledging his roots and family's past (Blake 79). He finally acquires his sense of self and purpose by discovering his roots. With Shalimar and his community guiding him, Milkman can "surrender" to the air and "ride" it (337). Toni Morrison uses Milkman's quest to highlight the importance of community by displaying how Milkman rises above individualistic values and accepts his community. His flight illustrates his journey to discover his sense of self and embrace his community and roots, ultimately emphasizing the drastic influence and importance of communal connections. Milkman's leap changes the meaning of flight in *Song of Solomon* from an individualistic and selfish way of escape to a selfless acceptance.

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"Investigating the Effects of Lyrical and Instrumental Music on Reducing Stress" by Aubrey Miller

Abstract

   The common feeling of stress is typically combatted with the listening of music of various genres. Previous studies conducted on music and stress have shown lyrical and instrumental music have the same effect in terms of reducing physical stress. However, certain meta-analyses have produced seemingly differing results, highlighting instrumental music as more efficient for psychological stress-reduction. This paper seeks to identify the effects of both lyrical and instrumental music on physical and psychological stress. This was accomplished by having participants listen to a ten minute instrumental and ten minute lyrical song. Stress was calculated via blood pressure, heart rate, and a visual analog scale survey. This study found that both lyrical and instrumental music are equally effective at reducing physical stress but instrumental music was found to be more effective at reducing psychological stress. These findings will allow the public to be better informed as to what effect their music choices will have on their stress level. This will be highly relevant for people who lead high-stress lifestyles, including but not limited to students, professionals, and athletes.

Introduction

   Stress is a prevalent issue in today's society (deVries et al.). Many health problems, including cardiovascular disease, chronic pain, anxiety disorders, depression, burnout, and addictions are associated with increased amounts of stress (American Psychological Association [APA]). People turn to different outlets, including music, in order to reduce their stress. Consistently, many studies have been shown that music helps lower stress levels (e.g., Adiasto et al.). However, there are many different types of music that humans listen to, making this data less conclusive. Music can have varying tempos, instruments, singers, and pitch, among other elements, which could have different impacts on stress and may contribute to a varying impact on people with anxiety or stress (de Witte et al.). Thus, this paper aims to address how specific types of music, specifically instrumental and lyrical, can affect humans' stress.

   Some people choose quiet or instrumental music to listen to because they feel it could lessen their stress. Two recent meta-analyses conducted on a very broad scope of stress and music showed, however, that there was no significant difference between lyrical and instrumental music on reducing stress (de Witte et al.). Thus, despite certain conscious decisions people make on music choice to better reduce their own stress, their efforts are in vain since there is little difference in the effect. Some other research has, however, shown significant differences between lyrical and instrumental music, which is contradictory to other information published. For example, one magnetic resonance imaging (MRI) study, although centering on how different types of music impact human emotions as opposed to stress specifically, has shown that instrumental music causes a different human reaction (with different brain activation and different emotions evoked) than lyrical music (Brattico et al.). Thus, based on the aforementioned seemingly conflicting studies, it is possible that stress can also be affected by

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lyrical and instrumental music in different respective ways, especially considering it from a more brain and emotion-focused approach such as the Brattico MRI study. However, there appears to be little-to-no independent research conducted specifically focusing on the impacts of lyrical and instrumental music on stress, considering most experiments discussed in the two meta-analyses and other aforementioned studies focus on one genre or the other. There were few studies containing a side-by-side comparison of both.

The purpose of this study is to determine whether instrumental versus lyrical music impacts stress levels. Evidence of whether or not one of these two types of music is better at reducing stress will help people be able to effectively choose music that will help their mental state, improving overall health and well-being. These results will show which specific aspects of music may be important for reducing stress, which can then help inform people in choosing what kind of music they want to listen to to reduce their stress.

The proposed study will be using three stress indicators (heart rate, blood pressure, and a pre-and-post survey based on various scales of psychological stress) to measure the change in physiological and psychological stress in participants. These stress indicators will be measured before and after listening to both instrumental and lyrical music.

To develop the hypothesis for this study, it was considered that using music containing lyrics could be more overwhelming and distracting due to more content within the music. Several studies agree, supporting that music with lyrics may be more distracting and activating instead of soothing (Good et al.; Halpern & Savary). The stimulation of being bombarded with musical content could increase stress in listeners. Therefore, It was hypothesized that instrumental music would be more effective than lyrical music in reducing both physiological and psychological stress.

Methodology

Participants and Recruitment

Convenience sampling was used, recruiting 30 participants from the nearby suburban area of Granite Bay.. Those who were minors had their parents sign the consent form for them. These participants were recruited via phone and provided a general overview of the study and an explanation of what participating in this experiment would involve. Participants were not compensated. To avoid placebo results, participants were not entirely informed of the purpose of this experiment. However, in line with APA ethical guidelines, all subjects were debriefed immediately after the study as to what the purpose of the study was. This group consisted of ages 12-79, the average age being 34.6 years old. The area of Granite Bay, California, is a primarily White area; however, some racial and ethnic diversity was included. The participants were 80% White, 16.67% Asian, and 3.34% Middle Eastern. 73.33% of the study was female due to increased willingness to participate; however, there was a significant number of male participants as well (26.67%). The inclusion criteria for these participants was that the participants did not have hearing difficulties and did not suffer any heart issues, such as arrhythmias. Both of these factors would have produced discrepancies in the experiment. Someone being hard of hearing

would make music have a lesser effect on them. Someone with a heart problem would produce unreliable results for the physiological markers of heart rate and blood pressure, since they are both dependent on a consistent and well-functioning heart. This criteria was outlined in the consent form, which participants were required to sign.

Variable	Classification	Frequency	%
Gender	Female	22	73.33%
	Male	8	26.67%
Race	White	24	80.00%
	Asian	5	16.67%
	Middle Eastern	1	3.33%
Music Experience	none	20	66.67%
	<2 years	3	15.00%
	>2 years	7	23.33%
Music Preference	Pop	14	46.67%
	Country	7	23.33%
	Rock	4	13.33%
	Rap	4	13.33%
	Classical	1	3.33%
Age	Mean	34.5667	

Table 1. Participant Characteristics

Study Design

This is an experimental study. The two conditions are listening to instrumental music versus listening to lyrical music. Each participant participated in both an instrumental music listening block and a lyrical music listening block. These blocks were randomized between participants (flipping a coin), such that there is an equal likelihood that a participant would be assigned to complete the instrumental or the lyrical condition first.

Procedures

This study was carried out in a house, specifically within the music room. This study was carried out using headphones, an iPad, a phone to play music, a sphygmomanometer (to measure blood pressure), and a Garmin smart watch to measure heart rate. Participants sat down in a naturally lit room on a small couch. Between conditions, the participants took a short five-minute

break within this room. Participants used an iPad to evaluate their stress levels on a validated Visual Analogue Scale (VAS) on Google Forms (as described in detail below). The experimenter sat adjacent to the left side of the participant. Participants were instructed to sit, complete a survey, and place on the smartwatch and headphones prior to listening to music. The smartwatch and sphygmomanometer were placed on participants five minutes before listening to the music. The smartwatch was placed on the right hand of participants. Before the music played, participants were instructed to sit silently and relax for the next ten minutes, focusing only on the music. While the music was playing, heart rate data was taken every minute. Participants were not informed of the intent of this study. Participants were not informed of what type of music they were listening to. A Google Form was also used for each participant to evaluate their stress levels before and after each condition. Heart rate data was collected using a minute-by-minute analysis and a before-and-after analysis for each condition.

This study took roughly 30-35 minutes per participant. The procedure for this experiment followed these steps:

1. Complete pre-stress survey.
2. Put on a smartwatch and measure heart rate and heart rate variability (HRV) for five minutes as a baseline measure. This data will be viewed firsthand on the watch and also stored on an iPhone.
3. Take blood pressure.
4. Play ten minutes of instrumental music (or lyrical music based on randomization).
5. Measure heart rate and HRV every minute. Complete post-stress survey.
6. Take blood pressure.
7. Take a five-minute break.
8. Re-complete steps 1-5 for lyrical music (or instrumental music based on randomization).
9. Fill out a final survey, which includes questions on musical experience and preference.

Measures

Music preference. Results from a meta-analysis of various experiments showed that there was a possible difference in how self-selected and predetermined music types affect stress levels (Adiasto et al.). To take these differences into account, a survey was conducted immediately after the experiment (including the VAS and musical experience questions), asking each participant, "What is your preferred genre of music?" with six different answers: rap, rock, pop, country, classical, and jazz.

Music experience. Music familiarity can also cause differences in stress levels (van den Bosch, et al.). Should a certain participant have more experience with classical music, it is likely that they would have a different stress response to this music than an average participant with little-to-no musical training. To control for this, a survey was conducted immediately after the experiment (including the VAS and musical experience questions) asking each participant, "Have you received classical training?" with a scale of three answers: never, for two or less years, and for two or more years.

Visual Analogue Scale (VAS). Before and after listening to each music group, participants completed a Google Form containing questions on visual analogue scales. The VAS was used to record the characteristics of the symptom severity in participants (in this case, acute stress) since this scale is able to achieve a rapid (statistically measurable and reproducible) classification of symptom severity (Klimek et al.). The VAS includes 5 items ('I feel on edge at present,' 'I feel emotionally uncomfortable,' 'I feel like my heart is pounding in my chest,' 'My mind is racing right now, I have a lot of thoughts,' and 'I feel fidgety right now, I need to walk around or move'), requesting that participants rate their severity on a scale of 1-10 (1 being the least severe and 10 being the most). This information was placed into a composite score out of 50 for each participant for before and after each condition.

Heart Rate in beats per minute (BPM). Before the participant listened to music, their heart rate was calculated for one minute. Once the participant began to listen to the music, their heart rate was calculated by a minute-by-minute scale. This provided an analysis of change in heart rate over time as well as a before-and-after comparison. Heart rate was calculated using a Garmin smart watch, which was placed on the right wrist of participants.

Blood Pressure (BP). Blood pressure was measured immediately before and after listening to each music group. A sphygmomanometer was used to obtain this data.

Data Analysis

A paired t-test was used to analyze both physiological measures (BPM and BP), as well as the results of the psychological VAS. The VAS scores from five questions were combined into a composite score out of 50. The information recorded before the experiment from the pre-survey, smart watch, and sphygmomanometer was used as pre-test indicators, whereas the post-survey and final recordings of physiological measures served as post-test indicators. For blood pressure, data was broken into four different groupings: initial systolic (pressure in arteries when the heart beats before listening to music), initial diastolic (pressure in arteries when the heart rests between beats before listening to music), ending systolic (pressure in arteries when the heart beats after listening to music), and ending diastolic (pressure in arteries when the heart rests between beats after listening to music).

Results

There appears to be little to no significant difference between instrumental and lyrical music and their effects on both physical stress. However, there is a significant difference between instrumental and lyrical music on a psychological level, and instrumental music is more effective at reducing psychological stress. This disproves my original hypothesis, that instrumental music is more effective at reducing both physiological and psychological stress.

			statistic	df	p	Mean difference	SE difference		Effect Size
INSHR0	LYRHR0	Student's t	0.207	29.0	0.837	0.333	1.608	Cohen's d	0.0378
INSHR1	LYRHR1	Student's t	−0.621	29.0	0.540	−0.600	0.967	Cohen's d	−0.1133
INSHR2	LYRHR2	Student's t	0.729	29.0	0.472	0.800	1.097	Cohen's d	0.1332
INSHR3	LYRHR3	Student's t	−2.282	29.0	0.030	−2.600	1.139	Cohen's d	−0.4167
INSHR4	LYRHR4	Student's t	−0.112	29.0	0.911	−0.133	1.188	Cohen's d	−0.0205
INSHR5	LYRHR5	Student's t	−0.947	29.0	0.351	−1.067	1.126	Cohen's d	−0.1729
INSHR6	LYRHR6	Student's t	−2.655	29.0	0.013	−2.567	0.967	Cohen's d	−0.4846
INSHR7	LYRHR7	Student's t	−2.629	29.0	0.014	−3.333	1.268	Cohen's d	−0.4800
INSHR8	LYRHR8	Student's t	−0.888	29.0	0.382	−0.833	0.938	Cohen's d	−0.1621
INSHR9	LYRHR9	Student's t	−3.036	29.0	0.005	−2.133	0.703	Cohen's d	−0.5544
INSHR10	LYRHR10	Student's t	−1.298	29.0	0.205	−1.567	1.207	Cohen's d	−0.2370

Note. H_a $\mu_{\text{Measure 1 - Measure 2}} \neq 0$

Table 2. Heart Rate Paired Samples T-Test

	N	Mean	Median	SD	SE
INSHR0	30	72.5	72.5	6.31	1.15
LYRHR0	30	72.2	71.0	7.94	1.45
INSHR1	30	67.5	69.0	7.10	1.30
LYRHR1	30	68.1	68.0	7.62	1.39
INSHR2	30	68.2	67.0	9.25	1.69
LYRHR2	30	67.4	69.0	7.74	1.41
INSHR3	30	67.2	67.5	8.52	1.56
LYRHR3	30	69.8	68.5	8.26	1.51
INSHR4	30	68.4	68.0	8.85	1.62
LYRHR4	30	68.5	68.5	7.60	1.39
INSHR5	30	69.3	67.0	8.89	1.62
LYRHR5	30	70.4	69.0	7.92	1.45
INSHR6	30	67.6	68.5	8.56	1.56
LYRHR6	30	70.2	70.0	8.31	1.52
INSHR7	30	67.2	66.5	8.50	1.55
LYRHR7	30	70.6	69.5	7.96	1.45
INSHR8	30	68.1	68.0	8.45	1.54
LYRHR8	30	69.0	70.0	7.85	1.43
INSHR9	30	68.2	67.5	8.24	1.50
LYRHR9	30	70.3	70.5	7.66	1.40
INSHR10	30	67.3	67.5	7.89	1.44
LYRHR10	30	68.9	69.5	6.50	1.19

Table 3. Heart Rate Descriptive Data

For heart rate, instrumental music appeared to be significantly better at reducing heart rate when minutes = 3, 6, 7, and 9. At minutes 3, 6, 7, and 9 (*p=0.03, 0.013, 0.014, 0.005, d=-0.4167,-0.4846,-0.4800,-0.5544*), the mean heart rate values for instrumental were 67.2, 67.6, 67.2, and 68.1 respectively, compared to lyrical mean heart rate values of 69.8, 70.2, 70.6, and 70.3. The other 7 timestamps reported no significant statistical difference between groups (lyrical and instrumental).

			statistic	df	p	Mean difference	SE difference			Effect Size
INS_initial_SysBP	LYR_initial_SysBP	Student's t	−0.0472	28.0	0.963	−0.0690	1.46	Cohen's d	−0.00876
INS_initial_DiasBP	LYR_initial_DiasBP	Student's t	0.7284	28.0	0.472	0.7931	1.09	Cohen's d	0.13525
INS_end_SysBP	LYR_end_SysBP	Student's t	1.0127	27.0	0.320	3.4286	3.39	Cohen's d	0.19139
INS_end_DiasBP	LYR_end_DiasBP	Student's t	0.2435	26.0	0.810	0.6667	2.74	Cohen's d	0.04686

Note. $H_a \, \mu_{\text{Measure 1 - Measure 2}} \neq 0$

Table 4. Blood Pressure Paired Samples T-Test

	N	Mean	Median	SD	SE
INS_initial_SysBP	29	111.4	111	12.9	2.39
LYR_initial_SysBP	29	111.5	110	14.7	2.72
INS_initial_DiasBP	29	75.5	74	10.5	1.95
LYR_initial_DiasBP	29	74.7	75	11.0	2.05
INS_end_SysBP	28	111.0	110	12.7	2.40
LYR_end_SysBP	28	107.6	105	13.5	2.56
INS_end_DiasBP	27	74.8	77	10.8	2.09
LYR_end_DiasBP	27	74.1	74	11.3	2.17

Table 5. Blood Pressure Descriptive Data

For blood pressure, there appeared to be no statistical significance between instrumental and lyrical groups (*p*=0.963, 0.472, 0.320, 0.810, and *d*=-0.0690, 0.7931, 3.4286, 0.6667) for initial systolic, initial diastolic, ending systolic, and ending diastolic.

			statistic	df	p	Mean difference	SE difference			Effect Size
initial_ins	initial_lyr	Student's t	−0.754	29.0	0.457	−1.13	1.504	Cohen's d	−0.138
ending_ins	ending_lyr	Student's t	−2.272	29.0	0.031	−1.20	0.528	Cohen's d	−0.415

Note. $H_a \, \mu_{\text{Measure 1 - Measure 2}} \neq 0$

Table 6. Visual Analog Scale Paired Samples T-Test

	N	Mean	Median	SD	SE
initial_ins	30	10.50	7.00	6.85	1.250
initial_lyr	30	11.63	10.00	6.13	1.120
ending_ins	30	7.70	6.50	3.49	0.636
ending_lyr	30	8.90	8.00	4.54	0.830

Table 7. Visual Analog Scale Descriptive Data

For the visual analogue scale results, the composite score provided no significant difference for initial data but a significant difference for the ending data (*p*=0.457, 0.031, *d*=-1.13, -1.20). For the ending survey results, instrumental music had a mean composite score of 7.7 while lyrical music had a score of 8.9. A lower score indicates lower stress, so instrumental music is psychologically more effective at decreasing stress than instrumental music.

Discussion

Overall, there is no trend on a physiological level between stress levels and instrumental music compared to lyrical music, though instrumental music is more effective at decreasing psychological stress than lyrical music.

The purpose of this research study was to measure the impacts that lyrical and instrumental music have on stress, and whether one genre of music has a more significant impact on stress levels than the other. The original hypothesis, that instrumental music would be more effective than lyrical music in reducing both physiological and psychological stress, was proven incorrect through the data collected from heart rates, blood pressure, and the stress survey. Instead, there was no significant difference between groups for both physical stress markers (heart rate and blood pressure). Simultaneously, instrumental music was significantly better at reducing physiological stress, considering the significant difference between groups for the visual analog stress scale data.

These findings appear to match those of similar studies done in the past. The two meta-analyses showed that there was little difference between instrumental music and lyrical music when it came to reducing physiological stress (de Witte et al.). MRI research supports the visual analogue scale data, demonstrating that there is a significant difference between the ability of lyrical versus instrumental music to reduce psychological stress (Brattico, et al.). That being said, there are little-to-no other studies that show both of these results simultaneously: an ability for instrumental and lyrical groups to be equally successful at reducing physiological stress but unequal at psychological stress.

These findings could possibly be applied when people are selecting music to reduce stress. If someone wishes to listen to music to reduce physical stress, they should potentially choose whichever genre they prefer. Neither selecting instrumental nor lyrical music will make an impact on how stress is reduced on a physical level. These findings could help people more effectively choose the music that will help their mental state, and the ability to make more informed choices could improve health and well-being in those who listen to music. The findings will also allow the general public to understand how their feelings of stress may or may not be reflected on a physiological level, considering that there appears to be a disconnect between changes in psychological and physiological stress.

In terms of implications for future research, additional research such as studies involving increased listening time, larger subject pools, and more psychological stress indicators should be conducted to ascertain these findings. A more diverse and extensive follow-up study would be valuable in terms of the results. It would be valuable to see if listening to instrumental music versus lyrical music for roughly an hour compared to ten minutes would skew results in any way. Additional research topics that should be investigated include whether someone's favorite genre of music can help reduce stress and whether song familiarity impacts stress levels. Additional research should also be done on whether there appears to continuously be a disconnect between psychological and physiological stress, which would confirm the results of this present study.

The study is limited by the song choice. The song played was "All Too Well Ten Minute Version" by Taylor Swift in both its original (non-explicit) form and an instrumental piano version. This song was chosen for its length of 10 minutes, since it was necessary for the pop song to be continuous so as to not interrupt the listening experience. A longer listening time provides more reliable results. That being said, Taylor Swift is a musical artist whose music may evoke strong feelings for some people, whether it be a love or hate for her. These feelings would likely work to skew heart rate and blood pressure results. Such skewing was found in four of the participants, who instantly recognized the song and began to smile and bob their head, which produced higher than average heart rate values.

More extensive retesting using various songs and longer listening periods could help remove any of these errors. Furthermore, the visual analogue scale was a self-report measure which could also produce human error. Additionally, this study of convenience was done in a predominantly White area, and therefore, there was a large discrepancy of racial diversity in the study. Retesting with a larger and more diverse group of subjects could help address this and increase the generalizability of results. The study had strengths in the various different forms of stress being evaluated, including heart rate, blood pressure, and the survey.

Conclusion

This investigation revealed significant information regarding the effects of instrumental and lyrical music on human stress levels. This was accomplished through an experimental study involving listening to the two genres of music for ten minutes and viewing their effects on participants. These effects were noted to be decidedly different between the two types of stress: physical and emotional. Physical stress was measured via heart rate and blood pressure, while psychological stress was measured by a visual analog scale survey.

Although some time frames demonstrated significant differences between groups, there was generally little difference between the two genres of music when it came to effects on heart rate. Therefore, there was no significant difference between lyrical and instrumental music on heart rate. For both systolic and diastolic indicators, there was no significant difference between groups for blood pressure as well. Overall, these results proved that instrumental and lyrical music have the same effect on physical stress.

On the visual analog scale, however, there was a significant difference between the composite stress scores for lyrical and instrumental music. Instrumental music had a significantly lower stress score, meaning that instrumental music was significantly better at reducing psychological stress.

In summary, this research proved that both lyrical and instrumental music have the same effects on physical stress. However, instrumental music is demonstrated to be significantly better at reducing psychological stress.

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'For A Drawing-Card': The Twentieth Century American Indigenous Identity in By Modernist Narratives

Abstract

This paper examines the twentieth-century American perception of Indigeneity and analyzes how this perception established socio-political reality for Native American life. Modernity is a political, social, economic, and intellectual movement founded on Enlightenment ideologies wherein Western doctrines of democracy, scientificism, and capitalism were extended to every nation and culture. The Indigenous identity became a modernist artifact, as it was commercialized, distorted, appropriated, and radicalized under all spheres of American society. Modernity proclaims the universality of the Western experience and the breaking of barriers, but in doing so, it wields confusion, enacting practical ramifications on marginalized communities. This paper analyzes not only academic works but plays, poetry, legislation, biographies, shows, letters, and court cases in order to unravel the fundamental irony behind modernity's preachings on Indigenous affairs.

Introduction

> *Thursday, 11th of October.*
>
> *....on Friday they arrived at a small island of the Lucayos, called, in the language of the Indians, 'Guanahani'. Presently they saw naked people…they were a people who could be more easily freed and converted to our holy faith by love than by force, [we] gave to some of them red caps, and glass beads to put round their necks, and many other things of little value, which gave them great pleasure, and made them so much our friends that it was a marvel to see … [they] appeared to me to be a race of people very poor in everything. They go as naked as when their mothers bore them, and so do the women, although I did not see more than one young girl.[1]*

This short description of the island of San Salvador, written by Christopher Columbus in 1492, documents the legendary 'first encounter' between Native American and European peoples.[2] It was a harmonious atmosphere, if Columbus' singular account may be trusted – though relations would swiftly deteriorate, unfurling a blood-ridden history of violence, oppression, and upheaval throughout the continent. Columbus' remarks, patronizing as they may seem, would continue to inform our perception of Indigenous-European relations for many years to come.

Although this paper will focus on the 20th-century understanding, it is important to reflect on the lengthy history of Indigenous misrepresentation. A few centuries after Columbus, Enlightenment philosopher Jean-Jacques Rousseau introduced the portrait of the 'noble savage' in 1755 with his work *Discours sur l'origine et les fondements de l'inégalité parmi les hommes,* which proposed that there was a human 'natural state of existence', devoid of all civilization and free of sin, thus rendering the 'savage' an ideology.[3] Nineteenth-century scholars Frederick Jackson Turner, Timothy Flint, Francis Parkman, George Bancroft and William H. Prescott were

among those who disagreed with him, believing instead that the 'failure' of Indigenous peoples was a genetic and historical inevitability. These scholars argued that the 'fundamental inferiority' of the 'Indian race' predetermined their defeat by white conquerors.[4]

At the dawn of the twentieth century, the academic discourse shifted its focus to assimilation. The Grant administration's 'Peace policy' enforced nationwide Native American assimilation and relocation,[5] and Supreme Court cases like *US v. Sandoval* (1913) established a precedent for government plenary power over Native American tribes.[6] James A. Clifton, a twentieth-century anthropologist and Indigenous scholar, thought the 1950s represented a threshold for Indigenous studies.[7] A decade prior, in the 40s, Native American communities faced almost uniform rejection from all spheres of society. A decade later, however, were the 60s, and the Youth Movement arose. This generation witnessed a mass adolescent migration into countercultural 'Indian camps' and an idealistic revival of 'savage practices', almost recalling Rousseau's vision of a society free of sin. At the point in time between these two polarities, audiences and scholars were entertained by florid, exotic illustrations; intrigued by philosophical discourse; bombarded with assumptions; daunted by captivity narratives; stunned by poignant accounts of mistreatment; all culminating in the inception of the American Society for Ethnohistory in 1966.[8]

This was a momentous occasion. The American Society for Ethnohistory declared Native American history as its main axis of research, never attempted in historiography. "Until the 1950s, the scholarly study of Indians was dominated by anthropologists", wrote James A. Clifton. He was likely referring to the theories of 'Indian inferiority' proposed by Turner et al. to elevate the status of European peoples. Yet Clifton continued that, since the founding of the Society, "droves of historians and smaller numbers of geographers, literary specialists, and political scientists have joined in" carving this relatively niche territory, expanding the bounds of Indigenous research and exploring its depths and possibilities.[9] Clifton's contemporary James Axtell, himself a historian, wrote in 1997:

> *Thirty years ago, when I was entering the academic profession, very few historians pursued the history of America's native peoples. Certainly no historians I knew felt particularly guilty for leaving Indian peoples out of their courses and books, for implying that America had no history until the advent of scribbling Europeans and that, even after 1492, Indians had little to do with the making of American society and culture generally.[10]*

Yet after the American Society for Ethnohistory, scholars finally directed their attention towards Indigenous peoples. Investigations into Native American culture, heritage, and society began emerging as independent ventures, not simply side pursuits in providing pseudoscientific evidence for white supremacy. Through legitimizing and attributing academic value to the field of Ethnohistory, the Society gave rise to well-known scholars such as Donald Fixico, James H. Merrell, and Arthur Parker.

Since then, Ethnohistory has experienced great and rapid change. A 1985 review conducted by Charlotte Heth and Susan Guyette stated that there were around 105 Native

American Studies programs operating on higher education levels in the U.S. at the time.[11] As of 2019, the Association on American Indian Affairs counted at least 215 Native American Studies programs hosted by U.S. universities, substantiating a doubling of quantity which had occurred over 34 years, remarkable considering the labor and funding it requires to construct an entirely new department for any institution. If these sums were averaged, more than 6 universities would add a Native American Studies program to their syllabus each year.[12] This is to say that, currently, Indigenous studies is a thriving field populated with learned and zealous scholars, wildly different from Clifton and Axtell's time.

It may be observed, however, that institutions no longer use the term 'Ethnohistory' to describe their courses. In fact, upheaval in this field has been so frequent and radical that 'Ethnohistory' no longer exists. Scholars found this denomination problematic due to its ambiguity, an ambiguity that can easily become offensive. 'Ethnohistory' denotes, literally, 'ethnic history' – and labeling Indigenous studies as simply 'ethnic' is hardly appropriate or productive, not to mention the racism in equating all ethnic minorities. Nowadays, we speak of NAS, 'Native American Studies'. But in this fluid, charged discipline, any dispute could switch directions overnight. Any statement could be overturned. More importantly, anything could become fragile.

Methodology is one such thing. Calvin Martin surveyed the field in 1987, stating that historians, in order to portray "authentic histories of American Indians", must "get out of history, as [they] know it", and see themselves as "cosmic mutilage", rewiring their heads with "mythic circuitry", writing their accounts in "mythic language", and to the greatest extent, becoming Native American.[13] Martin himself wielded grandiose, fantastical terminology, exposing an exoticized understanding of Indigeneity that is clearly incomplete. James A. Clifton advocated for quite the opposite, stating that in order to "avoid the biasing effects" of contemporary narratives surrounding Native American peoples, scholars must write history with "some distance…required" between them and their subjects.[14] Both documents, however, involved an internal analysis of the processes central to the field. They evoke one of the most significant questions in Native American Studies: where, when, and how should one investigate what it means to be Indigenous?

I will contribute towards the understanding of this question by exploring how, in the 'modern age' or twentieth century, scholars and civilians have portrayed and comprehended Indigeneity, and what effects these portrayals had on subsequent realities faced by Indigenous peoples. By inquiring into this time period, I aim to elucidate the ramifications of faulty modernist cognition. I hope that an analysis of the twentieth century Ethnohistorian psyche may caution those in and out of the field of the lasting power of racist outlooks.

It is important to note that, despite this essay's focus on white American interactions with the Indigenous identity, Indigenous history did not start with Christopher Columbus' expedition, nor is it limited to Indigenous resistance under colonial paradigms. That is to say, the importance of preserving Native American heritage should not be measured in its relevance to the Western narrative. Although this essay examines non-Native sources, Native American primary and/or

oral authority is preferable to second-hand accounts of white historians when describing matters of culture and identity, however, non-Native records can be useful when utilized as primary sources of their own. Lastly, while the term 'Native American' is used in this essay to represent a collective of Indigenous communities in the United States for the purpose of measuring a greater racial trend, it fails to acknowledge the heterogeneity of individual cultures which form this collective. Through clarifying my usage of the term, I hope to refrain from participating in colonial vocabulary.

In the following section, I will explain how Americans' interpretations of the Indigenous identity changed as a result of modernity, by first examining the commodification of Indigeneity, then the radicalization and reprivatization that simultaneously occurred during this time period. I will end by exhibiting the effects of these conflicting modernist models on Native American life in the twentieth century.

Commodified and Accessible

"So that when I say that I am not, have never been, nor offered myself as an authority on things Amerindian, I do not wish to have it understood that I may not, at times, have succeeded in becoming an Indian", writes Mary Hunter Austin in her 1930 analysis of Native American music *The American Rhythm*.[15] "I liked to visit the Indian camp, where people in headbands, fringed leather jackets, and moccasins padded quietly about, calling each other names I cannot quite recall but that had the kind of faux-Indian ring — Rainbow, maybe, or Green Wood," remarked Philip J. Deloria in his book *Playing Indian*, as he recollected childhood in the seventies.[16] "For Karl May aficionados…his descriptions of American Indian life are more real than reality itself," observes James H. Howard, a Native American Studies professor who went on a sabbatical in order to contemplate European Indianist movements. After attending a pow-wow at South Norwood, he concludes, "I was greatly impressed with the high quality of costuming and dancing of these English Indianists".[17]

By the time Howard set off for Europe, it would have been more than fifty years since Mary Austin lay down her pen. Yet these two generations would share the same outlook on identity and Indigeneity that reflected the development of American modernity, shadowed by the cultural primacy of a neocolonial and capitalist consciousness. Under this movement, the Indigenous identity was simplified and distorted into consumable mouthfuls that Americans could digest, blurring the labels of 'colonizer' and 'colonized'.

The popular narrative goes: stemming from intellectual movements like the Renaissance, the Protestant Reformation, and the Enlightenment, political movements such as the Atlantic Revolutions, and economic movements such as industrialization and commercialization, numerous Western European states sustained a series of rapid developments which fashioned structures such as parliamentary democracy, positivism and free-market capitalism. As these states globalized, they globalized a belief which held the aforementioned structures in the highest universal esteem.[18] That belief nursed specific social, political, economic, and even geographic conditions now widely denoted as 'modernity'. Of course, this was only the case for a certain

number of societies. Regilme notes that there exists a "whole canon on the 'European-centric modernity narrative' which attempts to exclude, to discriminate and to undermine non-Western/Other narratives of modernity", "acutely expressive of…non-willingness to understand the cultural intricacies of the non-Western 'Other'".[19] However, for the purposes of historiography, it is important to know not just the truth but what was then believed true.

Modernity, the perceived "rationalization of the world", boasted "putatively *universal*…criteria" and "boundary-crossing traditions".[20] Rigid class systems and pyramids of power were trespassed, borders were broken down, movements of delegitimization appealed "to an ethical universal".[21] It is easy to define modernity as a frame of thought; corporeal functions such as ethnicity and race melted together under "culture- and history-transcending standards".[22] The world was perceived as one entity and not a miscellany of diversities. Human rights, scientism and liberalism were declared universally correct. Max Weber saw it as the monopolization of the Enlightenment and Francis Fukuyama famously proclaimed it as the triumph of the Western liberal democracy and "the End of History".[23] Marshall Berman believed that modernity was an experience, breaking "all boundaries of geography and ethnicity, of class and nationality, of religion and ideology", an age meant to "unite all mankind".[24] He further cleaved the category of 'late modernity', a period starting from 1900 where the modern lifestyle became vividly etched into the daily experiences of North Americans. Late modernity, argued Berman, penetrated every individual living under the reach of European ideals with its full impact.[25]

Kwame Appiah Anthony agreed that modernity was a unification. However, he examined it as an economic movement, contending that it introduced the commodification of the world, every aspect of it – every physical and intangible object, among which all minor distinctions disintegrated.[26] He named this the "incorporation of all areas…into the money economy".[27] Elizabeth Outka, in *Consuming Traditions: Modernity, Modernism and the Commodified Authentic*, analyzed how a symbol of a desirable lifestyle could be captured and commodified by exploring the department store Selfridges. She identified manipulation of nostalgia in the store's layout and decor, and she found it effective – "the high class shopping experience was packaged and sold…shoppers were recast from materialistic consumers snatching up new and gaudy products to calm and dignified guests selecting choice items".[28] As concepts like love were reduced to sellable bouquets of roses, one too could simplify and exploit the Native American identity, an act that occurred almost instantaneously, in all walks of life, and not only for economic gains. Modernity, staking the claim that 'we are all the same', led previously uncrossed thresholds between ethnicities to break down. However, this was compounded by the fact that with the rise of a consumerist culture, anything could come to serve an economic purpose. With both these factors in place, Indigeneity became an accessible resource, a free-to-take possession which non-Indians could try on and take off, like a new dress.

In the intellectual community, scholars and writers subscribed to *salvage anthropology*, "the notion that one could cross time and culture to gather up an Indian past".[29] Identities blurred alongside boundaries. Historians morphed into their writing-subjects. Poet John Neihardt took up

residence with the Oglala Lakota community in 1931 and wrote two books, *Black Elk Speaks* (1932) and *When the Tree Flowered* (1951) in somber retellings of pre- and post-colonial Lakota heritage, exemplifying "modernist regret [and] nostalgia".[30] Yet he simply recounted his role in storytelling with a tag of *as told through*, rendering it ambiguous at times whether Lakota medicine man Black Elk was speaking or the author himself. This instance could evidence historians' own confusion of American, Native, personal, and historical identities; at worst, it could point to the very exploitation Kwame Anthony Appiah described. Neihardt's view of the Indigenous identity exemplified modernist boundary-crossing: "my acquaintance with the Indian consciousness had been fairly intimate…the inner world of Black Elk, imperfectly revealed as by flashes that day, was both strange and wonderful to me".[31] He delineated the depths of the 'Native American mind', constructed here as an eccentric fantasy-world, and he exulted in his own ability to enter it. This phenomenon would replicate itself two decades later, when scholar Joseph Epes Brown similarly "blurs the boundaries between subject and recorder" in recounting Oglala Lakota stories. Epes Brown published *The Sacred Pipe* in 1953, also about the Lakota community, also, interestingly, centered on Black Elk.[32]

Joseph Conrad's *Heart of Darkness*, published in 1899, told the story of how an individual, in visiting the colonized Congo, witnessed 'civilized people' melding into 'savages'.[33] What is also notable about this text, however, is its rise to stardom; when it was first published, in fact, alongside two other short stories, it was seen as the lesser of the three. Literary critic F. R. Leavis had defined it as a "minor work" characterized by "inexpressible and incomprehensible mystery".[34] And yet by the 1940s and 50s, when the self-reflective aspects of modernity reached their apex, Conrad's 'minor work' received an abundance of in-depth analyses and ascended to literary greatness for its portrayal of the 'noble savage' and the horrors of imperialism.[35] *Heart of Darkness* exemplified the function of historiography and the value of re-reading historical texts from a different era. More importantly, the book presented civilization as an alternate version of savagery. Native Americans and Europeans, in Conrad's words, became less polar opposites than shadows of one another; one just as bad as the next.

This shift was also reflected on a governmental level. The 1987 U.S. Congress, in a strange move that caught many off guard, approved a resolution declaring that "the Articles of Confederation and the US Constitution were modeled on the principles of the League of the Iroquois".[36] James A. Clifton called the decision "bizarre" and declared that "there is not a whit of objective evidence to support this political myth".[37] As contrived as it may seem, Congress' efforts did echo popular sentiment. The blending of the Constitution, something distinctly part of the American legacy, and the principles of the League of the Iroquois, perfectly symbolized modernist confusion. It was also a clear example of political exploitation. The government desired to embark upon a new direction, and in their aim, nonchalantly appropriated Iroquois heritage, assuming that it was free to take. Implying Iroquois inheritance onto every Constitution-protected American, asserting that Iroquois values aligned entirely with Western ideals of liberty and equality, and capitalizing off Iroquois history was a compound move by Congress that could not better encapsulate the purpose of modernity as an intellectual, political,

and economic force. "Our most powerful political institutions contribute to popular beliefs about Indians", Clifton concluded. He noted, significantly, that though the entire room knew these were faulty claims, there was "no apparent hesitation among the senators and representatives" as they cast their votes for the affirmative. Perhaps that observation cemented the acknowledgement as an empty gesture, devoid of respect.[38]

As significant as they were, institutions and academics only formed one factor in a larger socio-intellectual movement. Modernity was the reason behind the proliferation of non-Indian 'pretendians' who put on Indian acts for money: characters such as Ward Churchill, James Beckwourth, Jamake Highwater, Grey Owl, and Chief Buffalo Child Long Lance. Much-loved showman Buffalo Bill's 'Wild West' shows, spectacles romanticizing Frontier life and defining Native American stereotypes for the rest of modernity, were also prominent commercial abuses of the Indigenous identity. The trailer for the PBS program *American Experience: Buffalo Bill* narrated:

> *At the center…was one of the most famous people in the world: William Cody, better known as Buffalo Bill. The sixty-seven-year-old Cody was directing his first movie — a reenactment of the Wounded Knee massacre — and doing what he had always done: blurring the line between truth and entertainment, history and myth.*[39]

Individuals also received 'social capital' in response to playing Indian, another type of commercialization. Joel W. Martin observed that "an astonishing number of southerners assert they have a grandmother or great-grandmother who was some kind of Cherokee, often a princess", though these identifications of ancestry were made for no apparent material gain, engaging upon a sort of intellectual barrier-breaking behavior which posed the stereotypical Native American identity as desirable and exciting.[40] As Philip J. Deloria elaborated in *Playing Indian*, counterculturalists in Canada lived their interpretation of an Indigenous lifestyle: erecting tipis, maintaining a diet of corn-beans-squash, wearing Indigenous costume (often bare-chested ones), offering "compelling performances" of slapping at their chests and shouting incomprehensible 'Yi Yi's while exchanging joints and beer.[41] Individuals who did not commit to such a drastic change also showed affinity with the Indianist movement, by subscribing to fraternal clubs that flourished in cities like New York, attending Buffalo Bill's shows, reading magazines such as *Out West* which advertised primitivism as its own commodity.[42] This 'new dress' of non-Indigneous Indigeneity allowed Americans to see themselves as the people they oppressed.

For non-Native Americans, assuming Indigenous identity functions to mimic suffering under an imperialist regime, to appropriate the generations of oppression Indigenous people endured by wearing a feathered costume. "I have suggested that whenever white Americans have confronted crises of identity, some of them have inevitably turned to Indians", Deloria proposed. "To play Indian was to become vicariously a victim of United States imperialism".[43] It is possible that non-Natives who felt sympathy towards oppressed communities in the imperialist age experienced a need to align themselves in some way with a non-imperialist agenda. In realizing their own identities as the oppressors, they sought to shirk guilt by dressing up as a different

identity. This influx of modernist regret was catalyzed by a combination of intellectual and political developments. 'Vanishing Race Theory' presented the idea that Indians were disappearing, 'going extinct' and in need of some 'biological preservation'.[44] The stereotype of the 'noble savage' represented the pure uncivilized good vested in humanity. The strikingly named Trail of Tears appalled viewers ready to condemn their government.

Unto These Hills, an outdoor historical drama (for-profit) written by Kermit Hunter about the Trail of Tears and first performed in 1950, captured these modernist delicacies perfectly. Hugely popular at its time, Hunter wrote of the terrors of Cherokee forced displacement and their struggle to retain their homes, striking a chord with many and altering their perceptions of Cherokee people forever.[45] And yet all Indigenous characters spoke of themselves in the third person. Hunter confused Yonagusta, the Cherokee chief at the time, with later leader Junaluska. The costuming and choreography was based on that of Great Plains Indians.[46] Though the production meant to sympathize and put into perspective the horrors of the Trail of Tears, the original version hardly understood its subjects or conferred onto them the dignity that such a production claimed to restore.

During this period, society perceived Indigeneity as a commodified artifact, and with that, the boundary which had kept white American society on one side and Native American communities on the other suddenly shattered. Indigeneity was seen as a political phenomenon; a new jacket; an exploit for curious, rebellious youth. Yet burdened with all these representations, American society never gave it the right to determine itself. Indigeneity, once commercialized and made accessible to Non-Native use, could not retain its original meaning. Thus with a complete disregard for what it meant to be Indigenous, and with their own goals and fantasies in mind, the non-Native person became their own Native American, while Native Americans were doubly displaced – this time from their own identity.

Isolated and Radicalized

> *I'm just a red nigg*r who love the sea,*
> *I had a sound colonial education,*
> *I have Dutch, nigg*r, and English in me,*
> *and either I'm nobody, or I'm a nation.[47]*

Derek Walcott wrote the above stanza in his epic poem, "The Schooner *Flight*" (1979), as the main character Shabine set sail from his Caribbean hometown, Carenage, while delivering monologues that exhibited his cultural confusion. In the poem, Shabine pondered over the implications of his heritage, almost out-of-reach in a chaotic mixture of nationalities. "The Schooner *Flight*", a remnant of the seventies, perhaps told the story of Walcott's own frustration instead – showing a different side to modernity, not that of glory, but of disorientation.[48]

Modernity was "culture-crossing", a time when the 'civil' and the 'savage' became indistinguishable.[49] Under my first argument, Indigenous identity entered the public domain; however, accompanying this change was, strangely, a movement towards making Indigeneity

less accessible, a wave of reinforcement to the old borders which distinguished the oppressor from the oppressed, where academic and popular understanding of the oppressed relied directly on its relation to the oppressor.

'Culture-crossing' implies that both cultures were equally respected, an implication that is then struck down by the terminology 'civil' and 'savage', which denotes a clear power imbalance. With this imbalance, the cartoonish elements of teenagers living in teepees and the over-the-top exaggerations of White 'pow-wows' are accounted for: it was fine to 'play Indian', but to become Indian, to be born as an Indian, was to be frowned upon by society. Though, at first glance, it appeared as if Indigenous customs have become accepted in the US, this surface-level acceptance could not erase the ancient racism pitted against Indigenous peoples and the deep-rooted claims of white supremacy. Through modernity, Americans were offering pity, sympathy, curiosity; yet it was just another form of colonization. Indigenous peoples were, fundamentally, not perceived as equals, and modernity's arrival did not mark a change.

This was the psyche behind popular assimilationist policies regarding Native Americans during modernity's heyday. The most coveted thing for a Native American person, it had been thought, was to integrate into dominant American culture, a process which modernity made possible. Willard W. Beatty, an American politician and scholar, expressed his opinion in 1946 article *The Goal of Indian Assimilation*:

> *Indians who live in houses which are recognized as similar to our own, who accept our sanitary standards, who dress like the rest of us, who speak in the vernacular, and who have acquired a sense of money values, find themselves at home with the rest of us and, what is more important, we begin to feel at home with them.*[50]

Even Beatty's speech exposed casual inequalities: that Americans feeling "at home" was "more important" than the so-called Indians'. For a champion of cultural coalescence, Beatty was quite eager to pit "them" against "the rest of us", rendering it difficult to believe he would really feel "at home" with any Native American without first generating a non-exhaustive list of assumptions around their Indigeneity.[51] This boundary-building disguised as breaking manifested itself everywhere. For white audiences, Indigenous identity was free to privatize, to redefine; Native American audiences were chastised no matter how they expressed themselves. Ada A. Gridley, the Program and Publicity Chairman of the Grand Council Fire of American Indians, reported the following to Gertrude Bonnin in October 1926:

> *He came to our Sunday meeting, all decked out like a Xmas tree in factory-made Indian costume, and loaded with beads and jewelry. A few minutes' conversation with him discloses that he is very weak on Indian matters. He claims to be a Yale graduate, and speaks very good English, altho [sic] he rants, but were he that old, or even 25 or 30 years younger, we do not believe he could speak without any noticeable accent of the 'old Indian' any more than Dr. Eastman can. Furthermore, he is a full blood, and of that age, it does not seem probable he would have as strong a beard as is discernible.*[52]

Gridley, finding her subject's English too good and costume too shoddy, attempted to evaluate Osage Chief White Horse Eagle's 'Indianness' and returned with none too favorable

results. Little did she know, however, that she was speaking of a born-and-raised Osage Nation chief, who also happened to be a scholar and eloquent speaker. This quote is remarkable not only due to its satirical potential but also because, at its nucleus, were two extremely important ideas. Not only did Ada Gridley authorize herself to cleave a firm boundary between 'Indian' and 'Not', she participated in constructing the sudden 'exclusiveness' of being Indian – of being a 'real Indian' who did not wear a "factory-made costume" or speak "very good English".[53] She departed from the modernist way of thought where any white person was allowed to become Indigenous, and instead progressed to the next step – a new set of boundaries for who was Indigenous and who was not.

Gridley's correspondent, Gertrude Bonnin, or Zitkala-Ša, was a figure that almost perfectly embodied modernity's contradictions and hypocrisies. She was a Yankton Dakota activist with a white American upbringing, and sought to restore a utopian vision of modernity, one where two cultures could morph despite retaining their differences; after her death, historians posited that she was "profoundly conflicted", an individual with a "schizophrenic life, who was 'caught between cultures' and who existed in 'two diametrically opposed worlds'", a characterization which surely would have been despicable to an individual who viewed "the Indian/white binary as faulty".[54] In fact, that same binary, which had existed ever since the beginning of dialogue between Indigenous and European cultures, was meant to have been broken down by modernity's commercial framework, under which each consumer, regardless of race, presided. Despite Zitkala-Ša's efforts, the binary not only persisted, but it also thrived.

Philip J. Deloria characterized the beginning of Indigenous-European relations as comprised of "spatial metaphors" of "geography [and] conflict", in which there was "a moving boundary between European civilization and Indian savagery" termed a "frontier", the clear-drawn border Ada Gridley was referring to as she attempted to categorize Indigenous people from non-Indigenous ones, and that same binary that confounded Zitkala-Ša.[55] "Frontier paradigms suggest a relation between the ways in which Europeans understood cultural and racial difference and the ways in which they understood empire and colony," Deloria stated, exposing a long historical tendency of Europeans pitting categories against each other.[56] This 'Indian-white' dichotomy was evidenced by documents concerned with Indigenous peoples around the 1700s and 1800s, yet the symbols chosen to metaphorize European-Indigenous difference became increasingly creative. Francis Parkman, for example, in his *Conspiracy of Pontiac*, utilized the juxtaposition of 'metal' and 'rock' to contrast the durability of both sides of the frontier, one of a malleable nature, the other brittle and breakable.[57] All of these allegories, including Parkman's, posited Indigeneity as the antithesis to Western civilization; each represented different ends of a spectrum, and any understanding of the Native American end was entirely without nuance. Later on into the 1900s, as the argument went, representation diversified. Deloria himself argued that history had moved on, undergoing a "change in white historical consciousness concerning Indians",[58] and evolving into a modernist paradigm. The frontier was replaced by the amorphous whole.

The field of Native American studies had indeed evolved; Native voices like that of Zitkala-Ša were entertained; Indigeneity, though performative, still claimed a place in society; imperialism was rethought; racism became softer, more muted. And yet it was still present, just like how the frontier, though hidden under bushes and trees, was never really erased.

To recall some of the examples put forth earlier on, *Heart of Darkness* asserted the intersection of 'civil' and 'savage' identities, but not before stressing the distinctiveness of each one. Marlow, the main character, witnessed the civil become, entirely, the savage – there was no in-between. In Conrad's time, an individual was either one or the other, and this view was celebrated. Polarities were strengthened as Conrad had Marlow "feel the savagery, the utter savagery, had closed round him", and "being hungry", Marlow stated: "I was getting savage".[59] Counterculturalists in Canada and America embraced an image in stark contrast with the industrialized lifestyle in order to serve their political beliefs, living on corn, beans, squash, taking shelter in tipis and rejecting societal customs.[60] They 'crossed the frontier', went from civil to what was seen as savage, rejecting modernity's proposition that a person can at once possess characteristics both stereotypically European and Native American, albeit in a very extravagant manner. By remonstrating every single superficially white thing about them, or as they thought they were doing, these Indianists reinforced the image that once the frontier was crossed, everything white had been washed away – unless, of course, they should choose to step back into their own skin.

Recalling Congress' efforts at inheriting spurious Iroquois ancestry by claiming that the Constitution was copied from Native American treatises, the passing of this bizarre resolution was spurred by an infamous news-story concerning Slow Turtle, the "Supreme medicine man of the Wampanoag nation".[61] According to Clifton, Slow Turtle was presented as "close to nature, primal spirituality…symbol of long ago" which "expressed many of the most common American stereotypes about Indians".[62] This persuaded audiences that the injustices Slow Turtle claimed his grandfathers suffered were passed down the family, when in fact, he had been "reading… from the same press release issued elsewhere".[63]

A similar contention could be made for *Unto These Hills*, where Native American characters were purposefully made opposites of their white counterparts. An illustration of the original play denoted this binary: Indigenous characters wore little, their skins painted in a very deep red, while American soldiers stood nearby, wearing striking blue suits and purple cloaks, donning multiple layers of clothing.[64] In the script, Indigenous characters spoke stiltedly and in the third person, while white soldiers pronounced eloquent and heroic things. When placed in its historical context, Ada Gridley's previous letter suddenly makes sense – the prevalent idea in the era was that Indigenous people and white people were clearly distinguishable through surface-level characteristics, with some traits belonging uniquely to one side of the frontier and some to the other.

An understanding of modernity and its relationship with Indigeneity could not be complete without these frontiers, exemplified by their presence in every text this essay has evaluated and referred to so far. To explain this phenomenon, instead of a period, the frontier

could be interpreted as a psychological framework – a lens through which historians and civilians perceived Indigenous-white relations, carved by colonialism and loosely concealed by modernity.

Still, a mind that thinks in frontiers does not necessarily insinuate an abominable state of affairs. As Zitkala-Ša argued convincingly, one-sided assimilation, the inevitable product of deconstructing all frontiers, leads to a far worse outcome, the absolute extinction of culture and loss of meaning; she would prefer a cultural exchange where both cultures were viewed as equally important and were equally preserved.[65] Frontiers, in some form, are required. Modern-day historians such as Angela Cavender Wilson and Anton Treuer are adamant on prioritizing Indigenous oral traditions and native ways of learning and teaching, a form of self-constructed boundary.[66]

However, Zitkala-Ša, as opposed to assimilation as she was, still fought adamantly against the grand divide. There was something about these binaries built and perpetuated throughout the early and mid- twentieth century that was irresistibly, recognizably problematic. The commodification of Indigenous identity, as contended previously, warped and simplified this multifaceted cultural heritage into simple traits and manufactured products. That fact, alongside the inescapability of the mental set that was frontier thinking, created a self-feeding cycle. Boundaries can and should exist, yet Indigenous peoples did not have a chance to participate in drawing them, thus they were subjective to white understanding, and in every way wrong. 'Savagery' versus 'civilization' was hardly an accurate outlook on the Indigenous-American relationship. As everything Indigenous was defined in relation to whiteness, not to mention melded to contrast and oppose whiteness, this boundary was bound to mislead generations of people. It did not give both cultures equal space, importance, and respect – thus, frontier thinking would never come to any fruition. Instead, Indigeneity, in a time of broken barriers and commercialized identities, was pushed even farther along into extremities.

James H. Merrell declared that "the research on Indians, far from overturning long-held notions about America's colonial age, has done little to change the cast of mind that frames – and, by framing, limits – our view".[67] He was writing in 1989, retrospectively inspecting the past century's scholarship on Indigeneity, and he arrived at the conclusion:

> *The current scholarship on colonial America contains references to Indians that, combined, yield a composite portrait of natives that bears a striking resemblance to its counterpart in the 1950s (not to say the 1850s). In this portrait, North America on the eve of European colonization is a 'void', a 'virgin land', a 'vast emptiness', its 'handfuls of Indigenous people' a 'part of the landscape'; along with 'lurking beasts', 'floods and disease', Indians are one of the 'environmental hazards' colonists confronted upon disembarking….this picture, culled from many different works, only begins to convey the staying power of the older paradigm about Indians in the colonial period.*[68]

Later in this text, Merrell referenced Bernard Bailyn's *The Peopling of British North America*, intending to discuss the frontier thinking embedded in Bailyn's work. *The Peopling of British North America*, published in 1986, contrasted civilization and wilderness, detailing how

Europeans peopled a rustic, vacant land.[69] It neglected, however, to mention how Native American settlement was also a 'peopling', instead placing emphasis on "the blood that flowed when two worlds met".[70] Bailyn's work is notable due to its publication date – this theory, which should be regarded as long outdated and antiquated, he posited in 1986, a late modernist application of an extremely early modernist concept. The longevity of frontier thinking is astonishing.

Returning to Zitkala-Ša, she provided a fascinating interpretation of the frontier paradigm in relation to Native American social experiences, seen especially in her letters.

> *In a letter to Arthur Parker in March 1917, [Zitkala-Ša] notes that she has been invited to speak and play a piano solo at the 'most popular church in Pasadena', with the stipulation that she appear 'all in Indian dress'. As she writes, 'I have agreed, for in this case the use of Indian dress for a drawing card, is for a good cause'.…'No doubt, there may be some, who may not wholly approve of the Indian dress. I hope it does not displease you. Even a clown has to dress differently from his usual citizen's suit'.[71]*

Zitkala-Ša, pronounced objector of dichotomies and stereotypes, witnessed her own reduction into commodified artifacts in a manifestation of the invisible frontier. However, she withstood the discomfort such a characterization brought and agreed to operate under this framework, as she said, for the "good cause" of a frivolous, suburban-sounding drawing card.[72] A 'drawing-card' is "a performer, act…certain to attract a large audience".[73] This perhaps offers some insight into how Native American activists viewed modernity's boundary-breaking: knowing fully well how Indigeneity was manipulated by modernity, becoming both popular and ostracized, and yet embracing it nonetheless, forsaking authenticity in the short term for the sake of advancing their community's best interests.

Practical Ramifications in the American Legal System

It seems like a given that Western intellectual movements would have impacts on Western thought regarding Indigenous peoples. As abstract as modernity's collision of ironies may seem, however, it exerted a pronounced impact on the political and day-to-day realities faced by Native American nations at the time. Though "their views are often overwhelmed by messages spread by the mass media and other institutional forces," James Clifton reasoned, "scholars and academics make their distinctive offerings to what North Americans know of Indians".[74] The very North Americans receiving mixed messages about Indigenous peoples were the ones holding power in society, directly linking intellectual discourse in the mid-twentieth century United States to Native American livelihood – as in the case of *United States v. Antelope*, the fates of three Native Americans from the Coeur d'Alene Reservation in northwestern Idaho.

The predecessor of *US v. Antelope*, a landmark 1883 case named *Ex parte Crow Dog*, prompted Congress to pass a bill called the 'Major Crimes Act' which named Native American crimes within their own communities as federal offenses.[75] In *Ex parte Crow Dog*, the Lakota leader Spotted Tail was shot by Brulé-Lakota leader Crow Dog, who was tried in a federal court and sentenced to death. He appealed to the Supreme Court, however, which overturned his

sentence on the account that there was no judiciary basis for punishing Indigenous criminal acts within Indigenous reservations. Two years later, the Major Crimes Act was approved, incorporating Native American legal conflicts under U.S. jurisdiction, and depriving Native American legal systems of their authority – without Native input throughout the process.[76]

In the 1977 case *US v. Antelope*, Gabriel Antelope, Leonard Davison, and William Davison robbed and killed Emma T. Johnson, an inhabitant of the nearby town Worley, Idaho.[77] The enaction of the Major Crimes Act stated that they were to be tried under federal law, and Antelope was found guilty of first-degree murder and sentenced to a life term in prison. The problem was that federal law required a lower burden of proof to qualify for first-degree murder than Idaho state law. Idaho necessitated the State to prove premeditation, while federal law lacked such a provision. Antelope appealed to the Ninth Circuit Court of Appeals, contending that had he been a white American, he would not have been convicted of first-degree murder.[78] The Ninth Circuit Court agreed, stating that "the cornerstone of appellants' challenge is that they are discriminated against by reason of the racial based disparity between Government burden of proofs…a statute unconstitutional in its application to them".[79]

Assistant US Attorney Mikei Williams then appealed this verdict to the US Supreme Court, which unanimously voted to reverse it.[80] Chief Justice Burger delivered the opinion of the court:

> *Held: Respondent Indians were not deprived of the equal protection of the laws. Pp. 645-650.*
> *(a) The federal criminal statutes enforced here are based neither in whole nor in part upon impermissible racial classifications. Federal regulation of Indian tribes is rooted in the unique status of Indians as "a separate people" with their own political institutions, and is not to be viewed as legislation of a " 'racial' group consisting of 'Indians'...Morton v. Mancari, 417 U. S. 535, 553 n. 24. Pp. 645-647.*
> *(b) The challenged statutes do not otherwise violate equal protection. Respondents were subjected to the same body of law as any other individuals, Indian or non-Indian, charged with first-degree murder committed in a federal enclave. Congress has undoubted power to prescribe a criminal code applicable to Indian country, and the disparity between federal law and Idaho law has no equal protection or other constitutional significance. Pp. 647-650.*
> *523 F. 2d 400, reversed and remanded.*[81]

It is important to note Chief Justice Burger's wording when he speaks of "a separate people" and "federal enclave".[82] He pursued the subject, however, and continued molding a definition for Indigenous status within the United States:

> *"Indian tribes are unique aggregations possessing attributes of sovereignty over both their members and their territory, Worcester v. Georgia, 6 Pet. 515, 557 (1832); they are 'a separate people' possessing 'the power of regulating their internal and social relations…'" United States v. Mazurie, 419 U. S. 544, 557 (1975) .... we said in Morton v.*

Mancari, 417 U. S. 535, 552 (1974): "Literally every piece of legislation dealing with Indian tribes and reservations ... single[s] out for special treatment a constituency of tribal Indians living on or near reservations. ...the Court unanimously concluded in Mancari: "The preference, as applied, is granted to Indians not as a discrete racial group, but, rather, as members of quasisovereign tribal entities .. . ." Id., at 554.[83]

The Supreme Court contended that Antelope's claim of discrimination was invalid since the status of being Native American was a political state and not a racial one. Differential treatment could be legally applied to "*quasisovereign*" polities without violating the Constitution, which prohibited only racial discrimination.[84] In the perception of Chief Justice Burger and his contemporaries, "attributes of sovereignty" were sufficient for differentiating Native American peoples from ethnic groups in America, as other ethnic groups have accepted political assimilation while Native American nations retained their nationhood.[85] He exposed a heightened awareness of frontiers and boundaries, the understanding of Indigeneity as a political existence. In Chief Justice Burger's reasoning, Indigeneity would be impossible to appropriate, since it was merely a birth status, not at all abstract or cultural. The argument that Chief Justice Burger made and the terminology he selected connotes the narrative of 'two different worlds' rather than a unified one – "unique aggregations", "special treatment", or the second mention of "a separate people".[86]

The central irony to this document, however, echoing the irony discussed earlier in rebuilding Indigeneity, was the document it was defending – the Major Crimes Act. Congress' 1885 bill could be seen as one of 'unification' – of the incorporation of Indigenous territories under the all-seeing and all-knowing light of modern Western judiciary values – but it led to divide, the discrepancy between the punishment allotted to an American and a Native American person, as seen in *US v. Antelope* in 1977. The renewal and reinforcement of this bill in the 20th century sought to employ *divide* as an argument instead, contending that Native Americans were a "separate people" worthy of "special treatment", though clearly contrary to the intent of the original Major Crimes Act.[87]

These problematic subversions are fascinating as thought experiments, but they had a way of manifesting themselves in sociopolitical reality, waging chaos. *Antelope*, for example, as former U.S. Colorado Attorney Troy Eid and American Indian law professor Carrie Doyle argued, led to a "separate but unequal justice system" which "discriminates perniciously" against Indigenous defendants, disfavoured by the enforcement of federal law.[88] In Indiana State University professor David C. Williams' article on Native American legal advocacy*, US v. Antelope* was cited alongside similar landmark cases such as *US v. Kagama*, *Morton v. Mancari* and *Washington v. Washington State Commercial Passenger Fishing Vessel Ass'n* as an example of Congress' establishment of "plenary power" over Indian tribal affairs, in stark contrast to the inequality exposed by *Antelope*.[89] Additionally, like any other legal dispute and especially ones involving the Supreme Court, *Antelope* had a resounding impact on subsequent cases. Crucial to the Court's arbitration was the unanimous decision Justices made when called upon to answer the questions of what constituted a Native American person and who was qualified to claim such an

identity. In *U.S. v. Stymiest*, a legal conflict over thirty years later in 2009, *Antelope* was quoted as evidence that the state of 'being Indian' could be determined using a blood quantum:

> …*the court noted that tribal enrollment is the most important* St. Cloud *factor…we held the evidence sufficient to establish the defendant's Indian status without applying the* Rogers *test or even citing* St. Cloud…*"Indeed, some Indian blood and tribal enrollment are sufficient to indicate Indian status." See, e.g.,* **United States v. Antelope**, *430 U.S.641, 646 n. 7, 97 S.Ct. 1395, 51 L.Ed.2d 701 (1977).*[90]

The issue of blood quantum itself is also intricately connected with debates around Native American identity. A Native American individual's 'blood quantum' is the amount of Indigenous blood they are thought to possess, represented as a fraction and calculated theoretically by matrilineal lineage. It is not an actual measurement of bodily fluids, nor is it scientifically founded, ironic considering modernity's fixation on empiricism.[91] A 'half-blooded' individual may be recorded with a blood quantum result of ½, however, this does not denote that literally half of their blood is drawn from an Indigenous origin.[92]

Though such a function stemmed from colonial legislation, blood quantum remains in the center of controversy. Legitimate Indigenous tribes have different requirements as to what blood percentage they require their new members possess.[93] For example, according to Section I, Article IV of the Hoopa Valley Tribe Constitution, the tribe accepts for membership "all children, born to members of the Hoopa Valley Tribe, who are at one-eighth (1/8) Indian blood…degree or quantum of blood to be determined by adding one-half (1/2) the degree of Indian blood of each parent as shown on the approved Roll Schedules of the Hoopa Valley Tribe".[94]

Since the forsaking of the governmental legislature regarding assimilation, or the end of the early-twentieth-century Allotment Era when the federal government was intent on implementing blood quantum policies in Native American communities, even the Department of the Interior itself has encouraged the concept to be abandoned.[95] Yet this seems like an empty statement. In 1989, when James A. Clifton was writing, the government used blood quantum testing to "[restrict] delivery of federal services" and "[limit] legal recognition" to individuals of more than one-fourth of Indigenous blood.[96] To this day, the Bureau of Indian Affairs still requires blood quantum testing in order to qualify a Native American applicant for social services.[97] The origins of the Indigenous blood dispute can be traced as far back as 1846. In the Supreme Court case *United States v. Rogers*, William S. Rogers, a white man who was adopted by the Cherokee Tribe, was indicted for the murder of Jacob Nicholson, also white, also adopted by the Cherokee.[98] Under 1846 law, this case would fall into the jurisdiction of the tribal court. Having been called to define what made an 'Indian', Chief Justice Robert Taney delivered the opinion of the court, in which he stated that it was "very clear, that a white man who at mature age is adopted in an Indian tribe does not thereby become an Indian…He may by such adoption become entitled to certain privileges in the tribe, and make himself amenable to their laws and usages. Yet he is not an Indian".[99] Robert Taney's opinion brings to mind Chief Justice Burger's declaration of "separate peoples" but also contrasts narratives such as Mary Hunter Austin's of

succeeding in "becoming Indian". During the 131-year gap between 1846 and 1977, modernity wove its forces, but somehow Supreme Court Justices ended up exactly where they had begun.

The question of Indianhood was further explored in the 1978 case *Santa Clara Pueblo v. Martinez*, in which the Supreme Court established that laws implemented under individual tribal governing bodies that violate the Constitution were not protected under federal law.[100] Julia Martinez was a Santa Clara Pueblo citizen who married a member of the Navajo Tribe. She protested an internal ordinance that stated that female members who married out of the tribe could not have Navajo children, while children of male members who married externally could hold Navajo citizenship.[101] Amid discourse on what freedom individual nations had in passing discriminatory laws, the Supreme Court chose to reject Martinez's suit and left this power in the hands of tribal administrators. Gabe Galanda, an Indigenous rights attorney from the University of Arizona who represents victims of tribal eviction, reexamines this landmark ruling with outrage. He writes: "Justice Thurgood Marshall, of all judges, wrote a decision saying that an Indigenous person cannot go to federal court for a remedy when his or her birthright is threatened or has been taken…an Indigenous person on tribal land is the only citizen who doesn't enjoy the promise of life, liberty and the pursuit of happiness".[102] Thus an ever-largening group of individuals was caught between closing borders.

Pueblo v. Martinez greatly diminished the validity of the Indian Civil Rights Act of 1968, which was established "to insure that the American Indian is afforded the broad constitutional rights secured to other Americans".[103] Such a bill was passed by Congress in the interest of incorporating and regulating Native American nations under Western law and order, enforcing the universality of the Constitution, and "protect[ing] individual Indians from arbitrary and unjust actions of tribal governments".[104] If the ICRA was an act of breaking barriers, *Pueblo v. Martinez* was a move in the contrary, seeking to preserve the independence and disparity of Indigenous nations instead of forcibly implementing Western paradigms. Barrier-rebuilding has led to negative impacts, however.

The number of 'paperless Indians', Indigenous peoples unable to obtain recognition by their original tribes, and the societal problem of 'tribal disenrollment' continues to augment, as intermarriage inevitably results in mixed-blood children disenfranchised from tribal citizenship.[105] The real-life divisive effect of a wall is that it bars access to family, friends, identity, and cultural heritage. Unfortunately, this issue continues and extends into the twenty-first century. Justice Thurgood Marshall's 1978 verdict in *Santa Clara Pueblo v. Martinez* has a sustained impact in the modern United States – in 2017, the University of Arizona law college held an aptly-named conference with tribal leaders "Who Belongs?" aiming to combat the mass disenrollment occurring among Indigenous youth.[106] David Wilkins, author of *Dismembered: Native Disenrollment and the Battle for Human Rights*, told The Slate Group in 2018 that "nearly 80 tribes across 20 states have engaged in the practice [of disenrollment] that has affected up to 10,000 people".[107] Nonprofit director Souta Calling Last from the Kainai Nation is a Native American woman who oversees 'Indigenous Vision', an educational charity organization that seeks to promote mental wellbeing and healthy development among Native

youth. She and her husband, who was born in the Hopi Tribe, will not be able to see their child grow up in either territory. "[A] sense of belonging and identity has a lot to do with determining our emotional and mental health as well as our quality of life and even length of life", she remarks.[108] The Center for Native American Youth reports that "Native American communities experience higher rates of suicide than any other ethnic group". Youth, especially individuals between ages 10 and 24, are 3.5 times more likely to commit suicide than the average American. For Native American adolescents, the second leading cause of death is suicide.[109]

The significance of the controversies present in *Antelope*, *Mancari*, *Rogers*, blood quantum, *ICRA*, and *Santa Clara Pueblo* lies in that they actualize the contradictions at the heart of the modernist movement. Modernity's chaos was intimately connected with Indigenous experience in the late twentieth century. The discrepancy in judges' eagerness to draw a distinction between 'Indian' and 'American' and their interest in overriding Native sovereignty with Western ideals was confusing and inconsistent for Indigenous defendants. Between the unification and division of the time, Indigenous identity, in any interpretation, appeared as frivolous and inconsequential as a drawing-card.

Conclusion

In 1999, local Canadian fishermen had the pleasure of experiencing a situation not dissimilar to *US v. Antelope* decades ago. Donald Marshall Jr., a Mi'kmaw resident, had his earnings seized by local police when he was found fishing off-season. However, according to treaties in the 1760s between the British and the Mi'kmaw, Indigenous tribes in Canada were granted "free liberty of hunting and fishing as usual".[110] The Canadian Supreme Court reaffirmed Donald Marshall Jr.'s right to fishing and hunting whenever he wanted in order to sustain a "moderate livelihood",[111] immediately infuriating Non-Native fishermen who were prohibited to fish during off-seasons. In the following months, Indigeous fisheries and businesses were harassed, burgled, and even burnt to the ground by outraged fishermen. Non-Native people, unfamiliar with tribal conceptions of sustainable fishing, claimed this legislation would drain local fish supply and discriminate based on ethnicity.[112] Levi Paul, a Sipekne'katik fisherman who worked in Canada's first Native American fishery operating under tribal government, said that local fishermen "storm[ed] their docks", "2 feet away from ramming [him] with the big boats".[113] Few were ever prosecuted for these crimes.

The issue of "moderate livelihood", a term incessantly stressed throughout the *R. v. Marshall* case file, was itself vague. Indigenous fishermen argued that 'fishing to support one's living' did not necessarily preclude selling the catch. The Canadian government was historically ambiguous as to where it stood on the matter. Policies, however, did devote large sums of money to incorporating Mi'kmaw fishermen into the larger Western commercial sphere, "buying them licenses and equipment and even boats" to entice Mi'kmaw peoples into government-regulated markets.[114] This was a strong signal, a suggestion, yet not quite a decree. In addition, the Supreme Court made a second decision in the case, which determined that Indigenous peoples could hold fishing and hunting rights to an extent, but the government could "limit the exercise

of a treaty right" if "on conservation or other grounds".[115] That is, whenever Canadian politicians decided to tackle overfishing and other environmental concerns, they could pin the blame on Indigenous fishermen and suspend the Court's ruling. Essentially, the Supreme Court succeeded in mollifying no one. It implied that Indigenous communities could retain independent use of land, yet went only halfway, proceeding to assert that Western economic principles outweigh Indigenous measures of moderation and environmental protection and that tribal authorities were ultimately under the tutelage of Canadian government. This was 1999, at the century's end. On Thanksgiving 2021, another Mi'kmaw lobster pound was burnt to the ground.[116]

Zygmunt Bauman, a renowned Polish sociologist, believed that modernity never really ended, that instead, we have progressed to "liquid modernity", a new phase where things "are constantly ready (and prone) to change".[117] It is an accelerated modernity, where we try on any social experience as fleeting visitors. Information courses at us in incessant streams. Our identities become virtual, ephemeral, featherlight, yet even more extreme. If Bauman's claims do accurately represent the state of Western thought, and if we were to examine our contemporary period, should we not find Indigenous identity further devalued and commercialized, morphing from a captivity narrative or a Wild West show to just another ten-second-video in our constantly stimulated lives? As modernity quickens its pace, its impacts are similarly augmented.

In this paper, I have examined how modernity has blurred racial and social boundaries between Indigenous groups and Americans, as well as its role in, paradoxically, reinforcing frontier mindsets, in order to explore the sociopolitical conditions of Indigenous tribes and peoples during the twentieth century. My above investigation of perceptions and realities surrounding the modernist Native American identity has exhibited not only the close interrelation of Western thought movements and Native American livelihood, but the deceptiveness of such movements and how they entangle audiences in yet another muddied, racist lens. At the start of my paper, I asked the question: where, when, and how should one investigate what it means to be Indigenous? However, over the course of my research, I have found it not only impossible to abide by Calvin Martin's doctrine and 'become' Native American (as many have tried), but also inconceivable to heed James A. Clifton's advice and detach myself completely from the upbringing that I experienced and the stereotypes and frontiers I have been conditioned to see. It has become evident that each person can only perceive Indigeneity as their own selves, and we are all somehow entangled with the concept, as scholars, audiences, voters, performers. What we can do is remain conscious that our perception is not whole, nor is it universal. We must understand that Non-Native voices should not assume authority over Native identity.

Using historiography to examine the modernist period allows us to reconsider the real-world ramifications of these perceptions. Alongside twentieth-century shifts in Indigenous-European relations, Native American peoples have been abused by increasingly bureaucratic and intricate legal boundaries that struggle to keep pace with America's radically evolving definition of Indigeneity. The Major Crimes Act (1885), in trying to equate Indigenous and American peoples under the law, led to Gabriel Antelope's lifetime in prison. 'Blood quantum', a centuries-old colonial measure of Indigenous lineage, still causes adolescents to feel

alienated from their communities. Tribes are dispossessing mixed-blood members at unprecedented rates. Young people are taking their own lives. And, taking into account Bauman's argument of "liquid modernity", perhaps this sweeping intellectual movement is still present, necessitating caution.

"The current most-favored image of Indians past and present is a human invention, one construction of a complex social and historical reality", commented James A. Clifton in his 1989 book *Being and becoming Indian*: *biographical studies of North American frontiers*.[118] He suggested that the non-Indigenous American's 'Indian' was not corporeal, but a watery reflection of American society itself, something fundamentally disconnected from actual 'Indian-ness' and contrived to replicate the subtleties of the time. This, perhaps, best summarizes modernist Indigenous identity – it is fictitious.

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Assessing the Impact of a Robust Education System on National Development: A Comparative Analysis of Outcomes By Luke Slater

Abstract

As new research and literature are published, shedding light on education's considerable impact on economic development, the question remains of what the different ways in which education can make such a momentous contribution to economic growth are. Most of the current literature applies neoclassical economist Solow's growth theory, claiming that economic growth results from the total factor productivity increases associated with education from both a labor productivity standpoint and an innovation perspective (A Contribution to the Theory of Economic Growth 65-94). This paper explores this concept further and focuses on both perspectives and their effects on economic growth. Through an extensive analysis of research and data, the conclusion reached in this paper is that education's positive effects on labor productivity and innovation are ultimately how education significantly contributes to economic growth. This concept is also applied to Singapore and Pakistan, where its validity is reinforced by the distinct differences in their economic growth paths, and through an analysis of positive externalities and expert testimonials, the policy of greater investment into education to increase economic growth is proposed.

Introduction

Since the beginning of modern economics in 1776, with the publication of Scottish Philosopher Adam Smith's influential book, An Inquiry into the Nature and Causes of the Wealth of Nations, economists have been attempting to determine the causes of economic growth. While economic growth can be attributed to many factors, the current consensus among modern economists is that education contributes the most significantly to economic growth. According to the article *Education and Economic Growth in Pakistan: A Cointegration and Causality Analysis*, "Among all levels of education, general higher education causes economic growth highly and most significantly" (Afzal et al.). The reasoning behind this theory is that an improved education should result in more productive workers and lead to further innovation/technological advances in production. An increased overall level of productivity (total factor productivity) in producing goods and services would allow a country to produce more goods and services than previously possible, leading to economic growth. This theory was first developed by revolutionary neoclassical economists Robert M. Solow and Trevor Swan separately and introduced in 1956 with the publication of their corresponding journal articles, *A Contribution to the Theory of Economic Growth* by Robert M. Solow and *Economic Growth and Capital Accumulation* by Trevor Swan, each presenting the Solow-Swan model. The Solow-Swan model, more commonly referred to as the Solow model, was the first neoclassical growth model created and demonstrated how increased productivity results in an increase in the steady state level of capital and output, ultimately leading to long-run economic growth (Solow, A Contribution to the Theory of Economic Growth 65-94; Solow, *Growth Theory: An Exposition*

3-45; Swan 334-361). Since 1956, innumerable scholarly journals, reports, and scientific papers have been published investigating the substantial impacts of productivity on economic growth, first presented by Robert M. Solow and Trevor Swan.

Because education is the primary basis of the productivity level of a country, the economic impact of a stable education system should be significant. Economist David McClelland's states in his journal article *Does Education Accelerate Economic Growth?* that "countries investing more heavily in education have tended to develop more rapidly" (278). This research paper attempts to answer the question of what the development effects of a robust education system or the lack thereof in a country are. The phrase "development effects" refers to the effects education has on the economic development of a country. In this paper, the phrases "economic development" and "economic growth" will be interchangeably used and measured by the GDP (gross domestic product) growth of a country. This research paper differs from the present academic publications as instead of focusing on all the causes of economic growth, it focuses solely on the education factor and provides an applied instance of this concept by comparing two countries with widely dissimilar education systems, Singapore and Pakistan. These countries were selected because Singapore serves as an example country with a robust education system, while Pakistan serves as an example country without one. Another factor contributing to that decision was their relatively similar geographical location, as both countries are located in Asia, which would reduce the amount of unaccounted-for data variability, allowing for more precise comparisons.

This paper argues that a robust education system allows for improvements in human capital and increased innovation, both of which increase productivity, resulting in rampant economic growth. On the other hand, a country's lack of a robust education system obstructs its economic growth, hindering improvements in human capital and decreasing innovation.

This research paper investigates the development effects of a robust education system from two different perspectives. The first section explores how education affects human capital and labor productivity and establishes their relationship with economic growth. The following section focuses on education's impacts on innovation and technological advancements and, ultimately, their contribution to economic growth by increasing overall (total factor) productivity levels. After exploring these two perspectives in the first two sections, these concepts are applied to Singapore and Pakistan to investigate their validity. After this practical application, the policy of further investments in education in countries lacking in the education component is proposed. This policy proposal is evaluated in the following section through the lens of corruption and inefficiencies in funds management.

Education's impact on human capital and labor productivity

Better education leads to improvements in human capital, which increases labor productivity, resulting in increased economic growth. A significant component of overall (total factor) productivity, labor productivity, is the dollar amount of goods and services a worker can produce in one hour. Because better education results in more skilled workers (improvements in

human capital), these workers are also more productive and can produce more goods in the same amount of time. This explains why investing in human capital by improving the education system causes an increase in labor productivity. When labor productivity increases, the amount of output (goods and services) a country can produce directly increases, causing economic growth. According to celebrated economist Andrew Gunder Frank in his journal article *Human Capital and Economic Growth*, "education has made an increasingly large contribution to output; and that again, insofar as it constitutes a major part of the increase in human capital, investment in the human factor is a major component of economic growth" (173). To summarise this quote, education has significantly increased output (and caused economic growth) because it makes up a large proportion of human capital improvements, which ultimately causes economic growth. The Solow model (Figure 1.), which models economic growth as a result of changes in productivity, clearly reflects this concept.

Figure 1: Solow Model with Education Investment

Output per worker, y

$y'=A_{edu}k^a$ (Production Function with Education Investment)

$(n+d)k$ (Depreciation plus Population Growth line)
$y=A_0k^a$ (Original Production Function)

$i_t'=sA_{edu}k^a$ (Investment line with Education Investment)
$i_t=sA_0k^a$ (Original Investment line)

y^*_{edu}

y^*_0

k^*_0 k^*_{edu} Capital per worker, k
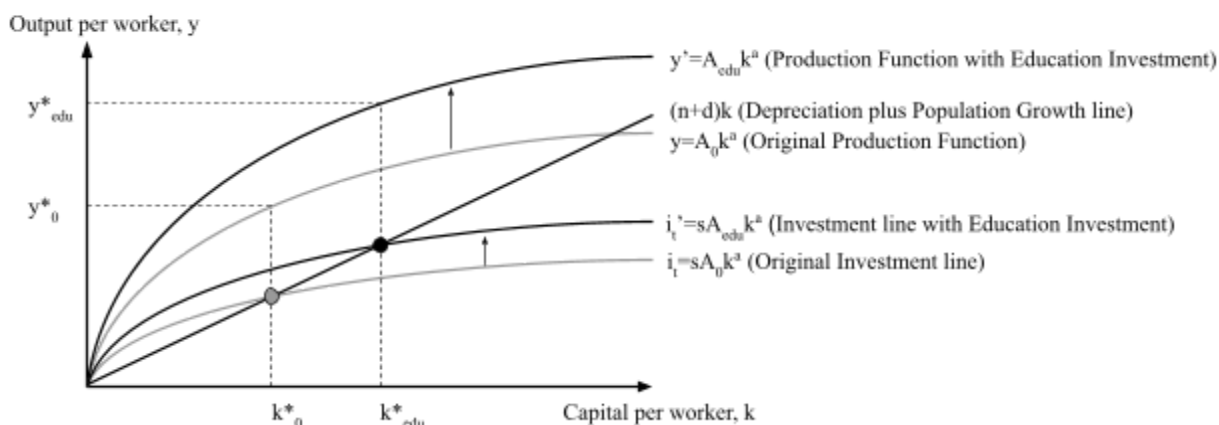
The Y-axis of the model measures the country's output per worker (the total amount of goods and services a worker produces). On the X-axis, that country's capital per worker (the average capital available to each worker for production) is measured. Prior to education investment, the investment line (which represents the part of a country's total output that is saved and reinvested into capital, indicated in Figure 1 by the function i_t) intersects with the depreciation plus population growth line (which shows the joint effect the population growth of the labor force and the depreciation of capital has on the capital stock of the economy, indicated in Figure 1 by the function $(n+d)k$) at the point where there is an equilibrium between investment and depreciation plus population growth (indicated in Figure 1 by the grey dot). This intersection determines the steady state level of capital per worker (the amount of capital per worker where the capital stock does not change, indicated in Figure 1 by k^*_0) and, directly, the steady state level of output per worker (the amount of output produced by each worker at the steady state level of capital per worker, indicated in Figure 1 by y^*_0). However, when investments in education are made in a country, they result in improvements in human capital (as workers are more educated), and as a result, both labor and total factor productivity increase. Reflecting this increase in total factor productivity (indicated in Figure 1 by the variable "A"), the total factor

productivity increases from A_0 to A_{edu}. This causes a simultaneous increase in the production function (which shows the amount of output per worker possible at different levels of capital per worker, indicated in Figure 1 by the function y) and the investment line, resulting in the formation of a new production function (indicated in Figure 1 by the function y') and a new investment line (indicated in Figure 1 by the function i_t'). As a result, a new intersection between the depreciation plus population growth line (which remains unchanged by the education investment) and the new investment line occurs (indicated in Figure 1 by the black dot). This results in an increase in the steady state level of capital per worker from k^*_0 to k^*_{edu} and an increase in the steady state level of output per worker from y^*_0 to y^*_{edu}. This increase in both the steady-state level of output per worker and the steady-state level of capital per worker is representative of the economic growth that the country experienced as a result of investing in education.

Another economic model that illustrates the economic growth resulting from investing in education is the aggregate supply and demand model (Figure 2.). This model determines a country's equilibrium real GDP (gross domestic product) and price level using its aggregate supply and demand curves.

Figure 2: Aggregate Supply and Demand Model with Education Investment
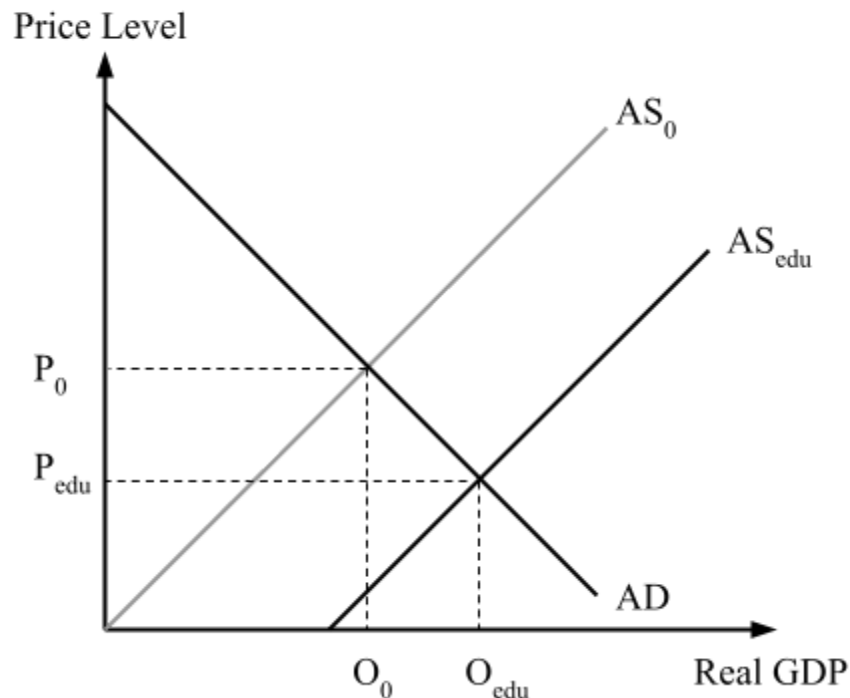
The country's price level (the average price of all goods and services) is measured on the Y-axis of the model. The country's real GDP (gross domestic product) is measured on the X-axis of the model. The curve on the model labeled AD is the aggregate demand (the total demand for all goods and services produced in that country) curve. The two curves on the model labeled AS_0 and AS_{edu} are the aggregate supply (the total supply of all goods and services produced in that

country) curves. Before investments in education, the equilibrium price level and real GDP are determined by the intersection of the aggregate supply curve, AS_0, and the aggregate demand curve, AD. This results in the equilibrium price level being P_0 and the equilibrium real GDP being O_0. However, because investing in education results in more skilled workers and increased labor productivity, the aggregate supply increases. This is reflected by the shift in the original aggregate supply curve rightward from the curve AS_0 to the new curve AS_{edu}. Because the aggregate supply increases, a new equilibrium price level and real GDP are formed. The intersection of the new aggregate supply curve, AS_{edu}, and the unchanged aggregate demand curve, AD, determines this new equilibrium. The new equilibrium price level becomes P_{edu}, and the new equilibrium real GDP becomes O_{edu}. This means that after investing in education, the country experienced not only a decrease in the price level (which means that the purchasing power of its residents has increased) but also an increase in the real GDP (which is representative of economic growth).

This concept of economic growth resulting from the increased human capital due to the investments made into education has been explored in many academic journals and studies. According to Zvi Griliches, in his journal article *Education, Human Capital, and Growth: A Personal Perspective*, "He made an estimate of the growth in total human capital in the U.S. created by the educational system and considered how much of the growth in output it could account for (about one-fifth was his estimate)" (S331). In this quote, Zvi Griliches references the renowned American economist Theodore Schultz and his influential research on the economic impacts of America's education system, presented in his Journal of Political Economy article, *Capital Formation by Education*. This quote states that approximately one-fifth or 20% of America's output/economic growth can be attributed to the increases in human capital caused by its education system. This notably high statistic supports the argument that the human capital growth resulting from the presence of a robust education is a significant contributor to economic growth. Another source providing strong evidence regarding the prominent human capital impacts on economic growth that come as a result of a country having an adequate education system is economist Ludger J. Löning's book, *Economic Growth, Biodiversity Conservation, and the Formation of Human Capital in a Developing Country*. In his book, he states, "Accounting for the sources of growth supports the importance of human capital in Guatemala. Such an exercise reveals that the increased skill level has been the main driving force behind productivity growth, and that education explains more than 50 percent of output growth during the past five decades" (73). This quote supplies an even higher statistic regarding education's impact on economic growth, as he claims that 50% of the output growth/economic growth in Guatemala is a result of education compared to the respective 20% in America (from Zvi Griliches's journal article). It is clear from observing the two economic models and the cited evidence that better education leads to improvements in human capital and labor productivity, which ultimately leads to increased economic growth.

Education's impact on innovation and total factor productivity

High-quality education results in more innovation and technological advances that raise productivity, causing increased economic growth. According to economist Assaf Razin in his renowned Economic Development and Cultural Change journal article, *Economic Growth and Education: New Evidence*, "technical progress was a result of investment in human capital" (317). Because better education results in more skilled workers (an increase in human capital), these workers innovate more and drive advances in technology (as described in his journal article), which makes the production of goods and services more efficient (increasing total factor productivity). As the total factor productivity increases due to innovation, more output can be produced with the same amount of input, which leads to economic growth. This development impact of education can be illustrated using the Solow model (Figure 1.) through the increase in productivity and its effect on the steady state level of output and capital.

Figure 1: Solow Model with Education Investment

Output per worker, y

$y' = A_{edu}k^a$ (Production Function with Education Investment)

$(n+d)k$ (Depreciation plus Population Growth line)

$y = A_0k^a$ (Original Production Function)

$i_t' = sA_{edu}k^a$ (Investment line with Education Investment)

$i_t = sA_0k^a$ (Original Investment line)

y^*_{edu}

y^*_0

k^*_0 k^*_{edu} Capital per worker, k
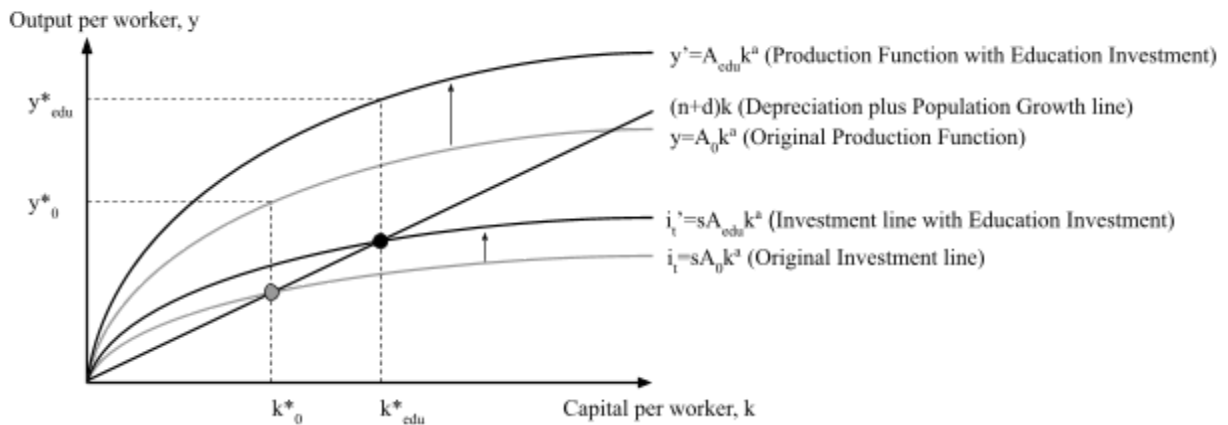
As mentioned above, an improvement in education results in an increase in human capital (as workers become more skilled and improve their technical knowledge), which leads to technological progress and increased innovation, ultimately increasing total factor productivity. This productivity increase is reflected in the Solow model by the change of the productivity variable from A_0 to A_{edu}. Because productivity (A) is a significant determinant of output per worker and investment, when productivity increases (from A_0 to A_{edu}) as a result of innovation, both output per worker (y) and investment (i_t) increase as well from y to y' and i_t to i_t' respectively. This, in turn, increases the steady state level of output per worker from y^*_0 to y^*_{edu} and capital per worker from k^*_0 to k^*_{edu}. These increases in the steady state levels of output and capital per worker are representative of the economic growth resulting from an increase in innovation and technological progress caused by a robust education system.

The aggregate supply and demand model (Figure 2.) can show the economic growth resulting from innovation and technological progress correlative with education.

Figure 2: Aggregate Supply and Demand Model with Education Investment
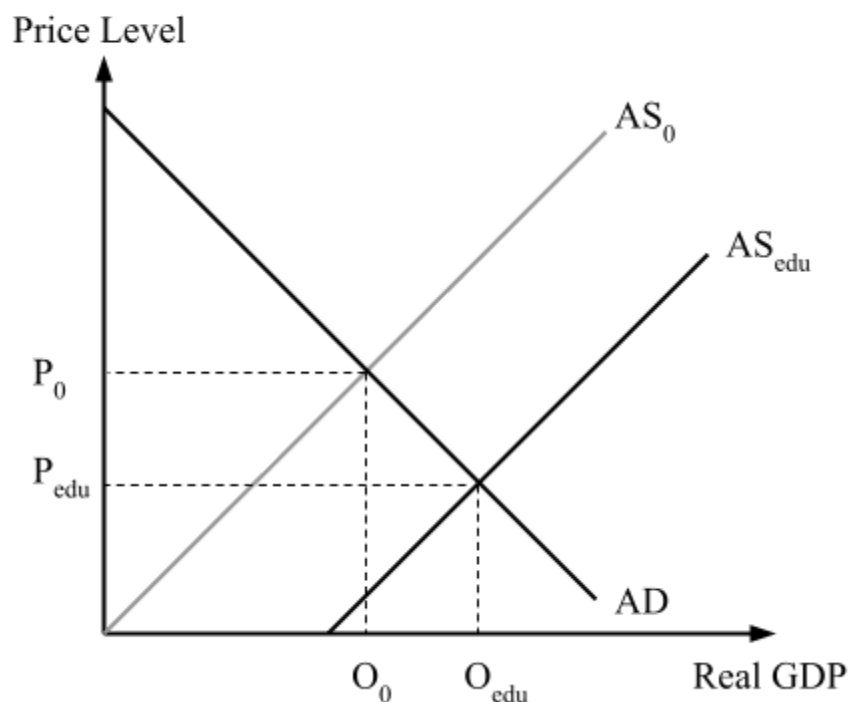
As stated in the previous section, before any investments are made in education, the equilibrium price level and real GDP (gross domestic product) are determined by the intersection of the original aggregate supply curve (AS_0) and the aggregate demand curve (AD). This intersection indicates an equilibrium price level of P_0 and an equilibrium real GDP of O_0. However, when investments are made by a country in education, they improve human capital and, thus, increase innovation, which leads to an overall increase in the total factor productivity of that country. As the total factor productivity of that country increases, the country can supply more goods and services than before, as more output can be produced with the same amount of inputs. This is reflected by the increase in aggregate supply on the model from A_0 to A_{edu}. This new aggregate supply curve results in a new equilibrium price level and a new equilibrium real GDP in that country. Visible in the model, the intersection of the new aggregate supply curve (AS_{edu}) and the aggregate demand curve (AD) results in the equilibrium price level decreasing from P_0 to P_{edu} and the equilibrium real GDP increasing from O_0 to O_{edu} (which is reflective of economic growth). This model demonstrates the significance of innovation as a significant factor in economic growth and how education is critical in a country's economic future. The prominent German economist Manfred Stadler investigated this concept extensively in his Review of Economics journal article, *Engines of Growth: Education and Innovation*, and concluded that "According to the Lucas mechanism education accelerates human-capital accumulation. Human-capital accumulation in turn accelerates the innovation dynamics such that education and innovation appear as in-line engines promoting economic growth" (123). In this quote, he

describes how education advances human capital, which increases innovation (and productivity) and ultimately results in economic growth.

An application of education growth theory to Singapore and Pakistan

The development effects of a country having a robust education system are clearly demonstrated when contrasting Singapore, which has one, and Pakistan, which does not. Singapore's education system is acclaimed by many and is considered one of the world's finest education systems. On the other hand, the quality of Pakistan's education system is nothing compared to the quality of Singapore's education system. According to Syed Kazmi and his coauthors in their Sustainable Development Policy Institute research paper, Impact Of Human Capital On Economic Growth: Evidence From Pakistan, "Pakistan, an economy of 180 million people, spends only two per cent of its GDP on education that is like a drop in the ocean" (2). This significantly low proportion of expenditure, which he analogizes to "a drop in the ocean" when compared to Singapore's proportional government expenditure on education, is magnified further. According to The World Bank, in 2003 government expenditure on education comprised 4% of the total GDP (The World Bank). This means that Singapore spends approximately double the proportional amount on education compared to Pakistan, which is reflected when comparing each country's literacy rate. Singapore's literacy rate (measured as the percentage of the population over the age of 15 that is literate) in 2019 was 97%, while the literacy rate in Pakistan was 58% in 2019 (The World Bank).

As mentioned repeatedly, the presence of a high-quality education system would result in higher labor productivity levels. Evidence of this is shown when observing the labor productivity levels of both countries. Singapore's labor productivity level (measured as the per-worker GDP contribution of one hour of labor) was $73.70 USD in 2021, while Pakistan's was $6.30 USD in 2021 (International Labour Organization). In addition to higher labor productivity levels, education also results in higher innovation levels, as stated in the previous section. This can be seen when comparing the World Intellectual Property Organisation's Global Innovation Index (GII) rankings, which can be utilized as a quantitative measure of a country's comparative innovation level. According to the 2022 results, Singapore ranked 7th in the world, while Pakistan ranked 87th (World Intellectual Property Organisation). This establishes a strong correlation between a country's education system and innovation levels. The development effects of a robust education system are shown when looking at the GDP per capita (measured in USD) of both countries. As expected, Singapore has a significantly higher GDP per capita than Pakistan, with the 2021 measurement being $72,794 USD, compared to Pakistan's GDP per capita of $1,537.90 USD (The World Bank). In addition to education contributing significantly to an overall better economy (which the GDP per capita measures), it is also a significant contributor to economic growth (which has been stated numerous times throughout this paper). This development effect is seen when comparing both countries' annual economic growth rates. According to The World Bank, in 2010, Singapore's annual economic growth rate was 14.5%, while it was 1.6% in Pakistan (The World Bank). This nearly 10-fold difference in economic

growth rates serves as solid evidence supporting the significance of education as a critical component of a nation's economic well-being. According to economist Biswajit Maitra in his Global Business Review journal article Investment in Human Capital and Economic Growth in Singapore, "The nature and direction of causal affect of the investment in human capital and labor force participation in economic growth of Singapore is established. Thus, the budgetary allocation for human capital formation appears to be effectively utilized in Singapore which, in turn, has contributed to its economic growth" (16). Here, he argues that Singapore's government expenditure on education/investments in education has contributed considerably to its economic growth. Because education is a commodity with positive externalities, many countries are not investing the socially optimal amount of resources into education as they overlook the positive externalities associated with education. This suboptimal level of investment into education that occurs in some countries can be explained by applying the positive externalities model (Figure 3.).

Figure 3: Positive Externalities Model (Applied to Education)
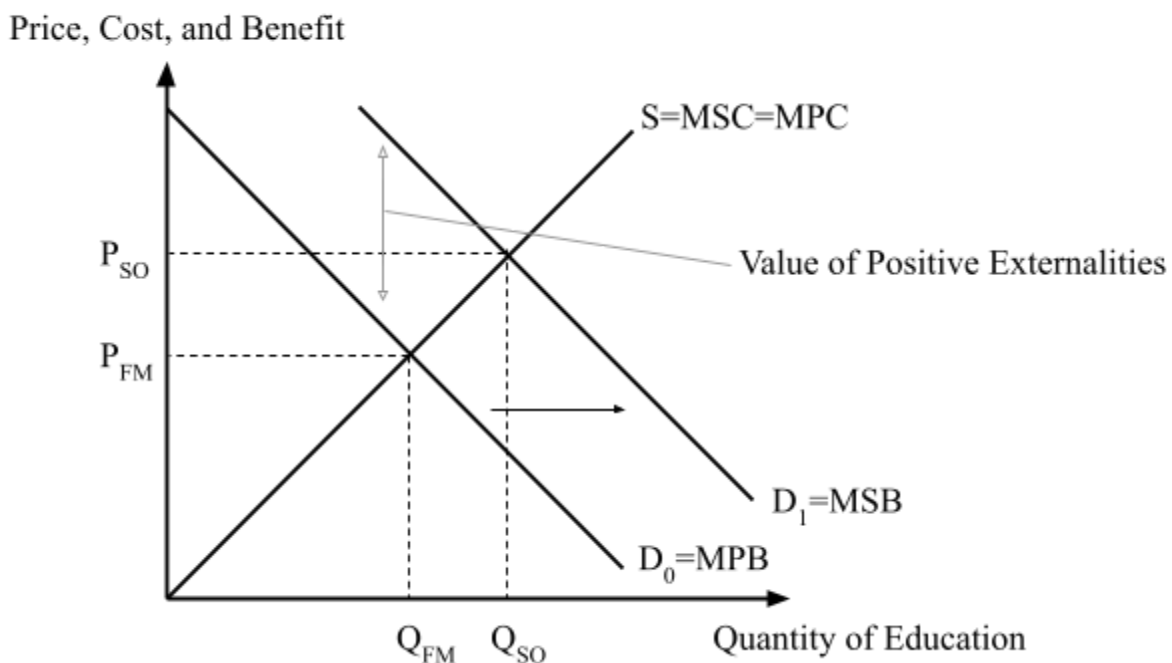
The price, cost, and benefit of education are measured on the Y-axis of the model. On the X-axis of the model, the quantity of education is measured. The positive externalities model has two demand curves (the curves labeled D_0=MPB and D_1=MSB) and one supply curve (the curve labeled S=MSC=MPC). The supply curve shows the supply, the marginal social cost (MSC), and the marginal private cost (MPC) of education in this market. On the other hand, the demand curve labeled D_0=MPB shows the marginal private benefit (MPB) of education in this market, while the other demand curve labeled D_1=MSB shows the marginal social benefit (MSB) of education in this market. As visible in the model, the difference between the two demand curves (indicated by the pink arrow) is the quantitative value of the positive externalities associated with

education. Because the free market produces the quantity of education where the marginal private benefit (MPB) is equal to the marginal private cost (MPC), the non-socially optimal education quantity, Q_{FM}, is produced in a free market. Since the socially optimal quantity of education is only produced where the marginal social cost (MSC) is equal to the marginal social benefit (MSB) at the quantity Q_{SO}, this will not happen in a free market without government intervention. To get the free market to produce the socially optimal quantity of education, the government subsidizes (invests) education by the value of the positive externalities. This would then cause the marginal private benefit (MPB) to increase (shift right) until it is equal to (lies on top) the marginal social benefit (MSB), resulting in the socially optimal quantity of education, $Q_{so,}$ to be produced in the free market. Pakistan is a favorably pertinent instance of a country that has disregarded the positive externalities associated with education (and does not subsidize the value of the positive externalities). As a result, Pakistan's free market produces the non-socially optimal quantity of education, which acts as a barrier to its economic development (as it cannot experience education's development effects).

Policy Proposal and Conclusion

      Countries that lack a robust education system and thus cannot experience the positive development effects it brings should invest in education. As described in the previous section, many countries ignore the positive externalities associated with education and, as a result, are producing the non-socially optimal quantity of education. The solution to this problem proves evident when observing the positive externalities model (Figure 3.).

Figure 3: Positive Externalities Model (Applied to Education)
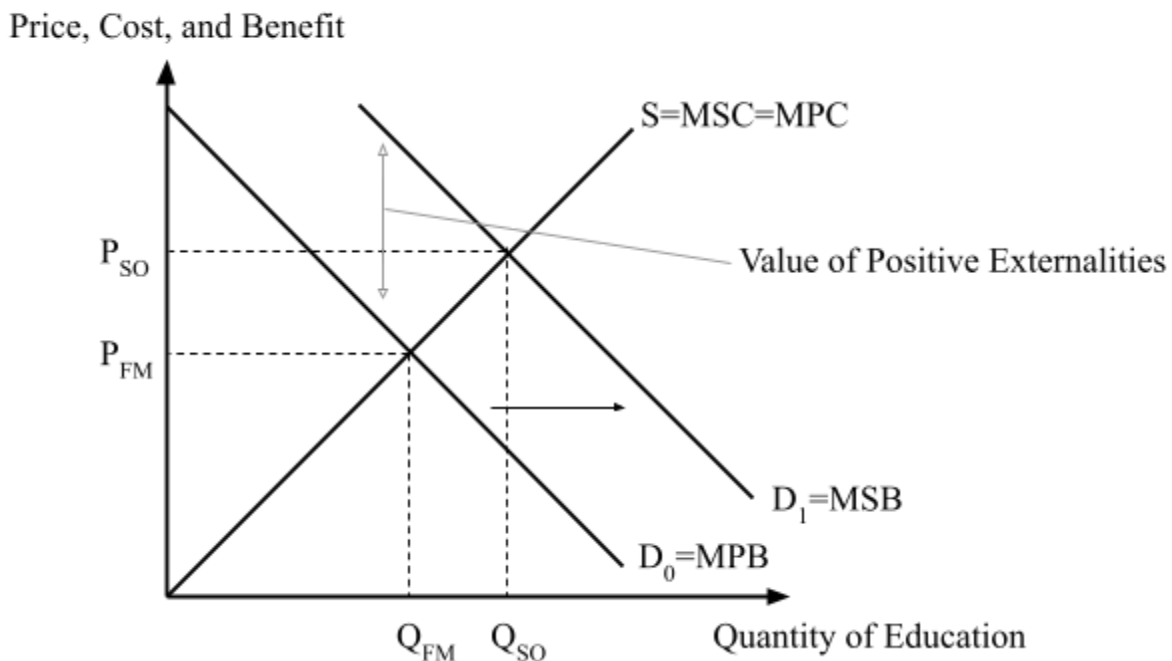
Suppose the country invests the optimal amount into education. In that case, the marginal private benefit (MPB) will increase (shown on the graph by the shift from D_0 to D_1) and result in the socially optimal quantity of education to be produced (as it is determined by the intersection of the marginal social cost (MSC) and the marginal social benefit (MSB)). This would then allow the country to experience the development effects education has, such as increased labor productivity, increased human capital, higher levels of innovation, increased total factor productivity, and rapid economic growth. According to Pakistani economist Muhammad Afzal and his coauthors in their International Journal of Educational Research article, Education and economic growth in Pakistan: A cointegration and causality analysis, "This study recommends more investment in university education so that economic growth can be further accelerated, that in turn, leads to further education and hence economic growth" (321). In this quote, they propose that Pakistan should invest more of its resources into Pakistan's education system to elevate its economic growth. While this policy recommendation is explicitly made for Pakistan in their paper, it can be implemented in all countries lacking a robust education system. Biswajit Maitra makes a concordant recommendation in his journal article, Investment in Human Capital and Economic Growth in Singapore. However, he extends this policy proposition to all developing countries (as they tend to lack quality education). He states, "Glorious achievements of human capital formation in Singapore may serve as a pathway to other developing countries in this regard" (16). His reference to "glorious achievements of human capital formation in Singapore" describes Singapore's strategic education investments that have allowed Singapore to experience education's development effects (which is the policy being proposed). According to Manfred Stadler's Review of Economics journal article, Engines of Growth: Education and Innovation, "It turns out that subsidizing education and improving the effectiveness of the educational system are suitable public policies to raise the long-run growth rate. Indeed, education policy plays the dominant role in growth policy...(a) government can therefore accelerate growth by enhancing education" (122-123). In this excerpt, he substantiates the policy recommendation of further investment into education to augment the economic growth rate and proclaims that education policy is the pivotal component of growth policy. Clearly, it is crucial for countries that lack a robust education system to invest an increased amount of resources into education in order to advance their economic growth and overcome the economic barriers created by the lack of a proper education system.

To conclude, the development effects of a robust education system are an increase in human capital, which results in increased labor productivity, and an increase in innovation levels, which results in increased total factor productivity, both ultimately inducing expeditious economic growth. In addition to this, the policy proposal of increased investment in education proves to be an essential growth policy for countries lagging behind in the educational sector, allowing them to access education's substantial development effects.

Evaluation

Some may argue that because of inefficiencies in governmental spending, investing in the education system may not always increase human capital and, as a result, not always cause an increase in economic growth. According to education economics expert Élisé Wendlassida Miningou in his published World Bank research paper, Quality Education and the Efficiency of Public Expenditure: A Cross-Country Comparative Analysis, "it is estimated that, on average, 16 percent of the public financial resources dedicated to education in developing countries are wasted because of inefficiencies. Although efficiency greatly varies across countries, low-income countries are overall facing a double issue of low levels of education expenditure and weak efficiency of public expenditure on education" (Miningou). This means that, on average, only 84% of the resources intended for education in developing countries are used to improve the education system. Because developing countries tend to be the countries that lack robust education systems, invest very little in education, and have the highest inefficiency rates, this proves to be a significant problem. Since a large proportion of the already inadequate investments made into education are wasted, the investments made into education may not improve its quality and, thus, human capital and, therefore, not result in an increase in economic growth, which supports this counter-argument. The inefficiencies in the investments in education are a direct result of the inefficiencies in governmental institutions, a major one being corruption. According to economist Zoe Pearson's chapter in the book Corruption and Anti-Corruption, published by the Australian National University Press, "Even where resources are provided, corrupt officials may divert these, and therefore the resources supplied will be inadequate or substandard" (57). Here, she addresses that even if investments are made into education, corruption may result in a negligible improvement in the education system, therefore not causing an increase in economic growth.

While a portion of the funds used to invest in education does get wasted due to inefficiencies, the large remaining portion of the funds ends up being used to invest in education and improve its quality, resulting in the positive development effects of a robust education system to be experienced in that country, such as economic growth. This can be illustrated using the production possibilities curve model (Figure 4.), which shows the various possible quantities and combinations of capital goods and consumer goods that can be produced in a country.

Figure 4: Production Possibilities Curve Model
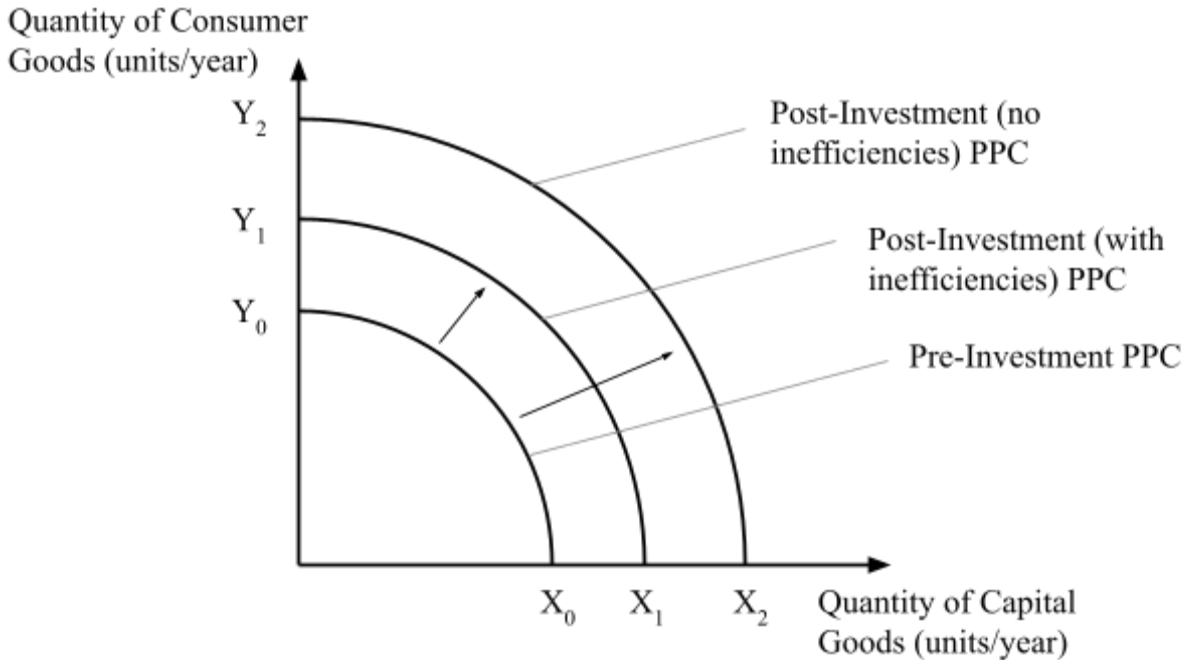
The Y-axis of the model measures the quantity of consumer goods that can be produced (in units/year), while the X-axis of the model measures the quantity of capital goods that can be produced (in units/year). The three curves pictured on the model (Pre-Investment PPC, Post-Investment (with inefficiencies) PPC, and Post-Investment (no inefficiencies) PPC) are the three production possibilities curves, each representing a range of different possible combinations of capital and consumer goods that can be produced. Before any investments are made into education, the production possibilities curve is the Pre-Investment PPC (as labeled on the model), the maximum quantity of consumer goods that can be produced is Y_0 (when no capital goods are produced), and the maximum quantity of capital goods that can be produced is X_0 (when no consumer goods are produced). However, after investments are made into education, increasing both labor (as human capital increases) and total factor productivity (as human capital increases and innovation levels increase), the production possibilities curve shifts outwards as the increase in productivity allows the country to produce more goods and services (both capital and consumer goods) which is representative of economic growth. The amount that the production possibilities curve shifts outwards due to investment into education is determined by the inefficiency rate of the country. The production possibilities curve of countries with a higher inefficiency rate, such as Pakistan, will shift out less than countries with a lower (or zero) inefficiency rate as more resources are wasted in countries with a higher inefficiency rate. To represent the different shifts, two other production possibilities curves are included in the model (labeled Post-Investment (with inefficiencies) PPC and Post-Investment (no inefficiencies) PPC). As visible on the graph, after investments are made into education, both production possibilities curves shift outwards (at different levels). When there are no inefficiencies, the production

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possibilities curve representing this situation is the Post-Investment (no inefficiencies) PPC, the maximum quantity of consumer goods that can be produced is Y_2 (when no capital goods are produced), and the maximum quantity of capital goods that can be produced is X_2 (when no consumer goods are produced). However, when there are inefficiencies, the production possibilities curve representing this situation is the Post-Investment (with inefficiencies) PPC, the maximum quantity of consumer goods that can be produced is Y_1 (when no capital goods are produced), and the maximum quantity of capital goods that can be produced is X_1 (when no consumer goods are produced). Even when there are inefficiencies present, the investments made into education result in an increase in both the maximum possible quantity of capital goods that can be produced and the maximum possible quantity of consumer goods that can be produced, which is, as mentioned earlier, representative of economic growth. This refutes the counter-argument, as even when inefficiencies are present, the investments made into education would still result in economic growth.

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Effect of Expressive Art Therapies on the Symptoms of Alzheimer's Disease By Sia Mehdiratta

Abstract

In recent years, the number of Alzheimer's cases has been rapidly increasing, with no known cure. Late-onset Alzheimer's is the most common form of dementia, and in most cases, it severely interferes with daily life. In an attempt to reduce the impact this disease has cognitively and socially, expressive art therapy was taken as a non-pharmaceutical holistic treatment which has been proven to have various clinical benefits, including improved cognitive abilities and memory recollection. Three different forms of expressive art therapy were taken into consideration in this review: music therapy, visual arts therapy, and dance therapy. A total of 16 studies were assessed. While it may not always be feasible to undergo these treatments, individuals with Alzheimer's and related dementias who are able to participate have an overall positive result on their memory and quality of life.

Introduction/Background:

The global population is aging as humans live longer (Wise, 1997). Consequently, the number of people with age-related neurodegenerative diseases like dementia and Alzheimer's disease is increasing. Dementia is the overarching term to define diseases that affect an individual's memory and decision making skills to the point that it interferes with doing everyday activities (Gustafson, 1996). The most common form of dementia is Alzheimer's disease (AD). AD is a neurodegenerative disorder that starts with mild memory loss and can progress to the inability to carry out everyday tasks and respond to the environment, depending on the severity of the disease. Approximately 55 million people worldwide have AD, with approximately three fourths of cases going undiagnosed. Dementia cases are estimated to increase in the coming decades, with over 100 million total cases by 2050 (Nichols & Vos, 2021). More specifically, the number of people with clinical AD is predicted to increase by about 8 million by 2060 (Rajan et al., 2021). While AD does not have a definitively known cause, genetic changes are the most prevalent source of AD. The three variants responsible for causing AD are an amyloid precursor protein (APP) on chromosome 21, presenilin-1 (PSEN1) on chromosome 14, and presenilin-2 (PSEN2) on chromosome 1 (*Alzheimer's Disease Fact Sheet*, 2023).

Symptoms of AD include dissatisfaction with life, a loss of interest in activities (Merriam et al., 1988), constant memory loss that interferes with daily activities, worsened judgment, and the inability to complete previously familiar tasks (*What Is Alzheimer's Disease?*, 2020). AD typically falls within four stages: preclinical, mild, moderate, and severe. As the stage of the disease progresses from mild AD to severe AD, symptoms worsen (*Alzheimer's Disease Fact Sheet*, 2023). Generally, preclinical AD occurs before the brain shows signs of dementia and mild (early-stage) AD occurs when an individual has trouble processing and understanding things around them. Once a person develops moderate AD, more intensive care is necessary due

to increased memory loss and cognitive decline. Those with severe AD may become reliant on others to perform activities of daily living as their cognitive function deteriorates.

No cure has been found for AD, but pharmacological and non-pharmacological treatments have been adopted by healthcare professionals in an effort to alleviate the impact of AD on patients. An important element of patient care involves improving the happiness and well-being of those living with AD. Non-pharmacological interventions often target a patient's quality of life and health (Castellano-Tejedor, 2022), including social activities, arithmetic, art therapy, and changes in diet ("Non-Drug Interventions for Alzheimer's Disease," 2017). Expressive art therapies integrate the creative arts to prompt emotional and physical growth (Hu et al., 2021.

Expressive art therapies have three main categories: music therapy, dance therapy, and visual arts therapy. Music therapy uses music participation or listening as an intervention to promote physical, emotional, and cognitive growth (Gómez Gallego & Gómez García, 2017). Visual arts therapy is a method of creative expression using visual art to achieve personal goals. Sessions can consist of both creating art as well as observing art made by others (Hu et al., 2021). Dance therapy uses movement to improve physical well-being and cognitive function (Koch et al., 2019). All three types of expressive art therapies target different symptoms of AD, like cognitive function and memory loss. If used in tandem with pharmacological treatments, expressive art therapies could pose as an effective intervention to treat or slow the progression of AD.

The main goal when completing this review was to determine if expressive art therapies have a positive impact on the core symptoms of AD, specifically the memory loss of patients, and the quality of life of people with AD. We specifically aimed to answer the following questions: How can expressive art therapies aid in the memory recollection of patients with late-onset AD? Does a certain form of art therapy have more cognitive benefit to the patients? Does a certain form of art therapy have a more positive impact on the quality of life of patients? Could multiple art therapies used in tandem with each other form the most beneficial treatment plan for a person with AD? The impact of each therapy was looked at separately to compare the benefits of each to one another. If each therapy has a different impact on AD, then using multiple forms of expressive art therapy together in conjunction with pharmacological treatments may prove to be the best treatment plan for a person with AD.

Methods

To complete this review, studies were collected from a Google Scholar search using the search criteria = all(alzheimer*) AND all(music* OR art* OR dance* OR art therapy*) AND all(cognitive function* OR memory loss* OR associative memory* OR nostalgia). Of the results generated from this search, 16 articles were analyzed in depth to assess the impact of expressive art therapy on AD. These papers were chosen for this review due to their study design and relevance to the central topic of expressive art therapies and AD. In addition, most patients in the articles fall above the age of 65 and generally have late-onset AD, which is AD diagnosed after

the age of 65. Other forms of dementia were also taken into consideration. Ancestry and descendant searches were conducted on the relevant review and empirical articles to gather as many relevant sources as possible by looking at either papers referenced within a certain article, or more recent papers that utilize information found within the article. The effect of various art therapies on the memory and cognitive function of patients were observed to make a conclusion about expressive art therapies as a probable treatment for AD.

Articles that utilized physical activity as a treatment were coded as dance therapy, studies that involved the patient creating art or viewing a form of art were coded as visual therapy, and treatment involving singing, creating music, or music listening as music therapy.

Type of Expressive Art Therapy	Number of Empirical Papers
Music Therapy	11
Visual Arts Therapy	3
Dance Therapy	2

Music therapy can include various activities, from listening to music to creating it. In a session, music therapists work with patients in either a group or an individual session and customize their activities accordingly based on the patients' preferences. When used for AD, music therapy can work to improve the associative memory of a patient when playing familiar songs, and short term memory when trying to remember a song they heard in the recent past (National Center for Complementary and Integrated Health, 2022). Music therapy can also boost the happiness and quality of life for a patient because music produces dopamine in the body, a pleasure-inducing neurotransmitter (Ferreri et al., 2019).

Visual arts therapy includes the patient either creating or viewing art. This form of therapy can be done on its own or with the aid of an art therapist. When used for AD, art therapy can improve the cognitive function of a patient when they create art on their own and also help mental health (Liu et al., 2023). Similar to music therapy, viewing and creating art can release dopamine, which can significantly improve mood and health (Zaidel, 2010).

Dance therapy involves group or individual sessions with a dance teacher or therapist where a patient does exercise or physical movement. When used for AD, dance therapy significantly benefits the cognitive and motor abilities of patients with dementia (de Natale et al., 2017). If used with music in the background, some benefits of music therapy may also apply because the individual will receive the same dopamine rush they get from listening to music.

Results

This review focuses on the impact of expressive art therapies on the quality of life and cognitive ability of AD patients.

Effects of Expressive Art Therapies on Cognitive Function and Memory Recollection

The effects of expressive art therapies on the cognitive function and memory recollection of an individual with AD was evaluated by analyzing nine studies. Out of these nine studies, most patients showed significant improvement in cognitive function, memory recollection, or both, depending on the varying methodologies used in each study. To determine which procedure was most beneficial to the patient, various subgroups within each expressive art therapy were created and analyzed separately. The findings of the study conducted by Gallego and García (2017) demonstrated that music therapy had a positive effect on the symptoms of AD. In this study, the participants listened to both familiar and unfamiliar music, and then were evaluated using the Mini Mental State Examination (MMSE). Using results from the MMSE, as shown in Figure 1 (left), they determined that, by study conclusion, all categories showed improvement. The most significant increases in score, however, were shown to be in orientation and memory. A similar procedure was used in the study done by Wang et al. (2018). This study also dealt with patients listening to music familiar to them and measured the MMSE score before, during, and after the treatment. As shown in Figure 1 (right), the mean scores of the patients' MMSE increased notably over the treatment period compared to the control group.
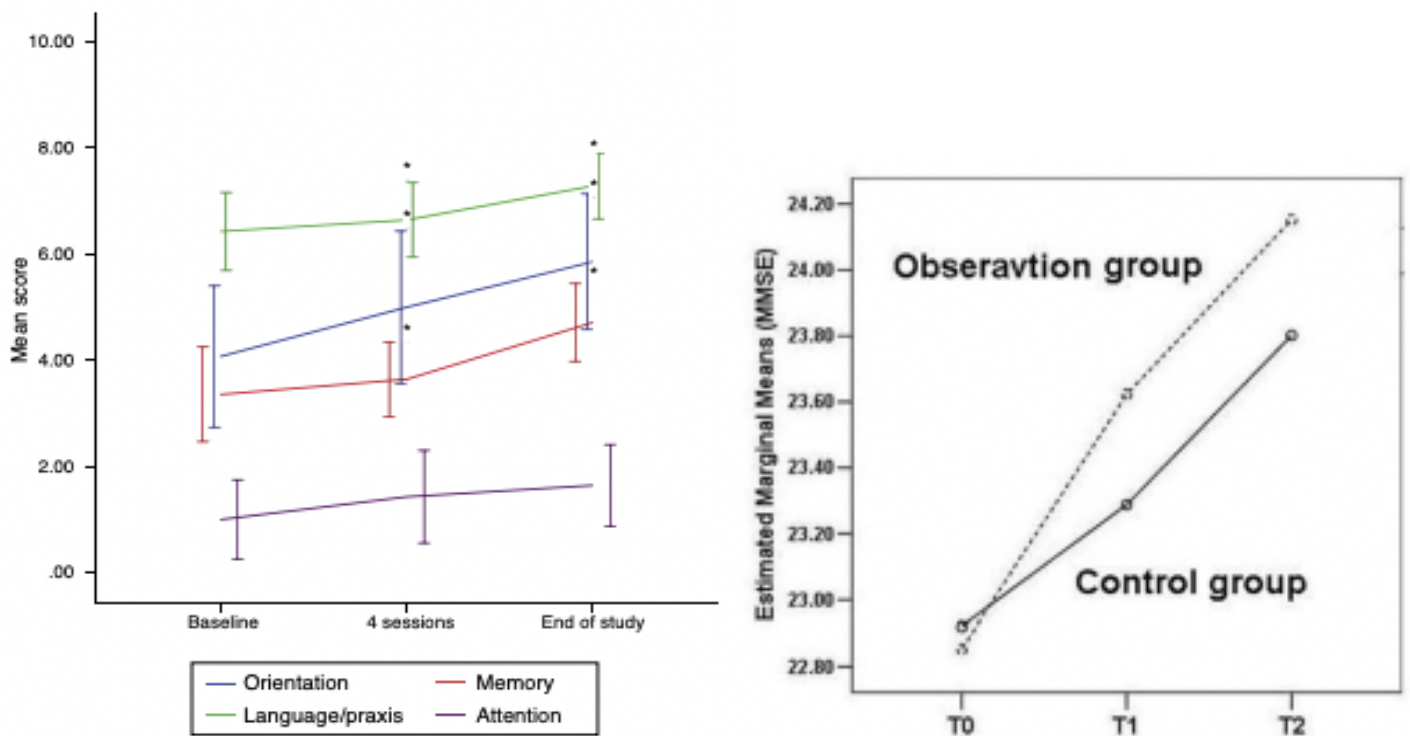
Figure 1   Changes in MMSE scores by domain.

Figure 1. Results from Gallego and Garcia (2017) and Wang et al (2018) demonstrating benefits of music therapy on MMSE.

Average Percentage of Words Recalled, by Task
Material Recalled

Subject #	Familiar Song	New Song	Familiar Spoken	New spoken
1	97.2	67.0	59.0	64.0
2	76.7	62.0	58.0	52.5
3	84.2	75.0	96.0	83.0
4	95.0	79.0	92.0	67.0
5	92.3	58.0	36.0	3.5
6	72.8	32.5	28.0	46.5
7	71.6	39.0	70.0	59.0
8	77.5	8.0	17.0	16.5
9	38.2	.9	11.3	1.3
10	12.5	.5	7.0	0.0
M	71.8	42.19	47.43	39.33

Table 1. Results from Prickett and Moore (1991) showing increased recall ability after familiar music.

The study by Prickett and Moore (1991) also tested the participants ability to remember lyrics and information while utilizing auditory stimuli that were both familiar and unfamiliar to the participant. Using both spoken and sung words, researchers tested the number of words recalled after listening to a song. The ability to recall certain information when receiving stimuli was evaluated as well. As shown in Table 1, familiar music was most easily remembered by participants. Similarly, the study by Fraile et al. (2019) created personalized music (connected to a prior memory of the individual) for patients with AD and tested their ability to remember the lyrics of the song after listening to it sung by the experimenter and singing it on their own. EFCL, a language cognitive function assessment, was used to evaluate the effects of music therapy on participants by evaluating verbal ability, memory, and executive processes. The total EFCL was used for analysis. Music therapy was found to have the most significant effect on the memory and executive function of the participants.

Another study that tested the effect of music therapy on the memory of a patient with AD is the study by Reschke-Hernández et al. (2020). In this study, there were 39 patients that participated, 20 that had AD, and 19 that were healthy. Each was given a song to listen to and were asked to evaluate their feelings immediately after completing the song. 5 minutes after the

test, they were given a memory test to see how much of the song they could recall. Within the 30 minute period after listening to the music, two more personal evaluations were done. During these evaluations, emotion ratings were converted into a percentage from 0% - 100%, based on how intense the emotions evoked were. It was found that those with AD performed lower on memory than the experimenters expected, but the emotions that they were experiencing remained consistent with the feelings of the music itself. This emphasized the idea that people with AD can experience strong emotions from brief exposure to music, supporting the idea that music could be used as a potentially therapeutic tool.

In the study done by Nektarios and Nikoleta (2021), 32 patients participated in music therapy sessions with the guidance of a music therapist. In each, patients chose an instrument to use and attempted to imitate the therapists singing/playing. A MMSE test was used to evaluate changes before and after music therapy and to determine whether the music made the patient recall anything. From this study, it was determined that the memory of music can retain within a person's memory even after their perception declines, showing that music is a unique stimulus that activates those with AD.

In the study by Hattori et al. (2011), patients colored abstract patterns with crayons and water-based paint of familiar drawings during 12-45 minute sessions. The MMSE score and Apathy Scale were used to determine if art therapy was an effective intervention. However, after evaluating these scores, they found that while some MMSE scores increased, it was not enough to show a direct relationship between visual art therapy and improvement in cognitive function.

In the study done by Matziorinis et al. (2023), 40 sessions were held weekly over a year with both music and physical activity included. Using music therapy, specifically singing lessons, the researchers evaluated the retention rates of participants with AD in the music therapy program. A control group also participated in the same forms of therapy to see if any significant changes were determined in the patients with AD. To determine the impact of music therapy on cognition, questionnaires like the World List Memory Test and stimuli from the Profile of Music Perception Skills were given to the participants. However, in the end, the researchers felt as though there were not enough participants that stuck with the music therapy to make an adequate conclusion about music therapy as a potential treatment for AD.

Parkinson's disease (PD), another form of neurodegenerative disease that can have dementia components similar to AD disease, has also been the subject of expressive art therapy. One study done by Natale et al. (2017) studied the effect of dance therapy on the motor and cognitive function of patients with Parkinson's disease. Along with the MMSE test, the experimenters used the UPDRS (Unified Parkinson's Disease Rating Scale), BBS (Berg Balance Scale) and other movement/balance tests similar to this. Compared to the group undergoing traditional rehabilitation, the group that was doing dance therapy had more improvements on the motor abilities of patients. The experimenters believe that the less significant effect traditional rehabilitation had on the patients could have been a result of that form of treatment being adapted to the length of the dance therapy sessions. This variation from how traditional rehabilitation would take place normally may have caused this difference in effect. Additionally, PD tends to

affect the motor ability of a patient more severely than cognitive ability, which may have resulted in less significant difference in the MMSE test before and after dance therapy.

Effects of Expressive Art Therapies on Quality of Life

The effects of expressive art therapies on the quality of life and mental state of an individual with AD was evaluated by analyzing eight studies. Most patients showed significant improvement in their quality of life.

In a study done by Hernández et al. (2020), participants with AD listened to personally-selected music intended to evoke strong emotions. Afterwards, participants were tested on their ability to recognize parts of the songs when given a stimulus, and self-reported their feelings on the Differential Emotions Scale (DES). While in comparison to the healthy control group, those with AD performed significantly lower on the memory recollection portion, the results showed that the emotions participants felt after listening to the music was consistent with the emotion the music was intended to evoke in listeners. This suggests that listening to uplifting music could have a positive effect on the well-being and mental health of AD patients. In a study done by Rio (2018), the effects of music therapy on individuals with AD disease and their caregivers was evaluated. Participants of this study went through various forms of music therapy in a group-based setting including both listening and creating music. As the treatment continued, the participants became more comfortable with each other, highlighting the potential that groups like these could have in improving the lives of patients with AD and their caregivers.

In the study done by Brotons and Pickett-Cooper (1996), sessions consisting of different musical activities were conducted twice a week. The 47 patients were observed by a music therapist or caregiver and the Agitation Behavior Scale and the Disruptive Behavior Rating Scale were used to assess the state of the patients before, during, and after music therapy intervention. It was found that when music activities are personalized to the patients, their agitation levels generally decrease, regardless of their musical background. This emphasized the idea that listening to music that is hand-picked to evoke certain emotions in a patient with AD can alleviate the anxiety that they may be feeling.

In the study done by Cevasco and Grant (2003), 38 sessions were held over 8 months with both music and a few movement activities incorporated into each 50 minute session. This study consisted of 14 patients, each with early to middle stages of AD. The goal of this study was to assess the amount of patient participation in various activities to see which would be most beneficial as a treatment method. While the study didn't produce precise responses, communication was developed between the therapist and client which showed potential in helping them learn new material.

In the study done by Matziorinis et al. (2023), the patients with AD also participated in physical therapy. With physical therapy, the researchers were trying to evaluate if there was a connection between the mental state of patients with AD and amount of physical activity. A control group that continued their daily routines was used to see if physical therapy proved beneficial to the quality of life of the patients. To determine the results, neuropsychological

testing and MRI measurements with repeated assessments were used. More specifically, the MMSE test was used to evaluate the patients' mental state before and after physical therapy. After evaluating the results, the researchers felt as though there were not enough participants that stuck with the physical therapy to make an adequate conclusion about physical therapy as a otential treatment for AD.

Purshouse and Mukaetova-Ladinska (2009) conducted a study to evaluate the effect of dance therapy on AD and well-being. After three 15-minute sessions of dance under the guidance of a facilitator, more engagement, improved mood, and better relationships between patients and their caregivers was detected.

Visual arts therapy was also found to have a positive effect on a patient's well-being. In the study done by Burns et al. (2018), a visual performance was given to the 147 participants and a questionnaire was given both before and after the performance to test their comfort levels and their opinions on creative arts. By the end, it was found that the viewers were emotionally influenced by a single performance and had improved comfort with discussing dementia with others. This can reduce the stigma associated with AD and can improve management of symptoms and stress surrounding the diagnosis. Another case where visual arts therapy was found to uplift the quality of life of patients was in the study done by Ehresman (2014). In this study, the researcher had the participants, both with and without AD, split into three groups, and gave them four different drawing tasks. To evaluate results, the experimenters compared the details found on the drawings from people with AD to those from the ones without AD. They found that people with AD tend to have less detail in their drawings and the faces that were drawn often looked odd and unproportional. Even while neurological effects may not be as prevalent in individuals with AD, it has the ability to enhance their well-being and quality of life. Images created during a visual art therapy session may also be representative of past experiences, allowing an outlet of expression for people while helping them recall details about their life.

Discussion

This review suggests that expressive art therapies may improve various aspects of the symptoms of AD and the quality of life of individuals with this condition. While each expressive art therapy addresses different sides of the disease, when the various types of art therapy are used together, it offers a potential non-pharmacological approach to improving the lives of those with AD. Music therapy, as shown in the studies, seems to have the most significant effect on memory recollection of patients. This is likely due to the ability of music to evoke certain emotions and memories in a patient, allowing it to be a valuable tool for AD patients suffering from memory loss. Visual arts therapy also seems to hold benefits for AD. Engaging in artistic activities can boost a person's mood due to the dopamine of completing such tasks, possibly enhancing patient quality of life. While studies on dance therapy used for AD patients is limited, the study involving Parkinson's disease shows the potential for it to improve patients' motor and cognitive function. By using music, visual arts, and dance therapy together, healthcare professionals can create a comprehensive treatment plan for AD patients to supplement pharmacological

treatments. While some benefits from these art therapies were evident, it is necessary to note the scarcity of studies in visual arts and dance therapy. The limited amount of studies in these areas could limit our understanding of their full potential in an AD treatment plan. Additionally, longitudinal effects of expressive art therapies should be observed to determine if they could prove beneficial as a long-term treatment. The relationship between an AD patient and their caregiver is crucial to the quality of life of both individuals. Many of these expressive art therapies do have a positive impact on caregivers' well-being when they also participate, but this effect would need to be looked at closer to determine if this could be a feasible way to boost the lives of patients.

An important aspect of expressive art therapy that needs to be better investigated is program feasibility. In the study done by Matziorinis et al. (2023), the main goal was to determine the feasibility of implementing both physical and music therapy into the treatment plan of a patient with AD. However, due to high costs and unexpected conflicts that arose from the intervention by staff, participation in the activities was found to be not feasible. Additionally, many of the participants didn't adhere to protocols such as attendance, causing the study results to be challenging to interpret. More research is needed to determine the feasibility of expressive arts therapies for older adults with dementia and determine possible protocols and treatment plans that can be easily prescribed by physicians.

Since most of the benefits of expressive art therapies are to the quality of life and mental state of an individual, if a treatment plan includes pharmacological treatments that can help reduce or control the cognitive decline of individuals, then a patient can receive both mental and physical benefits by incorporating arts-based therapies into their treatment plan. Due to the limitations and variation in data for expressive art therapies affecting memory, and due to the fact that it is a lot riskier to rely on a untested, non-pharmacological treatment for such a key symptom of AD, using both forms of treatment in tandem could be most beneficial and reliable for the patient. With the current research in this field being limited to small populations, a next step could be to expand the number of patients taking part in each clinical trial. As participation increases, it will be important to ensure that the patient enjoys the form of therapy they are being given, as otherwise it could have an overall detrimental effect on the well-being of the patient.

Additionally, as this form of treatment expands, rather than conducting each session in a professional setting, as many current studies are done, research could be shifted to an app-based setting. Similar to how therapy is shifting online in recent years, a therapist specializing in the specific art therapy could be present in video sessions with the patient. As time passes, the caregiver could become more attuned to the form of therapy and slowly take over for the therapist, or perform additional sessions outside of scheduled therapy. This could allow the relationship between caregiver and patient to become deeper while allowing for expansion of this treatment plan. This could also allow for expressive art therapies to be assessed in the long-term because a specialized therapist and formal setting wouldn't be needed to undergo this treatment. Another way to expand this form of treatment could be implementing locations that specialize in these forms of therapy. Similar to therapy nowadays, a patient could schedule weekly or

biweekly sessions, depending on their need for therapy, with a specialized individual and could continue for as long as the patient or caregiver feels it is beneficial. The caregiver could also be present during these sessions to gain information on how they can also help the patient in the time outside the sessions. Since the number of studies on this topic is very limited, especially in more untested forms of art therapy like dance, more research is needed to determine the overall positive result that can be seen in a majority of studies conducted to date.

Ultimately, expressive art therapies pose as a non-pharmacological intervention to enhance the cognitive function, memory recollection, and overall quality of life for AD patients. Combining these therapies into a single treatment plan may offer a more extensive approach to improving the various symptoms of AD. While further research is needed to address existing limitations, the potential impact of expressive art therapies on AD is promising, offering a beacon of hope towards a future treatment of this disease.

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The Effect of the Economy on Foreign Aid: A Meta-Analysis By Matthew Su

Abstract

Spending on foreign aid often fluctuates as time goes on, reflected by cycles of growth and decline in the economy. While there is significant literature surrounding the topic, the question of the magnitude of these different stages of the economic cycle on the perception of foreign aid is often conglomerated and difficult to quantify, with many studies using various measures. Therefore, this article investigates how the economic state in the United States influences public perception of foreign aid. I expect that when economic declines occur, voters would rather spend money on domestic issues rather than foreign ones. Thus, voters advocate for spending on domestic programs such as welfare, social security, or medicare, which they perceive benefit them, rather than a foreign population. Similarly, when the economy is doing well, voters are more sympathetic towards spending money on foreign issues, believing that the government has money that is unnecessary for domestic programs. In order to determine the effect of the economy on foreign aid, I analyze a comprehensive set of literature on the public perception of foreign aid during different economic phases and collect the estimates from said literature to conduct a meta-analysis. Overall, the effect of the economy on political support for foreign aid is negligible, and while it does have an effect, it's not large enough to be significant.

Introduction

For decades foreign aid has been one of the most important factors in global geopolitics (Milner). From spreading soft power to developing the Global South and beyond, foreign aid is an important aspect of current world affairs. As a result, aid has become a battleground in important political debates. This importance is reflected in the thousands of articles written about the various political factors associated with aid, whether it be in donor or recipient countries (Baker, Cacha, Doherty). These papers have spawned decades of disagreements about the effectiveness of aid, the potential harms of aid, and the causes of aid cuts and aid increases in various countries. This last question was of particular interest during the literature review, and the factor that I decided to focus on.

The research question I sought to answer was "How does the economic state of countries affect the political popularity of Foreign Aid to other countries?" While the question seems simple at face value, there are still significant disagreements within the literature. The biggest discrepancy comes from the mechanism by which aid is decreased. For example, people argue whether voters disagree with general spending during difficult economic times or whether they disagree with foreign aid spending because they want the government to focus on domestic issues rather than issues abroad. A second large disagreement comes from the extent to which aid fluctuates during various economic times (Henrich, Bayram, Yoshisharu). Specifically, whether economic declines have a large or small effect on political support for aid. If people don't support aid it could cause politicians to cut foreign aid to appease voters, potentially causing

negative harm for foreign aid recipients. If we are able to pinpoint the reason for the lack of support for foreign aid, it could help

Given the disagreements in the literature, I conduct a systematic literature review using the meta analysis to find an answer to these disagreements and a) pinpoint the mechanism by which aid decreases and b) quantify the amount aid decreases in various economic times. My analysis fills the gap of this lack of quantification and adds a novel perspective to the mechanism debate. The specific factor of aid cuts, and the independent variable, I analyzed was decreases in political popularity. I decided this because political popularity drives legislation and the spending decisions that politicians decide to take. The independent variable that I selected was the economic state of the donor country.

In order to complete the literature review and metaanalysis I first compiled all literature on political support of foreign aid. I ensured compilation of all sources I inserted the keywords "foreign aid," "political support," "political popularity,," "public support" and "public popularity." I then used backwards and forward citation mapping to capture all literature on the dependent variable. After, I went through all the dependent variables and controls and pulled all coefficients and standard deviations to pull all data and data. After, I analyzed the data by converting the data to Q standards, weighted Rs, and partial correlation informality to analyze the data in my metaanalysis.

In my analysis, I find two things: first, for the most part, the effect of the economy on the political support for foreign aid was negligible. The coefficients rarely fluctuated beyond one absolute value unit from 0, and those that do often have extremely high standard variations. Thus, it can be reasonably concluded that the effect of the economy on the political support for foreign aid is relatively low. In other words, all of the data reflecting the effect of the economy on the political effect on foreign aid indicates that the effect is pretty low, and not significant when analyzing the data. The reason is pretty simple: voters don't really mind spending a little extra money to support developing nations because they perceive they need the money, especially during times of economic downturn (Yoshiharu). However, while the change was small, some variables affected the popularity of aid more than others.

Literature Review

Throughout the literature on the popularity and flow of aid during various economic states, the only thing that all papers seem to agree with is that the popularity of foreign aid decreases in times of economic shocks, and increases in times of economic development. However, the literature disagrees on where the decrease in popularity stems from, focusing on three main disagreements: (1) the reasoning behind the decrease in political support, (2) the extent to which economic ties impact the favorability of foreign aid, and (3) whether foreign aid works.

The first disagreement focuses on the reasoning behind voters' decrease in political support for foreign aid. There are three main beliefs within this disagreement: the first is that voters would want the government to spend on domestic programs rather than international programs because domestic programs are considered more important during times of economic

hardship. These scholars use empirical evidence from the COVID-19 recession to support their claim (Yoshiharu). The second argument under this umbrella argues that government spending in general during an economic downturn is unfavorable because they want the government to cut back on spending to get out of the recession. For example, Henrich (2016) uses empirical evidence from the 2008 recession to support their claim. The final argument claims that during economic hardships, the suffering of the people in the developing world becomes less salient to voters, causing them to support more aid cuts (Bayram). The extent by which aid is cut is important to resolve as it drives the way that researchers and politicians should think of budget constraints in various economic states, and how they should approach dealing with the political implications of these states.

The second disagreement in the literature centers on the extent to which economic ties affect the favorability of foreign aid in countries. On one hand, scholars have found that foreign aid is intrinsically tied to the economy, and will increase when the economy is doing well and crash when the economy fails (Dabla-Norris). This is because voters scrutinize public spending during times of economic downturn and are more lenient with government spending during economic growth (Dabla-Norris). On the other hand, others argue that the effect is insignificant, primarily because voters do not mind helping the developing world because they feel that the developing world needs it more during times of economic downturn (Yoshiharu). Resolving this debate is important because it dictates to what extent politicians would be forced to cut foreign aid in economic downturns or would have leeway to add foreign aid during periods of economic growth.

The final debate about aid is whether or not foreign aid works in achieving its goals. There is a significant amount of literature and debate surrounding this topic, and as a result, there are a lot of beliefs that can be split into three main schools of thought. The first is that aid is net beneficial for a variety of reasons. For example, Glennie (2014) explains that foreign aid saves lives, making it beneficial. Others say that foreign aid incentivizes countries to be less corrupt in their practices to receive more aid (Efobi). Another finding in the literatureis that aid is net harmful to the countries that are receiving it for a variety of reasons. First, it crowds out domestic spending in these countries, causing less tax revenue for the government, less money to spend in the long run, and an over reliance on foreign aid (Benedek). Second, it props up various terror organizations across the globe by funding various governments and organizations that either supply arms to terrorist organizations or directly fund these terrorist organizations for political or economic reasons (Boutton). The third, arguably most popular group in the literature, claims that foreign aid should be determined on a case-by-case basis and there is no one-size-fits-all policy for foreign aid in any country or government (Adelman). Resolving these debates is crucial since if aid does not work or increases harm, then the political popularity of aid in various economic times does not matter because the overall effect of aid is negligible or even negative.

Overall, the study of economic circumstances impacting the favorability of foreign aid helps us understand a variety of important political concepts and can be used by policymakers both domestically and abroad. The most obvious benefit is predicting how voters will react to

various economic states. By analyzing the effect of political support for aid, politicians can better predict how and why their aid packages will be viewed in differing economic times. Moreover, if aid is not more likely to be cut during economic downturns, politicians could be more aggressive in passing aid packages, allowing for larger and wider-reaching aid packages to be passed. Finally, because politicians are inclined to do what gets them votes, they are more likely to cut aid if aid is politically unpopular, allowing us to better predict policy and predict the effect of various economic times on policy. For the developing world as well, analyzing the political support of aid is beneficial. For example, politicians in the developing world could easily predict the resulting aid outflow depending on the economies of various Western nations, allowing them to better prepare for the various complications that could result from these cuts. Moreover, less aid could harm the Global South by decreasing the amount of spending power that these countries have.

Methods

I conduct a meta-analysis to estimate the average effect of the economic state on political support for foreign aid in all relevant studies. A meta-analysis brings clarity to previous studies and their findings. It is a quantitative review of all literature that yields a numerical summary of all the literature's overall findings (Baker et. al). By looking at all literature on political support for foreign aid I can analyze the trends on the effect of the economy on the political support for foreign aid to other countries to determine the scale and mechanism by which people desire aid getting cut. By analyzing all literature we are able to ensure we have a holistic picture of the mechanism.

The raw materials of the meta-analysis are the coefficients and the standard errors of economic states of countries on the independent variable of interest with political support for foreign aid or the appropriate dependent variable. I first established the inclusion criteria for my research. To be considered for my analysis, the study must use a quantitative-statistical model that uses the measure of political support for aid as a dependent variable. For the independent variable, the model must include some reflection of the economic state of the host nation. Such independent variables include GDP Growth/decline, tax revenue growth/decline, average income growth/decline, consumer price index growth/decline, and poverty rate growth/decline. These independent variables were chosen because they reflect both the overall economies of countries as well as the mindset and financial state of individual consumers in the economy that voice their opinions on fiscal policy.

GDP growth/decline is included because it reflects the total output of countries' economies (other reflections of GDP such as nominal or GDP per capita were also accounted for for the same reason). Average income growth was chosen because it reflects the mindset of the economic time for many consumers. Consumer price index growth/decline was chosen because that is how the Federal Bureau measures inflation, making it a good benchmark for total inflation in the countries. Poverty rate growth/decline was included because it reflects the amount of poverty and the amount of people in poverty in countries, reflecting the economy. Some notable exemptions from this list include individual economic class, political bloc of persons surveyed,

and economic state of recipient countries. These were not considered for a variety of reasons. Individual economic class was not considered because it did not capture the overall economy and how changes in those states affected the political popularity of aid. The political party of the person surveyed was not considered because that did not reflect economic status either, as it's just a reflection of their personal political beliefs, rather than the economy. The economic state of recipient countries was not considered because it does not reflect the change of political popularity in donor states during economic states. To find the sources, I used the keywords "economic/foreign aid," "political support," and then inserted the independent variable words to ensure I gathered all scholarly works that fit the above inclusion criteria. Moreover, I used backward and forward citing to ensure that I captured all data on the question.

Tables
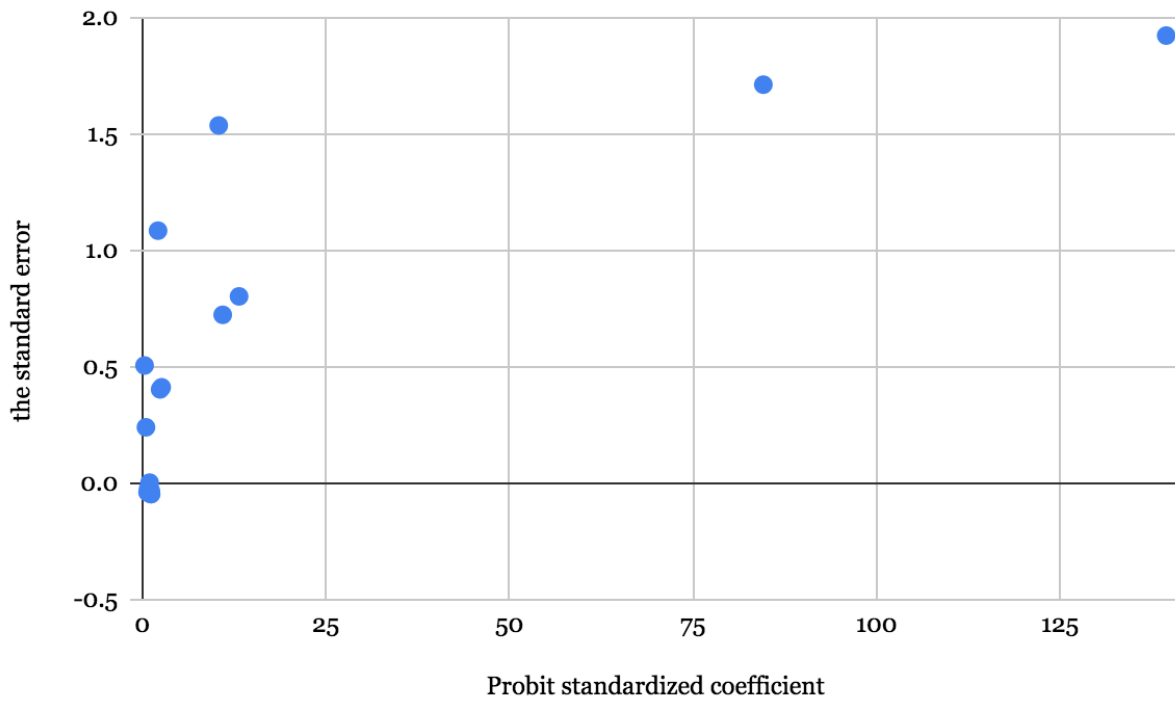
Fig 1: Probit Standardized Coefficient to the Standard Error

OLS standardized coefficient

OLS Standardized Coefficient to the Standard Error

	CPI	Employment	Inequality	Perception	Income	Poverty	Tax
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept	0.122^{**}	0.953^{***}	-0.299^{***}	0.089	0.912^{***}	1.164^{**}	0.999^{***}
	(0.057, 0.188)	(0.727, 1.179)	(-0.300, -0.298)	(-0.947, 1.124)	(0.755, 1.069)	(0.249, 2.078)	(0.849, 1.149)
Observations	6	6	6	3	10	12	11
Note:						$^{*}p<0.1;\ ^{**}p<0.05;\ ^{***}p<0.01$	

Average effects of all

Analysis

The results from the meta-analysis are shown in Table 1. The independent variables that are taken into account in the meta-regression analysis are Consumer Price Index (CPI), Employment, Inequality, Perception of the Economy, Income, Poverty, and the Tax revenues from the government. Figure 1 depicts the Probit standardized coefficients and Figure 2 depicts the OLS standardized coefficient. As can be seen in Figures 1 and 2, for the most part the effect of the economy is negligible on the political popularity of foreign aid. Specifically, in Figure 1, it can be clearly seen that the majority of the coefficients are in the 0 to 15 range, with the majority of the coefficients higher than that having significant standard errors. Moreover, in Figure 2 almost all of the coefficients are in the -1 to 1 range, with the majority of the coefficients being clustered around the -0.5 to 0.5 range. Similarly to Figure 1, the outliers in Figure 2 have large standard errors, indicating that they are statistical outliers.

Table 1 depicts the result of the meta-analysis. Specifically, it depicts the effect of all factors of the economy analyzed in the meta-study and analyzes them when all other variables are held at 0. In other words, it isolates the overall effect of each category independent of all other factors of the economy. The intercept represents the average effect size of these variables, and the numbers below it represent the standard error. Note that some coefficients are only statistically significant at certain P-values, so for example, income is statistically significant when p<0.01 as indicated by the footnotes at the bottom of the tables..

For CPI the intercept is 0.122 with standard deviations 0.057 and 0.188, which are not statistically significant. This indicates that every one percent increase in the independent variable, or CPI causes the dependent variable, or political support for aid, to increase by 0.122 percentage points. This is in line with the idea that economic factors do not have a large influence on political support for foreign aid. Moreover, CPI specifically should not have a large influence on foreign aid because CPI is simply a reflection of the price ranges at times in the economy, and would not have large implications on consumer spending or how voters perceive the economy is doing at a given point in time.

Employment has a much larger effect on the economy than CPI. Specifically, every one percent increase in employment causes a 0.953 percentage point increase in political support for foreign aid. This is somewhat in line with the idea that economic factors do not have a large influence on political support for foreign aid. It seems that employment is the most correlative factor out of all the factors that I examined. However, it does make sense that employment and increasing employment has a larger effect on political support for foreign aid than other factors because employment is a) something tangible that can be measured and compared from different economic times and b) something that directly harms consumers and voters who are likely to desire employment, and are more sympathetic to economic policies when they are employed and have income.

Inequality is the only negative coefficient, representing a decrease in political support for foreign aid. Inequality was measured using the Gini Coefficient which measures income distribution and inequality in certain states (Lee). A Gini Coefficient is a number between 0 and 1 with a 0 representing 0 inequality in an economy and a 1 representing the maximum inequality in an economy (Lee). Every one percent increase in inequality causes a 0.299 percentage point *decrease* in the political support for foreign aid. This data also supports the general idea that economic factors do not have a large effect on the economy overall, but the results are still significant at the [0.1,0.5] level. It is somewhat unsurprising that inequality has a negative correlation with political support for foreign aid, as inequality represents imperfections in our economy that could reflect on voters. However, it is surprising that this is the *only* negative coefficient in the entire analysis. Specifically, it is surprising that poverty has a negative coefficient with every one percent increase in poverty increasing the political support for foreign aid by 1.164 percentage points. This is surprising because poverty should probably decrease political support for foreign aid, as voters should perceive that there are domestic problems that should be solved before helping abroad (Tobias). Studies that have been conducted in the past

have had similar results and found that poverty hurt foreign aid opinions in the United States (Lee).

Perception about the economy has the lowest influence on the political support for aid. A one percent increase in how somebody feels about their economic situation or the economy causes a 0.089 percentage point increase in political support for aid. This is in line with the idea that the economy has a negligible effect on political support for foreign aid, as it has no significant effect on political support for foreign aid. This also makes logical sense, as the perception on how the economy is doing is not the greatest reflection of the real economy. As a result, most consumers and voters would not feel the effects of the weakened or strengthened economy, regardless of how they feel about it personally.

Income is one of the highest coefficients, with it almost being correlative to the effect on political support for foreign aid. Every one percent increase in income increases political support for foreign aid by 0.912 percent points. This also makes a lot of sense. Like employment, income is both something tangible that voters and consumers can feel the effects of and something that directly harms/benefits consumers when it changes. As a result, it makes sense that income has one of the largest effects on the political support for foreign aid.

The final factor that I analyzed in the meta-analysis was tax rates. Tax rates had a large effect on the political support for foreign aid. Specifically, to be considered as "Tax Rates" the tax money that the government has had to increase or decrease. My results indicate that every one percent increase in tax rates increases political support for foreign aid by 0.999 percentage points. This also logically makes sense for a couple of reasons. First, consumers would see increasing tax rates and perceive that the government now has excess money which they would be willing to support spending on countries abroad. Second, consumers would want their tax dollars to go to somewhere they deem "good" so they would be more willing to support programs that go to the developing world.

Discussion and Conclusion

My findings indicate that political support for foreign aid is *sometimes* tied to the economy, but the overall effect of the economy is for the most part negligible. Some factors of the economy heavily influence political support for foreign aid such as employment rates, tax rates, and income. Others, however, do not have large influences on the political support for foreign aid such as the perception of how the economy is doing, inequality, and CPI. Some results in my meta-analysis were a little ambiguous such as the poverty rate. My findings indicate that there is a positive correlation between political support for foreign aid and poverty. However, other studies have run analyses on the relationship between public support for foreign aid and poverty, and found that there is a negative relationship between poverty and public support for foreign aid.

The vast majority of literature indicates that support for aid decreases during economic downturns because voters no longer have the stomach to continue sending aid abroad (Tobias, Yoshiharu). The extent by which public approval of foreign aid is influenced by the economy is answered by my study: not very much. The reasoning is pretty simple: as discussed in my

literature review and analysis, voters often do not mind spending some extra money on the developing world during times of economic crisis because they perceive that they need the money a little extra (Yoshiharu). As reflected by the data, however, some specific factors have significant effects on public support for aid. Notably, the effects of the economy that directly hurt the consumers are most likely to have a large effect on the influence it has on political support for foreign aid. Overall, common consensus amongst scholars indicates that foreign aid usually gets cut if voters vote against it, so my study is important because it reflects likely aid flows from various democratic countries (Canes-Wrone, Powell, Soroka).

There are some limitations that may have hindered my results. For example, it is possible I did not capture all literature on the issue, whether it be because I did not have access to all literature on the issue because my methods of finding all literature on the issue were flawed, or because the keywords I used in the meta-analysis did not capture all parts of foreign aid. Moreover, future definitions of what signifies the "economy" could be tweaked as well to encapsulate other potential factors of the economy, as the economy is a large subject which can be captured in multiple ways. For example, the economy could be represented through other factors such as banking failures, investment, level of consumption, etc. Finally, my study provides pretty conclusive results on the political support for aid, but there are a lot of other factors that could influence aid flows or the amount of aid given by a government. Further research could be done on other factors of foreign aid such as the type of government being donated to, monetary capacity, or empirical trends in aid flows to different countries.

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Cosmic Ghosts: Hunting for Clues in the Dark Matter Realm By Bao Ha Ngoc Le[1] (student) and Jacob Wiesser[2] (mentor).

Abstract

Dark Matter appears as a central and mysterious entity that permeates the cosmos, standing as one of the most perplexing and intricate challenges in physics, overcoming borders and driving the convergence of several scientific fields in an attempt to solve its mysteries. As Dark Matter is by far the most prevalent particle in the universe, we would like to know what exactly makes it up since this would be helpful in understanding the dynamics of galaxies and the development of the universe. In fact, scientists have been meticulously cataloging the stuff in the cosmos for more than 50 years. But in spite of our astounding findings in the field of physics, the puzzle of dark matter, which dates back to 1993 when Zwicky remarked that the Coma cluster of galaxies would not remain bound unless it contains considerably more mass than we can see in stars, has still been unsolved [1]. It is embarrassing to know that 95% of the universe's gravitating matter is non-luminous, and we do not yet know the exact amount or the nature of this major component of the physical universe. In this paper, I will outline a thorough overview of the data and scientific details about Dark Matter's astrophysical evidence, candidates, detection methods, and alternative theory, with the goal of providing non-expert readers with insight and an approachable view of the Dark Matter question.

Introduction

We embarked on a quest to answer the most basic questions about our existence. What is it that decides whether we live or die, and what forms the bedrock of reality? In trying to solve this conundrum, we are irresistibly drawn towards the enigmas of dark matter. Non-baryonic dark matter accounts for approximately 23% of the universe's total mass, according to what we know about space today. However, it has never been seen directly because its presence can only be inferred through gravitational effects on galaxies at large scales, which means that if such an enigmatic entity did not exist, cosmic structures would not have formed due to insufficient gravity pulling things together. Hence, different theories propose that dark matter might consist of some undiscovered elementary particles having mass but feeble interactions with ordinary matter. Astronomical observations lead us into the most remote regions, while experiments in particle physics bring us face-to-face with high-energy collisions, all in a bid to reveal this hidden stuff that constitutes most of the material content of our universe. These particles have an influence on large-scale structures through their gravitational attraction, and these are precisely what those new techniques try to detect. This article sets out with the aim of exploring an intriguing puzzle called "dark matter" and looking into its invisibility, gravitational impact over space, and current scientific queries surrounding its nature.

Evidence for Dark Matter

The galaxies spin differently than expected.

From the beginning of the 20th century up until now, researchers venturing into space have found out that stars orbiting around the center of our galaxy move at about the same rate as those close to it. It seems that stars are moving faster than they should be able to [2].
In Newton's law of universal gravitation:

$$F = \frac{GMm}{r^2} = \frac{mv^2}{r}$$

The gravitational fields drop off with the square of the distance from the mass, and objects should move much more slowly because the force of gravity decreases with increasing distance. The evidence for this is all of the orbits of planets in our solar system. For example, the two planets closest to the Sun, Mercury and Venus, have the highest velocities when it comes to orbiting around the Sun: 47 km/s and 35 km/s, respectively. As we move farther from the Sun, planets begin to move at a slower pace [3].

To illustrate this, let's use the idea of circular motion. In order for an object to move in a circle, it must be supplied with a force that will keep it in that curved path. For an object to travel along circular paths, forces are needed. Sometimes, we have taken a ball, tied it with a string, and then rotated it over our heads. The string that is between our two hands always pulls towards the middle point or center of the ball. If we spin the ball faster, there will be more tension in the thread. However, gravity performs such a function not only on stars but also on galaxies where no strings exist, otherwise known as cosmic gravity. Faster stars move; a stronger gravitational pull should be exerted by them. Therefore, a comparable analogy can be applied to galaxies, wherein, assuming that the luminous region of a galaxy indicates the location of the majority of its mass, the center of the galaxy houses most of the mass, and the outskirts possess a notably lower mass. Accordingly, objects that orbit a galaxy's center at a large distance should have lower velocities than those closer in, just like planets behave within our solar system. Yet this inverse square law does not fit with the mass of all visible matter in galaxies for some reason. To experimentally examine this proposition, researchers scrutinized the incident light originating from a spiral galaxy, which is similar to our galaxy - the Milky Way - and graphed the velocities of stars as a function of their displacement from the galaxy's center [3]. Surprisingly, stars moved at about 200 km/s regardless of their distance from the center. At this rate, the galaxy should have ripped itself apart.
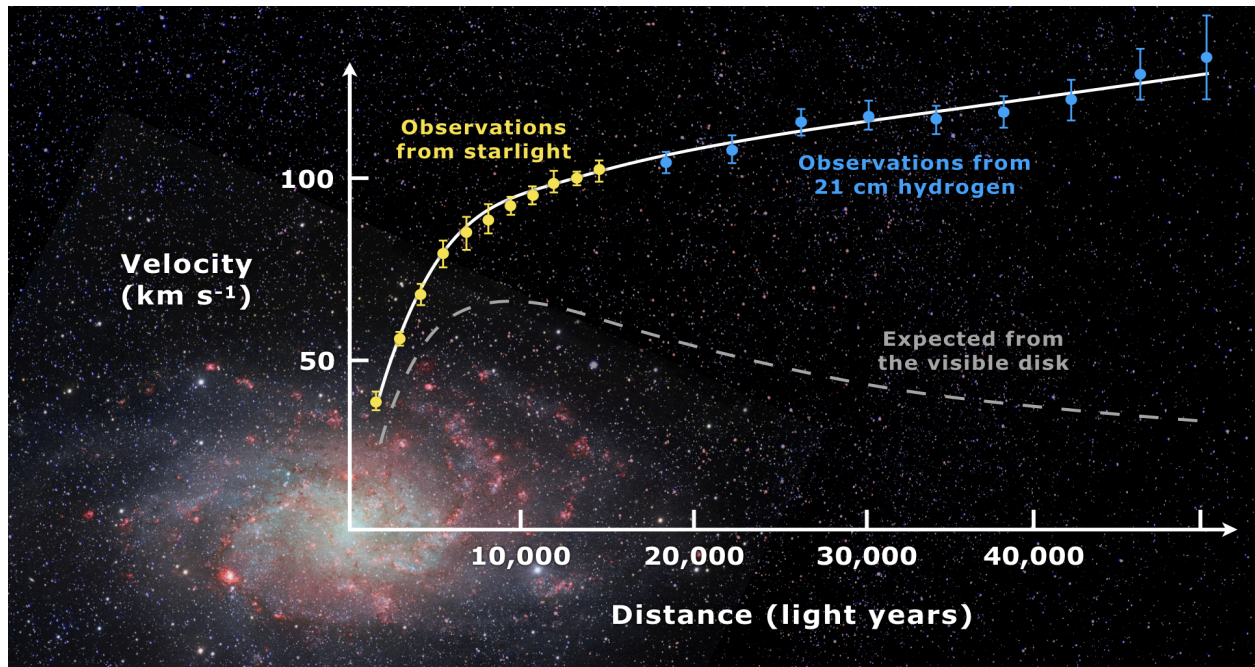
Figure 1 demonstrates the difference between the expected and actual velocity curves of a galaxy. The predicted curve is represented by orange-red dots, while the observed curve is represented by blue dots. This variance indicates that dark matter exists in galaxies.

For everything to be sure, scientists established that stars located further from the center moved at considerably higher velocities than anticipated. Such an outcome is only possible if a greater mass exists within the external regions of galaxies than is detectable by us. That's why it was theorized that the absence of observable light emitted by this mass is due to extra unseen matter or dark matter.

The bending of light

The works that showed astronomical bodies were moving too fast to explain using the known laws of physics and the observed matter are similar sorts of measurements telling a similar story. Still, they are not observations that suggest dark matter is real. In the end, strong evidence for the existence of dark matter finally arrived in the mid-2000s in the form of the Bullet Cluster, which is two clusters of galaxies colliding with each other [4]. To bring us to the next piece of very strong evidence for Dark Matter, a technique called gravitational lensing is applied. Thanks to this method, we discovered that there is much more undetectable dark mass in the universe than normal matter that our telescopes can detect. Gravitational lensing happens when a great deal of matter, for example, a star, galaxy, or cluster of galaxies, makes a powerful gravitational field that is capable of distorting space-time so that light from sources beyond it curves around. A suggestion by Einstein's theory of general relativity, this event implies that gravity does bend space-time, bringing about light curving around massive objects. It tells scientists how heavy something is by showing them the amount of light that gets bent near it. The reason why this works is that if there is an eclipse on Earth where the moon blocks the sun's

rays, making it dark for some time; likewise, during such periods when there are no clouds around our planet and we can see stars clearly from the surface then still those far away points in heaven will be shifted due to Sun's gravitation bending their beams towards Earth instead of going straight past us.
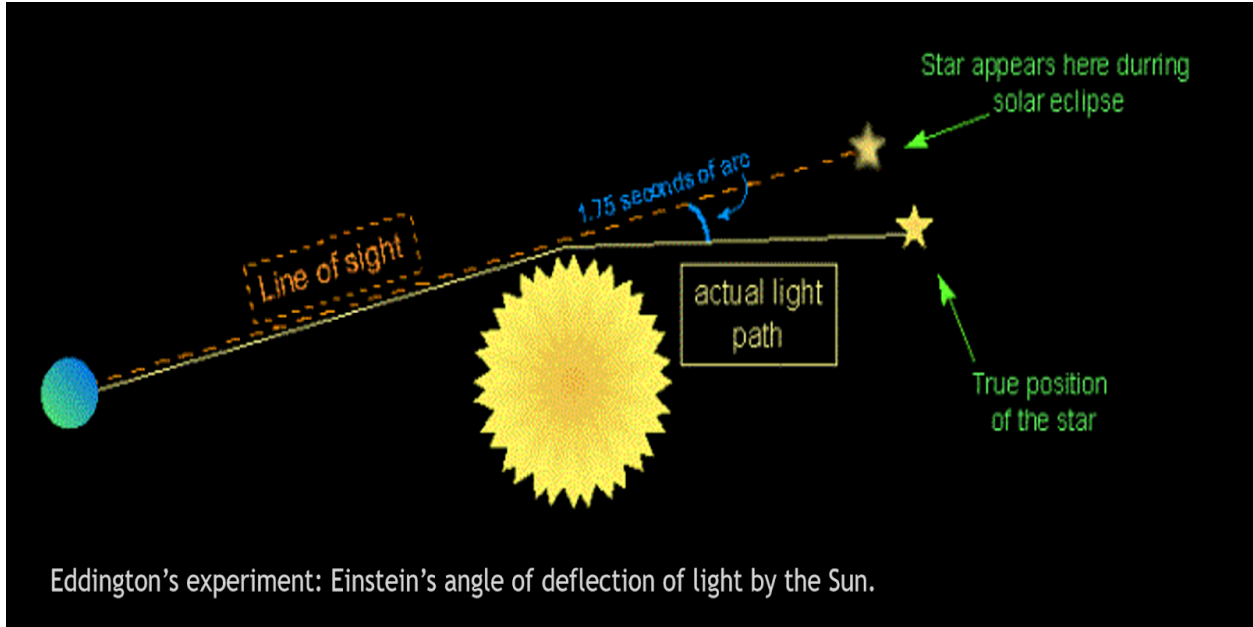
Figure 2: Observation of the gravitational lensing effect. During a solar eclipse, the sun bends light from a faraway star to distort the actual position of the star.

We can use gravitational lensing where there is matter and then see whether that corresponds to actually observing matter or not, so that brings me to the next piece of solid evidence for Dark Matter, which is Bullet Cluster. As two large clusters of galaxies collide, gravitational lensing observations reveal that most of the mass is concentrated in regions with little visible light. This discrepancy indicates the presence of dark matter, which does not interact with regular matter and passes through unaffected. What is shown in Figure 3 is that the blue clumps passed through very quickly and did not interact much, whereas the red slowed down and got stuck in the middle. That's because ordinary matter interacts and gets slowed down as it passes through each other, whereas dark matter does not just interact and pass straight through. The gravitational maps of the Bullet Cluster further corroborate the need for dark matter by showing that the distribution of matter does not align with the distribution of visible light [4,5].

Figure 3 shows the galaxy cluster 1E 0657-56, formed after the collision of two large clusters of galaxies.

Cosmic Background Radiation

Apart from those pieces of evidence mentioned above, there is another compelling proof to explain Dark Matter's existence: precise measurements of the temperature anisotropies in the cosmic microwave background (CMB). The Cosmic Microwave Background (CMB) is the cooled remnant of the first light that could ever travel freely throughout the universe [4]. Today, the Universe is transparent to light, and the light from distant objects can travel unimpeded through space before reaching our eyes. But it was sometimes different. In particular, during the early universe, photons and energy were abundant for roughly the first 380,000 years, but they were not free to move much. Thus, the atomic component, or baryons, is not electrically neutral, and because the photons from a high-pressure fluid, baryons, and the CMB photons are tied together to make a "baryon-photon" fluid. This fluid has a high sound speed since the photons provide most of the density and almost all of the pressure. In a region with high initial density, there will be high pressure in the baryon-photon fluid, which will propagate as an expanding spherical sound wave [6]. The Universe kept expanding, and as it expanded, it cooled, as the fixed amount of energy within it was able to spread out over larger volumes. About 380,000 years after The Big Bang, it had cooled to around 3000 Kelvin, and electrons were able to combine with protons to form hydrogen atoms, making the Universe transparent to light and able to reach out. This process is known as recombination. Recombination allows photons to decouple from matter and freely stream through the universe. The acoustic density waves froze in place during recombination, or, in other words, relics of the photon-baryon fluid at the surface of the last scattering, where photons from recombination have come to Earth, are the observed CMB photons [7].

Thanks to the Cosmic Microwave Background (CMB), we can determine the exact temperature of the universe's background radiation. The nearly perfect black body spectrum suggests that the temperature is evenly distributed, indicating isotropy and homogeneity in the early universe. These characteristics have continued to manifest in the universe today, with a consistent density of galaxies across all directions. Nonetheless, the CMB exhibits very little variations in both temperature and polarization across various sky locations with a variation of 0.00003, or roughly 1 in 100,000, and these small temperature fluctuations are called anisotropies [8]. These fluctuations originated from density variations in the early universe. There were areas that were less dense and others that were marginally denser. Scientists frequently utilize color coding to depict temperature fluctuations in their CMB images. In Figure 4, scientists frequently utilize color coding to depict temperature fluctuations in their CMB images, with blue-coded regions indicating higher matter density and red-coded regions indicating lower matter density. Higher-density regions attract more matter due to gravity, leading to increased energy [9], while lower-density regions have less matter and lower energy.
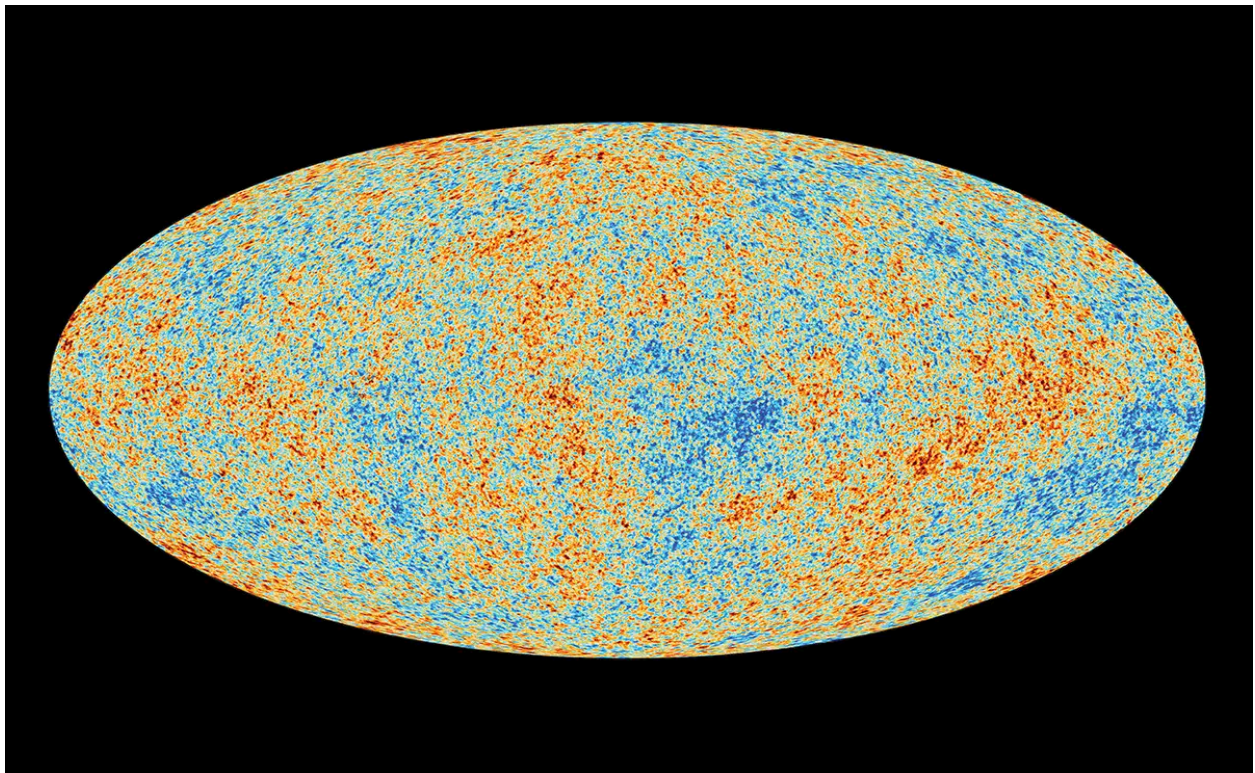
Figure 4: Planck's view of the cosmic microwave background. The spots on the map correspond to photon energies at the time of the last scattering of photons by electrons.

These over-dense regions served as the seeds for the formation of galaxies and other cosmic structures when they fell due to gravity. The observable distribution of galaxies throughout the cosmos should have expanded from the density variations during the recombination event. These fluctuations need to be around 1% of the mean density; otherwise, the large-scale formations that we observe today would not have developed. However, the CMB shows remarkable uniformity over the sky (up to more than a part in 10^5 compared to growth by

a factor 10^3 measured since then), which is consistent with a uniform baryon density during recombination [10]. Its extraordinary uniformity implies evenness in baryonic matter density at recombination. Therefore, the collapse required for galaxy formation could not have been caused by baryonic matter alone because of its electromagnetic interactions with resultant pressure forces. This leads us to think about dark matter, which interacts only through gravity and does not experience electromagnetic forces, as being responsible for the necessary gravitational pull [10]. During their gravitational fall towards each other, these regions attract baryonic matter too, which then condenses into small, dense pockets filled with stars or any other cosmic bodies eventually [11].

To prove the existence of dark matter, scientists determined the angular anisotropy spectrum of Cosmic Microwave Background (CMB) that was measured by Planck [12]. These observations are given in Figure 5 and represent those peaks that tell us about the universe as well as baryon density. The geometry of spacetime has this odd multiple peak, with the first peak corresponding to spatial curvature. Some ratios like (2:3) provide additional information regarding baryonic participation. Therefore, these measurements are consistent with cosmological models where the majority is played by Dark Matter. Baryon density can be understood from the ratio between odd-numbered peaks, such as the second and third ones, which represent the second acoustic oscillation mode for the second and third peaks, respectively. Thereafter, its height sheds light on the balance between baryonic substances and dark stuff, also reflecting the higher proportionate weight of baryons relative to Dark Matter. During acoustic oscillations, electric magnetic pressure does not affect Dark Matter, hence making it sensitive to total matter density (including both baryonic and dark matter) while responding mainly at 3rd peak because synchronization radiation matter lacks feedback mechanisms, thus revealing the 3rd peak's dependence upon total mass, specifically secondarily attributed to first.
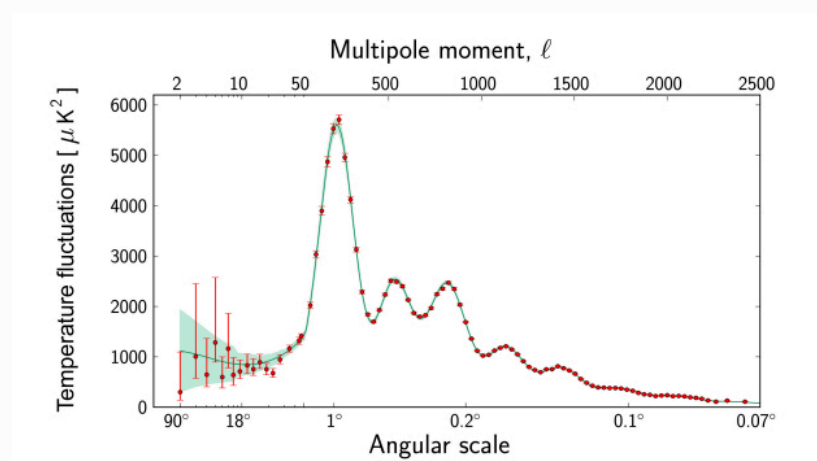
Figure 5: The CMB power spectrum versus the multipole moment l and the angular size θ. The curve shows the theoretical prediction of the power spectrum, while the red points represent the Planck data as of March 2013

What could dark matter be?

One thing all the evidence for dark matter stated in the previous section has in common is that we only discovered its presence by its gravitational pull on the universe, as seen in the orbits of stars and galaxies, in the way light bends around galaxies and clusters, and in the clumpiness of the cosmic microwave background radiation. The concept of dark matter was developed because the gravity of today's visible matter could not provide an adequate explanation for the formation of mass in the early universe. Many things were once thought of as possible explanations, such as black holes - which attract matter but don't emit light and are detected by gravitational lensing - or failed stars - or even stranger so-called "compact objects" - hiding out in a galaxy's halo, having large mass but not much light. However, scientists are still mystified by dark matter as to its nature. In short, all of these explanations were not sufficient to explain the quantity of dark matter required. According to modern-day astrophysicists, dark matter is likely to be composed of subatomic particles with properties that differ from protons and neutrons, namely non-baryonic matter.

Dark matter's properties

The Standard Model is one of the most popular theoretical frameworks that describe the behavior of a vast family of particles. These particles constitute everything we see in space. There are 2 main types of fundamental particles: fermion and boson. Leptons and quarks are the two families of fermions. Protons and neutrons contain up and down quarks, which belong to the quarks family. Each of the twelve fermions has a spin value of ½. They interact with one another through fundamental forces: weak interaction with Z and W bosons, electromagnetic force with photons, and nuclear force with gluons [13].
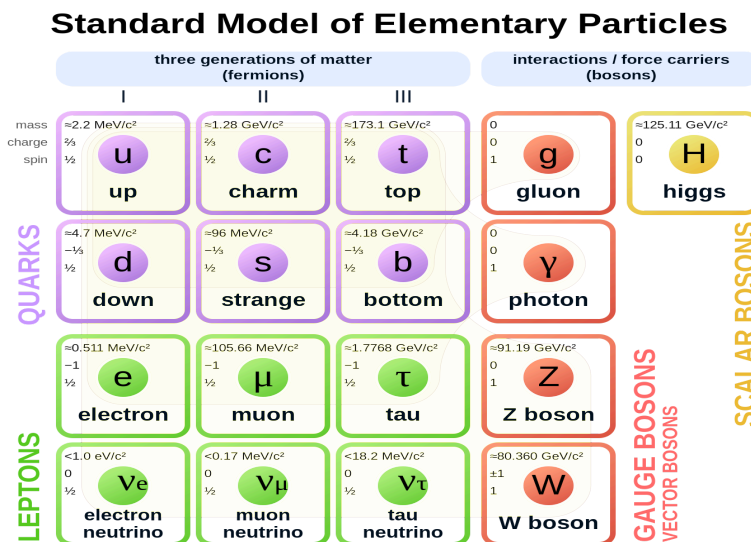
Figure 6 shows the chart of the Standard Model of Elementary Particles.

Most matter particles in the universe are either too light to become Dark Matter or have lifetimes shorter than the age of our universe, thereby making any evidence for dark matter beyond SM impossible [14]. The condition for a dark matter particle is that it should be

collisionless [15]. If it interacted, then giant regions of dark matter would lose energy in those collisions and contract. They might collapse into dark matter galaxies and dark matter stars. But no - dark matter seems to stay puffed up in gigantic halos surrounding the much more concentrated clumps of visible matter [16]. The fact that dark matter forms those giant halos at all tells us something fundamental. It gives dark matter a temperature. We refer to such dark matter as "cold" [15]. This is because the universe expanded and cooled, and particle interactions decreased. At this time, Dark Matter particles decoupled from the thermal bath, effectively "freezing" their velocities, and these slow-moving dark matter particles could then gravitationally attract each other to clump together. Over time, these clumps grew, forming those massive halos. If dark matter particles were too fast, they would be able to elude the attraction of crowded areas and the development of small-scale structures, resulting in structures that differ from what is seen [16]. Another condition for a dark matter particle is that it cannot communicate via electromagnetic or must have very weak electromagnetic interactions because it does not emit light, thus the term "dark." Besides, it does not absorb light otherwise, we would be able to detect it when it blocks light from the more distant universe. From this, we may conclude that dark matter is both absolutely dark and perfectly transparent, implying that it, like the neutrino, is electrically neutral [16, 17].

Dark Matter's candidate

Supersymmetry is an expansion of the standard model that suggests every ordinary particle, whether it is matter or a force carrier, has a twin or counterpart on the opposite side [13]. Each matter particle or fermion possesses a supersymmetric force carrier or boson, and every boson has its fermion. These supersymmetric particles are anticipated to be much heavier compared to their standard model counterparts, which may account for why we have not observed them in our particle accelerators. However, it is conceivable that they were created during the enormously energetic early universe, and the remnants from that time might still be having an impact. The simplest form of dark matter resulting from supersymmetry is known as a neutralino. It is a combination of the electrically neutral superpartners of the Z boson, photon, and Higgs particle [13].

Different types of supersymmetry offer various candidates for dark matter, such as the counterparts of neutrinos or gravitons, referred to as "LSPs." These particles have a remarkably similar mass to the expected mass of a specific type of dark matter, leading some to argue in favor of supersymmetry [20]. This occurrence, often known as the "WIMP miracle," requires clarification on what a WIMP is. The WIMP, or "weakly interacting massive particle," is a general description assigned by physicists to dark matter particles, including supersymmetric ones like the neutralino. The concept of the WIMP arose independently of specific WIMP candidates, signifying particles that are both massive and weakly interacting. The massive aspect is self-evident, as it allows a particle to contribute significantly to the universe's mass and maintain a slower velocity, making it "cold" [20]. Weak interaction, as we previously discussed, helps sustain the expanded form of dark matter halos because shortly after the Big Bang,

particles and their corresponding antimatter counterpart would annihilate, releasing the borrowed energy. As the universe cooled down, this process ceased. The result was a universe filled with particle-antiparticle pairs that gradually annihilated over time. Nevertheless, certain particles may not have had the chance to encounter an antimatter partner before being carried apart by the universe's expansion. Particles like electrons or positrons were highly interactive due to the electromagnetic force, consequently finding each other too easily. These particles didn't experience sufficient expansion to separate them, resulting in the majority annihilating. However, WIMPs, with their extremely weak interaction, had a higher chance of evading their antimatter counterparts, potentially allowing numerous WIMPs to survive to this day. The strength of this interaction aligns with that of the weak interaction. WIMPs solely interact through the weak force or something even weaker. This suggests the presence of an entire ecosystem of particles conducting their mysterious activities throughout the universe, interacting via dark forces, all involving oscillations within their obscure quantum fields, perhaps exhibiting their complexities and diversities [21].

Method detection
        Over the years, scientists successfully developed a couple of methods of detection via special and complicated experiments. There are now three main ways to find dark matter: in particle
accelerators, by direct detections of scattering in terrestrial detectors, and by indirect detection of products from dark matter particle annihilation in the galactic halo.
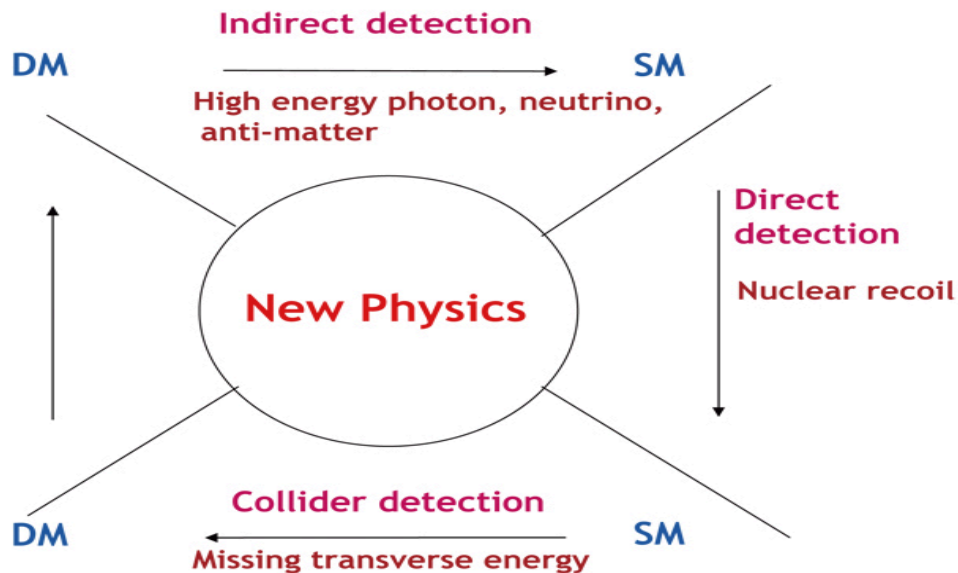
Figure 7: The three main methods of detecting Dark Matter. From the right to the left, one can create dark matter particles in collisions by accelerating ordinary particles to a specific high energy. In the direction from the top to the bottom, dark matter particles can be elastically scattered off from normal particles, and by picking up the signals produced by this scattering,

Dark Matter can be directly detected. In the direction from the left to the right, two dark matter particles can collide with each other and annihilate, producing a pair of standard model particles.

Particle Colliders

By colliding standard model particles and searching for events with missing energy or transverse momentum, it is possible to infer the existence of a dark matter candidate. As shown in the figure, we can find dark matter, much like scientists conduct experiments at Large Hadron Colliders, such as ATLAS and CMS [22, 23]. Einstein's most well-known equation, $E = mc^2$, states that one may create more massive particles (with a mass m) with energy (E) that is approximately 14,000 times greater than a proton's rest mass. In the same manner that proton-proton collisions produce the Higgs boson, it is hoped that enormous dark matter particles can be created at the LHC by colliding known particles.

As their name suggests, Dark Matter particles lack interaction between Dark Matter and ordinary matter. Thus, the primary marker of dark matter production at the LHC, conducted in ATLAS searches, is the existence of invisible particles in proton-proton collisions. The main signature of a Dark Matter particle's existence in proton-proton collisions from the LHC is called 'Missing transverse momentum' [24]. According to one of the main classical physics principles - momenta conservation - the total momentum before the collision must be equal to the total momentum after the collision. Similarly, because protons move parallel to the LHC beams before a collision, the resulting particles' total transverse momenta also have zero net momentum in the transverse direction [23]. Still, it is possible that unseen particles' momenta were neglected if the total transverse momenta of visible particles did not equal zero. This transverse momentum that was lost is referred to as "ETmiss." The LHC looks for dark matter collisions with high ETmiss values, wherein dark matter is produced together with other visible particles from the Standard Model, such as electrons, muons, or tau leptons, or photons, quarks, or gluons (creating particle jets). Because it depends on accurate measurements of other particles in the collision, ETmiss is challenging for physicists to detect DM [24].
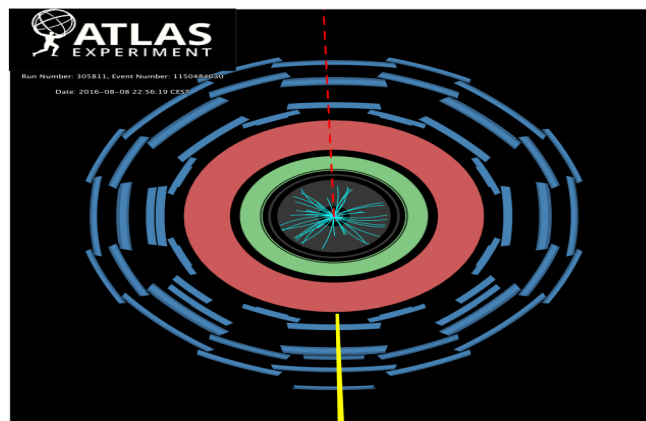
Figure 8: A visualization of a photon and ETmiss event is shown in the ATLAS detector. A photon with a transverse momentum of 265 GeV (yellow bar) is balanced by an ETmiss of 268 GeV.

An important aspect regarding collider searches for dark matter that needs to be stressed is the fact that colliders, generally speaking, offer a complementary and important probe for dark matter, but they cannot determine if what they see is the dark matter of the universe, since any neutral particle that decays outside the detector can be seen as missing energy. Only direct and indirect detection methods provide a way to confirm.

Direct method

Direct detection aims to detect recoils from interactions of dark matter particles with target nuclei in detectors. WIMPS detection offers the possibility of directly detecting dark matter particles. As the WIMP is electrically chargeless, it will generally elastically scatter off the atomic nucleus rather than interact with the atomic electrons.

WIMPs can be detected by their interaction with nuclei through three signal types based on the detector technology; these signals are separable or combinable. Depending on the type of particle being searched for, the relative magnitude between two combined signals represents a potent detection technique. Interacting predominantly with atomic nuclei rather than electrons because of their feeble matter interaction, WIMPs cause nuclear recoils as opposed to electronic recoils where particles such as gamma or beta rays interact with an electron resulting in less ionization produced. This difference allows one to differentiate between low-energy nuclear recoils caused by dark matter interactions and those caused by electronic recoils [25]. Specifically, in the figure 8, for ionization signals, germanium detectors or gasses are utilized, whereas scintillation can be recorded for crystals and noble-gas liquids. At mK temperatures, cryogenic bolometers are used to gather phonons generated in crystals. In tests with superheated fluids, nucleation processes are also caused by heat signals. Detectors that investigate discrimination power by measuring two signals include double-phase noble-gas detectors for charge and light read-out, scintillating bolometers for phonon and light detection, and germanium or silicon crystals for phonon and charge. Moreover, scintillation detectors are used in the DAMA/LIBRA experiments. They are the only direct detection experiment that has produced any good results thus far. Their findings indicate a dark matter signal that varies with the season, which is to be expected given that the experiment's dark matter density would fluctuate as the Earth revolves around the Sun [26, 27].
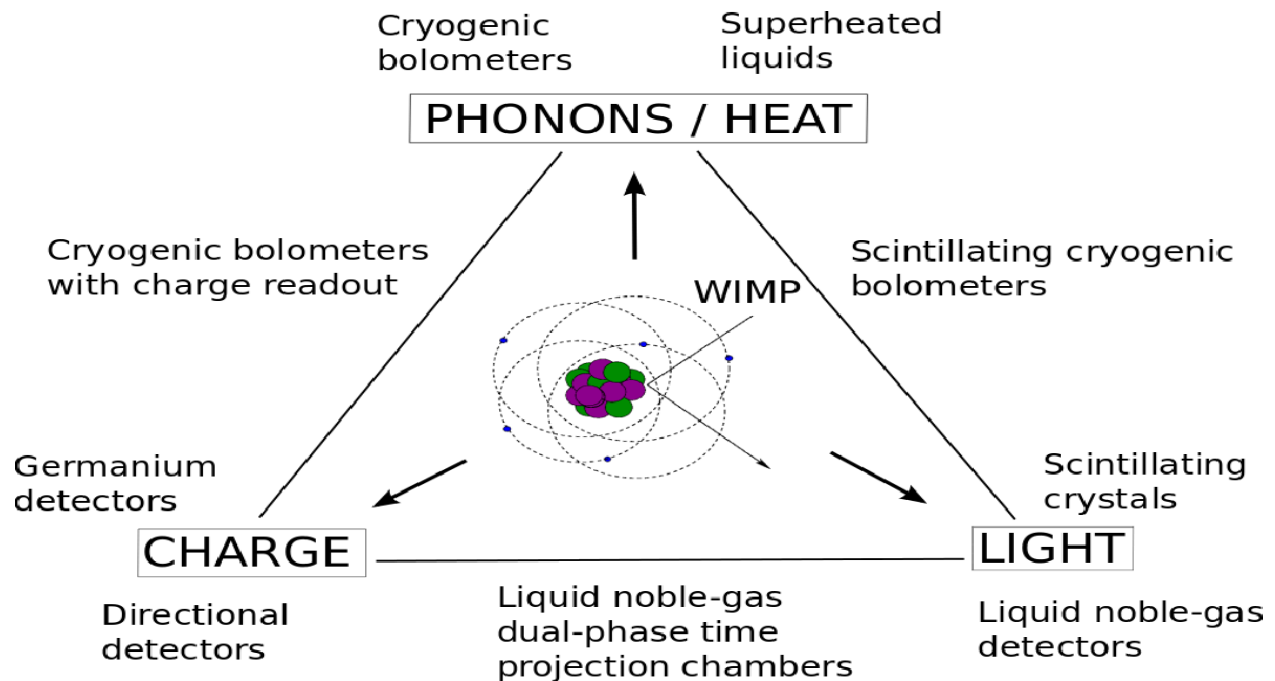
Figure 9 shows a scheme of the possible observables, as well as the most common detector technologies.

Four years ago, we developed and tested the LUX-ZEPLIN, also known as the LZ detector, which is one of the largest and most sensitive WIMP detectors ever made, to serve the purpose of a direct method. Looking at Figure 9, LZ's heart comprises a reservoir containing an impressive 7 tons of liquid xenon. If a particle traverses the tank and collides with a xenon nucleus, there are two distinct phenomena that occur: a quick flash of scintillation light and a delayed flash of electroluminescence. The light signals are detected by 494 photomultiplier tubes [28], which are positioned at both the top and bottom of the tank. The process begins with xenon producing light and freeing electrons which move to the top of the tank, leading to another flash of light. These bursts will be detected by 500 light-sensitive tubes. In this article, WIMP (Weakly Interacting Massive Particle) can produce different combinations of bursts. Cosmic rays, gamma rays, and neutrons will create background noise that scientists at LZ have to deal with through a multi-layered system aimed at reducing such noise. Radioactive krypton will be eliminated when purifying xenon; only 80% is used for dark matter detection, while the remaining serves as a shield. Called the "skin," it rejects signals from gamma rays and neutrons. The container holding xenon must be made from pure titanium and placed inside another tank filled with liquid for radiation detection; both tanks should then be surrounded by a third one containing water for extra protection against radiation.

The LZ Detector

7 tonne liquid xenon time-projection chamber

Instrumentation conduits

Existing water tank

Liquid Xe heat exchanger

Gadolinium-loaded liquid scintillator

120 outer detector PMTs

High voltage feedthrough

494 photomultiplier tubes (PMTs)
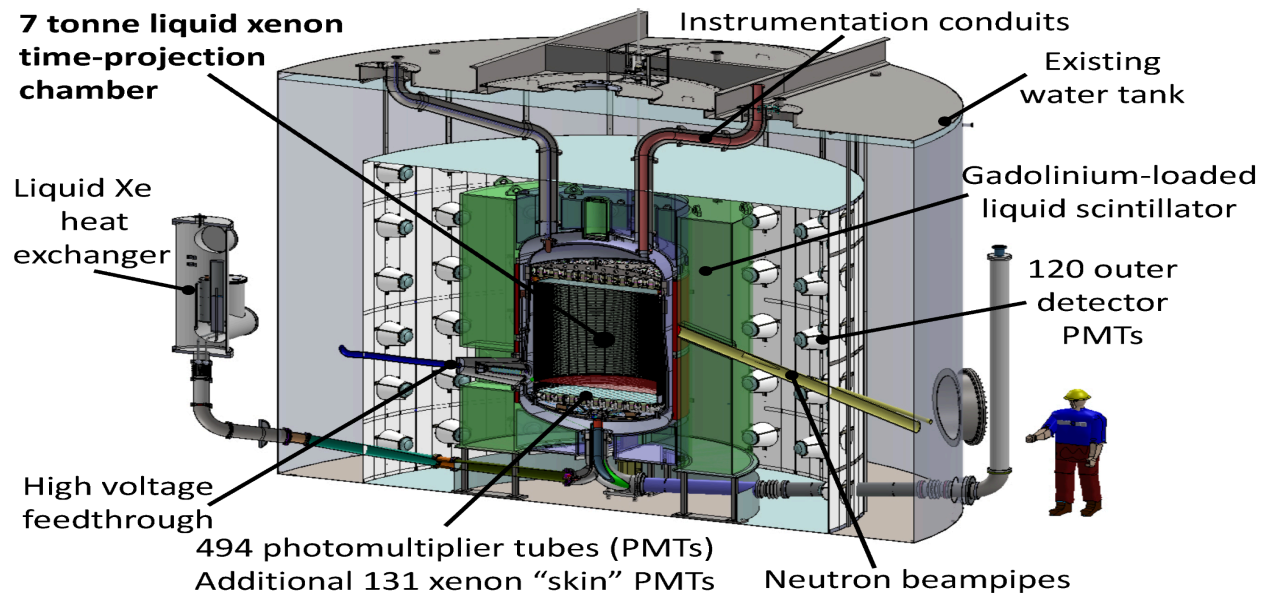Additional 131 xenon "skin" PMTs

Neutron beampipes

Figure 10 shows the mechanics of the LUX-ZEPLIN Dark Matter experiment.

Indirect method

Dark matter cannot only be detected directly in dedicated experiments searching for nuclear recoils from the scattering of dark-matter particles or produced in particle accelerators such as the LHC, but it can also reveal its existence indirectly. In contrast with direct detection techniques, where the interaction of dark matter particles with a suitable target is searched for, the term "indirect" refers to those methods linked to the products of interactions of Dark Matter candidates gravitationally accumulated in cosmological objects. The accumulation of dark matter is expected in the galactic core, dwarf spheroidal galaxies, or galaxy clusters because they are thought to be the regions with a high density of dark matter.

Usually, searches for dark matter are conducted indirectly by looking for evidence in regions with high densities of dark matter; this is because they do not decay easily and are assumed to be stable [29]. Rather than doing this, however, most attempts focus on detecting signs left by the annihilation of one dark matter particle with another. Two particles annihilate when they collide and change their mass into other particles, thereby producing energy. The resultant particles rely on initial properties and energies involved with these events. Observable signals could be produced if weakly interacting massive particles (WIMPs) were self-annihilating such that their make-up was constituted by some amount of dark matter. This releases energy that forms familiar particles like quarks as well as leptons, including positrons, but also electrons alongside protons, among others, such as antiprotons, neutrinos, or photons [29].
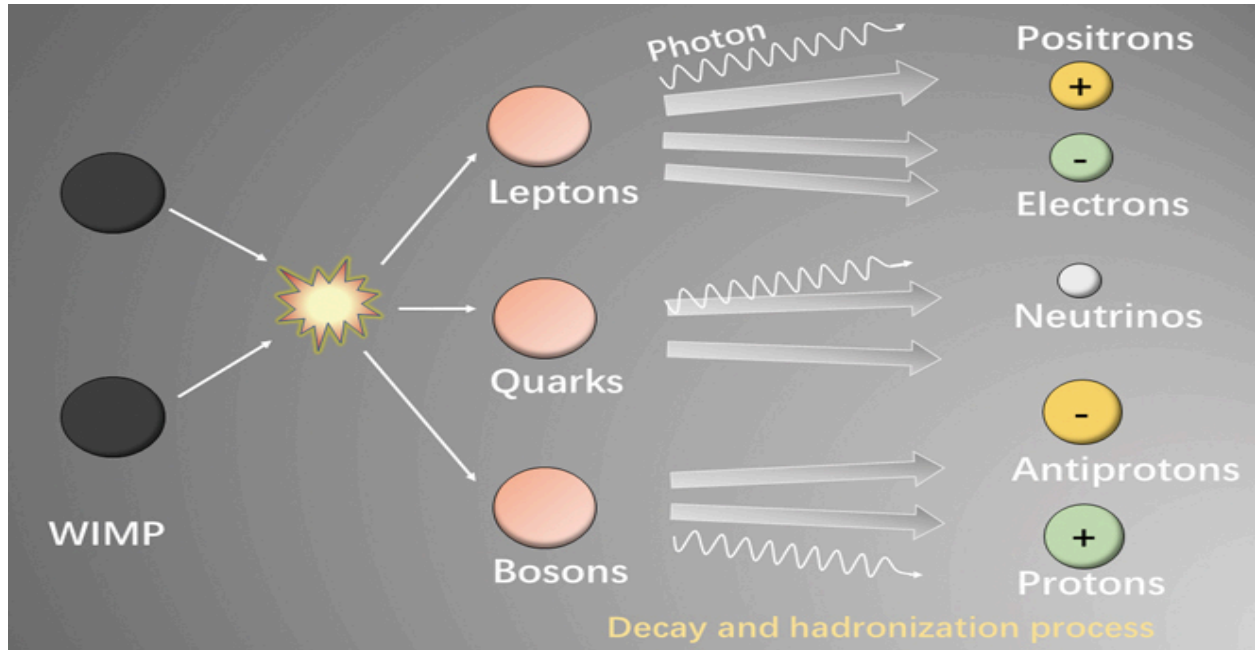
Figure 11: Principle of self-annihilation of Dark Matter particles.

Indirect detection of dark matter involves studying gamma rays, which have unique properties that make them ideal for studying dark matter annihilations. Gamma rays travel in straight lines, allowing us to trace them back to their origins, like a cosmic breadcrumb trail [36]. This helps us find places where dark matter might be annihilated, even in distant galaxies or galaxy clusters. The energy of gamma rays from dark matter annihilation is limited by the rest of the mass of the annihilating particles, meaning the energy cannot exceed the mass of the particles; as dark matter particles are thought to be heavy, gamma rays with high energy (in the GeV and TeV range) are expected to be detected, matching the energy range where dark matter signs are expected [30]. Think of yourself inside a highly dark room where nothing is visible to your eyes, but footsteps and whispers are heard which give you the impression that there might be someone else present in the room. Likewise, we cannot see dark matter directly because it does not give off any light. However, we are able to detect its existence by observing the signals it sends out, such as gamma rays produced during collisions between particles of Dark Matter, which result in weak emission signals. Currently, indirect gamma-ray dark matter detection is developing extremely quickly, mainly because of the Fermi-LAT space detector's successful operation and the advanced plans for a very large imaging air Cherenkov telescope array, which will replace the HESS detector.

While dark matter is stable in many theoretical models, some theories propose that it could be unstable and eventually decay over cosmic timescales [31]. In the context of dark matter, decay refers to the transformation of a dark matter particle into other particles. Unlike annihilation (where two dark matter particles collide and produce other particles), decay involves only one dark matter particle. The decay process occurs spontaneously, and the resulting decay products carry away energy and momentum. The Large High Altitude Air Shower Observatory

(LHAASO) in China is searching for gamma rays from the Milky Way and beyond, aiming to detect signs of heavy dark matter decay within our Galaxy [32]. The absence of such signs limits the decay rate of dark matter particles with masses in the PeV range. The team analyzed data from LHAASO's kilometer-square array, concluding that PeV-mass dark matter has a lifetime of at least a billion trillion years.

Another alternative for Dark Matter

Even though it is a widely known fact in contemporary cosmology, the true essence of Dark Matter still remains a mystery. All particles within the Standard Model cannot account for it; hence, this leaves behind several candidates like axions and WIMPs that have yet to be discovered by scientists. No valid proof has been obtained from tests such as CRESST, The Axion Dark Matter Experiment (ADMX), Xenon1T/XenonnT (XENONnT), DAMPE collaboration, or any other experiment carried out at the Large Hadron Collider so far according to Dark Matter maps produced during DES survey; however, they are inconclusive too. What if gravity isn't what we think about it? Might there have been something wrong with our understanding this whole time if we only consider using DM as an explanation? Often, different models compete before one emerges victorious over others, thus leading us closer to realizing a new approach to explaining natural phenomena based on history's teachings.

Modified gravity is also known as "modified Newtonian dynamics" and is created to solve one of the biggest questions in cosmology, namely the problem of Dark Matter. Newtonian dynamics, based on the inverse square law of gravity, successfully describes the motion of celestial bodies under the influence of visible matter [33]. However, when applied to galactic and cluster scales, it fails to account for the observed rotational velocities and gravitational lensing effects. To remove the discrepancy between the theory and the observed rotation curves, Milgrom, the father of MOND theory, proposed that at the edge of galaxies, the gravitational force is weaker than in Newton's gravity instead of invoking an invisible matter to explain stars in most galaxies are observed to move at similar speeds regardless of their distance from the center of the galaxy. This means that at extremely low accelerations (far from massive objects), the gravitational force behaves differently. More specifically, MOND introduces a critical acceleration a0. It is stated that if acceleration were to exceed the critical threshold, gravity would be inversely proportional to the square of the radius according to Newton's equations; if at a smaller acceleration, the gravity may fall off at one over radius instead of one over radius squared. Put another way, MOND predicts Newtonian behavior for galaxies, whose accelerations are usually bigger than a_0. MOND predicts departures from Newtonian gravity in the outer regions of galaxies [33].

At high acceleration	At low acceleration

$$F = \frac{GMm}{r^2}$$	$$F = \frac{GMm}{\mu\frac{a}{a_0}r^2}$$ Where μ the interpolating function, $\frac{a}{a_0}$ is a new fundamental constant.

Figure 12: The table shows the comparison of gravitational force at different regions with different accelerations.

But why don't we just accept MOND as a new scientific theory and do away with dark matter as a particle entirely, given that we have not found any evidence of it in decades of searching? In science, very few things are flawless, and the MOND theory will inevitably encounter difficulties. MOND is able to explain the motion of stars within galaxies but not the motion of galaxies within clusters. This implies that MOND is unable to explain the bullet cluster, which points to the presence of dark matter. Gravitational lensing indicates that there must be invisible matter in the blue regions of bullet clusters [34]. Another problem for MOND is creating large-scale structures of the universe. This has been achieved by dark matter models when it comes to explaining how the cosmic web forms, but in order to explain those same formations without any other mechanisms being brought into play, MOND would need a lot more work done on it. As mentioned before, galaxies, galaxy clusters, and the cosmic web itself are formed through the gravitational collapse of initially small density fluctuations in the early universe. According to general relativity theory, as well as dark matter's postulated properties like non-interaction with light waves or other particles that interact electromagnetically while also remaining invisible altogether, this form still lacks explanatory power without considering modification theories such as adding new fields or combining them together within the framework of the MOND approach, which cannot produce this kind of structure because they do not predict hierarchical growths. Therefore, if there are no additional steps taken into account during these events, then the predictions made by modified Newtonian dynamics will not be able to match observed features associated with creation processes related to matter distribution over large volumes, known as the cosmic webbing phenomenon.

Briefly, MOND still offers a different explanation for the observed gravitational behavior, suggesting that modifications to Newtonian dynamics can account for the discrepancies without the need for dark matter. If MOND is empirically supported and widely accepted, it would require a significant shift in our understanding of the nature of gravitational interactions, the formation and evolution of galaxies, galaxy clusters, and the large-scale structure of the universe. Scientists would need to explore the precise mechanisms and underlying principles that govern MOND, examining how its modified laws of gravity can reproduce the observed behavior without incorporating invisible matter. Additionally, the compatibility of MOND with other

established theories, such as general relativity, would need to be thoroughly examined. Researchers could explore potential unification or modifications to existing theories that can incorporate MOND and provide a more comprehensive framework for understanding gravitational phenomena.

Conclusion

What we currently know about dark matter is both fascinating and perplexing. It influences the universe's structure, exerts gravitational pull, and is essential to the development of galaxies. Its makeup and how it interacts with ordinary matter are yet unknown, though. We get closer to discovering the mysteries of dark matter and learning more about our cosmos with every new finding. However, it is still unclear precisely what dark matter is and how it interacts, which motivates scientists to keep looking for solutions and piques their curiosity in the uncharted. To continue in the journey of finding the answer to this puzzle, scientists are still developing both experimentally and theoretically. Lately, besides WIMPs, only left-handed neutrinos have been observed, but a hypothesis suggests right-handed neutrinos interact only gravitationally, possibly as dark matter particles. And a bunch of other updated recent advances for both dark matter particles and non-dark matter particles, such as the possibility of dark matter's existence in primordial black holes. Aside from evidence bolstering the Dark Matter theory, there are an increasing number of alternative theories emerging to disprove Dark Matter, suggesting there is no room for Dark Matter.

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Analysis of Economic Factors affecting Student Attrition in Tertiary Education By Prakarsh Jhajharia and Anay Garodia

Abstract

      Student attrition is a major challenge faced by higher education institutions worldwide, with significant consequences for students, institutions, and society. This study examines the factors affecting student dropout rates by using statistical analysis techniques to a dataset of 4,424 students enrolled in undergraduate degree programs. Through linear regression models, the research examines the impact of key factors including academic performance, demographic data, and financial background.

      The results indicate that attrition rates are most strongly predicted by the number of curricular units taken in the first two semesters which has a high inverse relationship with dropout rates. Additionally, gender and indebtedness also emerge as important factors with male students showing less likelihood to drop out compared to those who lack debt. It is surprising that displacement status does not appear to have any effect on attrition contrary to what was anticipated earlier. Interestingly, retention rate in older individuals surpasses their younger peers. This research helps provide a broad understanding of the highly complex challenges surrounding student attrition.

Introduction

      This paper takes an analytical approach to analyzing the causes of student attrition by applying statistical analysis models to a publicly available dataset on student dropout rates. The results obtained are compared with other studies and student attrition models to gain a better understanding of the reasons that lead a student to take the decision to drop out.

      Student attrition is a major problem faced by many tertiary education institutions, with an average of 31% of students in higher educational institutes failing to graduate among 18 OECD countries.

      There are many critical consequences of student attrition. It has a negative effect on the academic institute, the student's well-being, and the community at large. For the individual, it can lead to social isolation and reduced employment prospects. From an institutional perspective, low student retention rates can affect tertiary institutions' academic and financial plans. In a 5 year period from 2004-05 to 2008-09, a study concluded that the United States spent a total of 4 billion dollars of taxpayer money in appropriations and student grants on college students who dropped out.

Literature Review

      Dropping out can roughly be defined as an act of failing to enroll for a definite number of successive semesters. It is more complex, since many different definitions exist. We will consider the definition of dropout as all students who did not enroll in the same university the next year or canceled their enrollment during the first year. Many studies have concluded that

academic performance and achievement is the primary determinant in the decision of a student to drop out. It has also been found that the reason for a student dropping out of an online course is varied and unique to each individual.

There are two primary theories used to describe the factors that lead a student to dropout. The first is Tinto's *Student Integration Model* according to which both the formal and informal academic and social integration of a student into the institution's environment has a significant impact on the student's persistence. He identified three major sources of student attrition: academic difficulties, failure to accomplish educational and occupational goals, and inability to socially integrate into the institution's environment. The second theory is Bean's *Model of Student Attrition* which predicts that the student's background, i.e. their academic, social, and personal background, is the primary determinant of their interaction with the institution and their environment, which in turn lead to their decision to dropout.
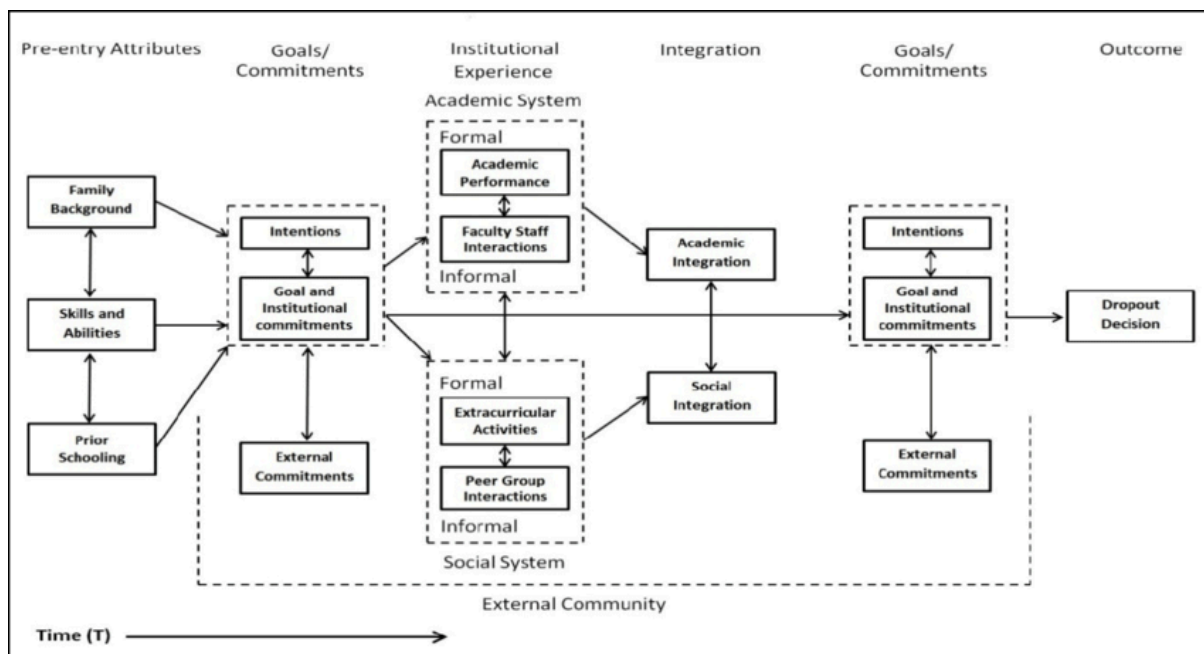
Fig 1: Tinto's Model
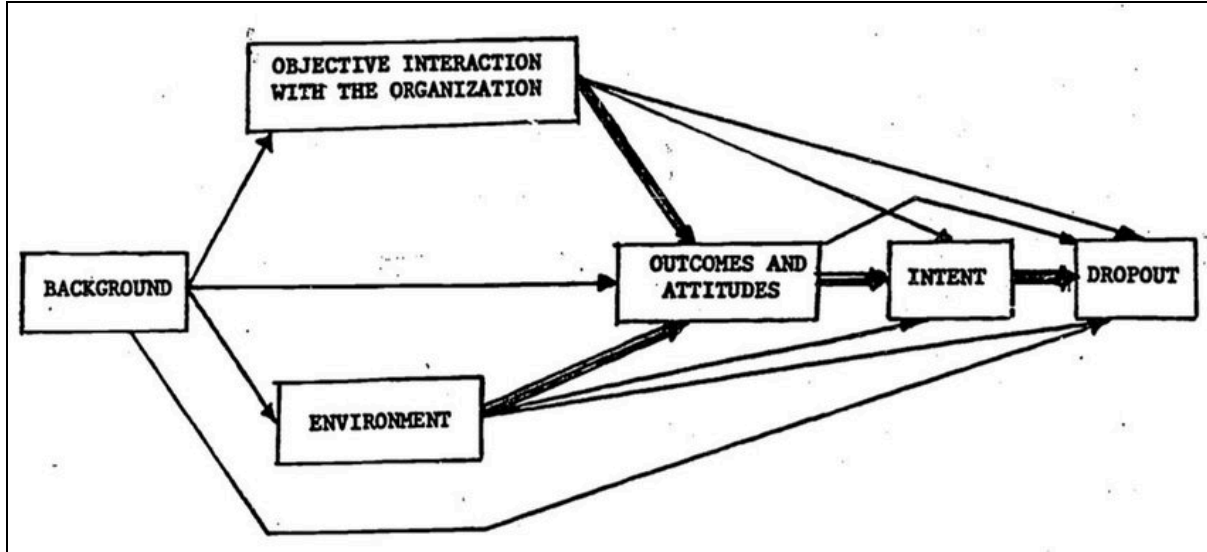
Fig 2: Bean's Model

Data
Collection

      The dataset was collected in 2021 from several disjoint databases consisting of relevant information available at enrollment, such as application mode and courses taken, by Realinho et al. (2021). It has data related to students in higher education institutions in different undergraduate degrees. The data includes the student's demographic data, socio-economic factors, and academic performance information. It consists of data from 4,424 students.

Features

      In terms of the features analyzed, our study encompassed 13 major aspects that could affect student dropouts.

Features	**Purpose**
Previous qualification	The highest level of education attained by the student before enrolling in college.
Mother's qualification	The educational attainment of the student's mother.
Father's qualification	The educational attainment of the student's father.
Mother's occupation	The profession or job role of the student's mother. (Categorical)
Father's occupation	The profession or job role of the student's father. (Categorical)
Displaces	Indicates whether the student is a displaced person.

Features	Purpose
Debtor	Indicates whether the student is in debt.
Tuition fees up to date	Indicates whether the student's tuition fees are up to date.
Gender	The gender of the student.
Age	The age of the student at the time of enrollment.
International	Indicates whether the student is an international student.
Curricular units 1st sem	The number of academic units completed by the student in the first semester.
Curricular units 2nd sem	The number of academic units completed by the student in the second semester.

Table 1: Features in our dataset along with their purposes.

Methodology

We use various predictive statistical models to analyse the dataset and obtain their coefficient of correlation in Python. The primary statistical model used is linear regression. In this model, we best estimate the coefficients of a linear equation that best fits the data set based on the variables. It is also known as the line of best fit and minimises the discrepancies between the predicted data and the actual data. We also use polynomial regression which involves using higher-order polynomials to approximate the data but find that linear regression is more adequate.

The amount of error in the linear regression model is estimated through the mean squared error, which is the average of the square of the distance between each individual data point and the line of best fit. It is inversely proportional to the accuracy of the statistical model and helps us understand how dispersed the dataset is. The line drawn minimizes this value. The mean squared error is given by $MSE = \frac{\Sigma(y-y_i)^2}{n}$, where y is the data point, y_i is the predicted value, and n is the number of data points.

To improve the ease and accuracy of the linear regression, the dataset was first normalized to a scale of 0 to 100. This prevents outliers in the dataset from dominating the statistical model. We consider a coefficient of correlation value above 0.5 to be indicative that the variables are correlated and a coefficient of correlation value above 0.8 to be indicative of a high degree of correlation between the variables.

In Python, we use the Scikit-learn package to create the regression model. It is a commonly used model for making models for statistics and machine learning. Further, we use the Pandas and Numpy models to process the dataset and Plotly to make the graphs.

Results and Discussion

Hypothesis 1: A student in debt is more likely to drop out of college.
Explanation: The hypothesis analyzes the impact of debt on the student dropout rate. The hypothesis is based on the conception that financial burdens have a significant impact on a student's decision to drop out.

Findings: Analysis showed that more than 90% of the graduates are not in debt. Although a majority of the dropouts also have no debt, the dropout rate is significantly higher among the debtors. This indicates that while debt may have a small impact on the dropout rate, it still is an important factor..

Conclusion: A student in debt is more likely to drop out than their debt-free counterpart, but the effect may be less significant than anticipated.
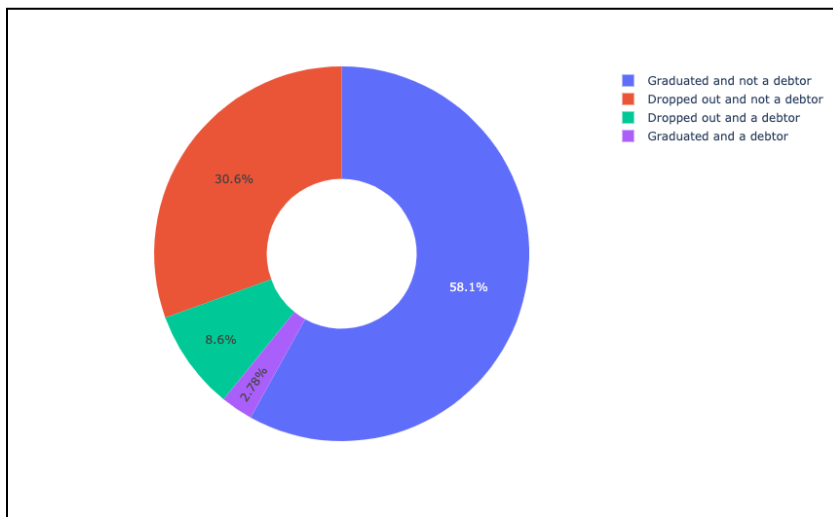
Fig 3: This graph illustrates the percentage distribution of students across various debt and dropout categories.

Hypothesis 2: A displaced student is more likely to drop out of college.
Explanation: This hypothesis analyzes the relationship between displacement and the chances of students dropping out from college. It is understood that the instability associated with displacement can create problems in a student's academic life leading to him dropping out.

Findings: Upon analyzing we found out that around 33% of the displaced students dropout of college. This rate is slightly lower than the dropout rate of non displaced students (45%). This tells us that being displaced does not make a student more likely to drop out.

Conclusion: Whether a student is displaced has no real effect on his chances of graduating or dropping out.
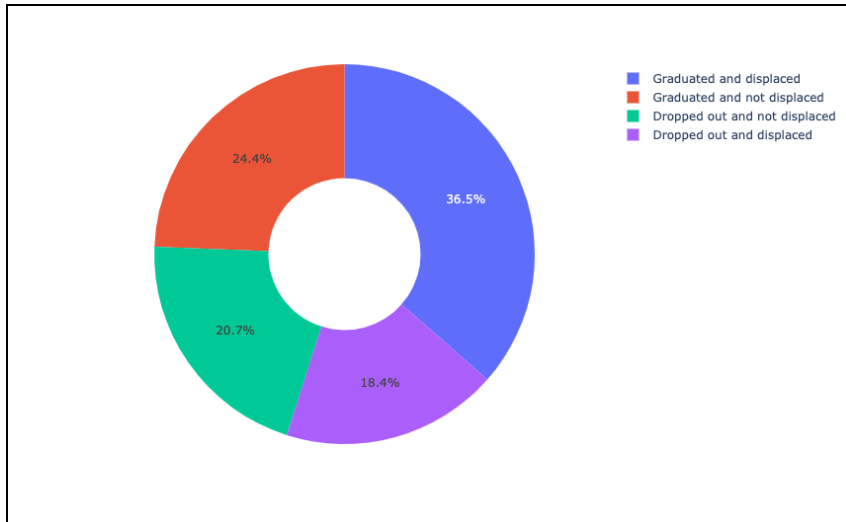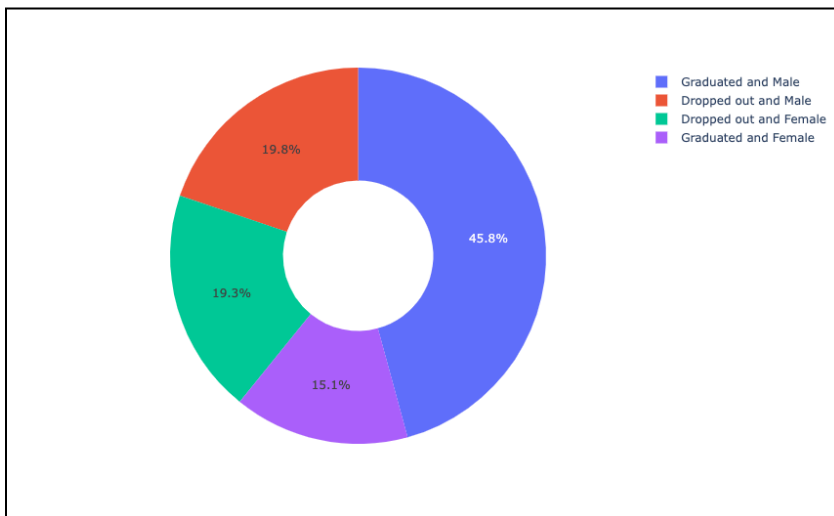

Fig 4: This graph illustrates the percentage distribution of students across various displaced and dropout categories.

Hypothesis 3: Gender of a student has no affect on his or her drop out chances.

Explanation: The hypothesis challenges the notion that gender has a significant impact on the student's academic life.

Findings: An extensive analysis of data revealed distinct differences in dropout rates by gender. The data showed that males have a relatively lower dropout rate at 30%, whereas females show a higher dropout rate of 57%.

Conclusion: A male student is more likely to graduate than their female counterparts.

Fig 5: This graph illustrates the percentage distribution of students across various gender and dropout categories.

Hypothesis 4: Parental occupations have an effect on the college dropout rate.
Explanation: This hypothesis explores the influence of parental occupational levels on a student's chances of dropping out of college. It is based on the theory that higher occupational status of parents might reduce their chances of dropping out due to factors such as greater educational support, and better financial stability.

Findings: Upon analysis it was found that students with parents in higher occupational categories (scale of 1-10) tend to have lower dropout rates. The dropout rate gradually decreased as the parental occupational category increased. This suggests a correlation between higher parental occupations and a reduced likelihood of student dropout.

Conclusion: The findings support the hypothesis that parental occupations have an impact on the college dropout rate but the effect is less than originally expected.
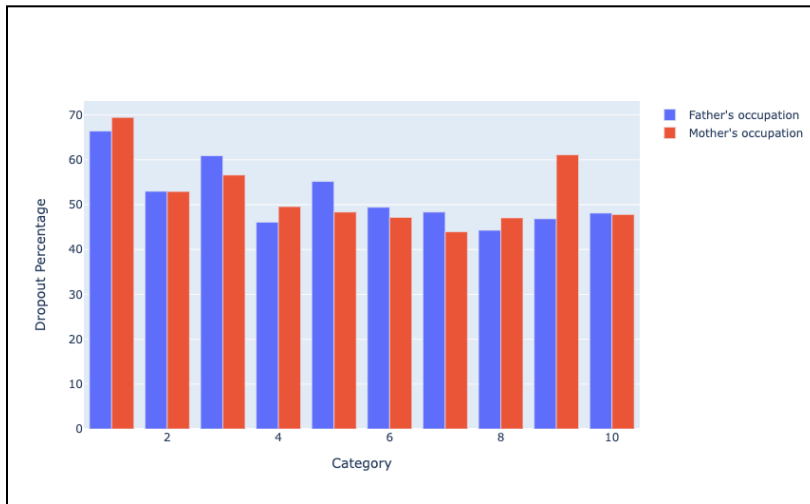

Fig 6: This graph illustrates the dropout rate of students across various parental occupation categories.

Hypothesis 5: Age at enrollment has no relation with college dropout rates.
Explanation: This hypothesis examines whether the age at which the student enrolls in college affects the chances of him dropping out. The assumption here is that age at enrollment does not significantly impact a student's decision to continue or discontinue their education.

Findings: We find that older students tend to have lower dropout rates compared to their younger counterparts. Older students may have more stability, motivation, and life experience, which contributes to their lower dropout rates.

Conclusion: Despite the initial hypothesis that age at enrollment has no effect on dropout rates, analysis shows that as age at enrollment increases, the dropout rate decreases.
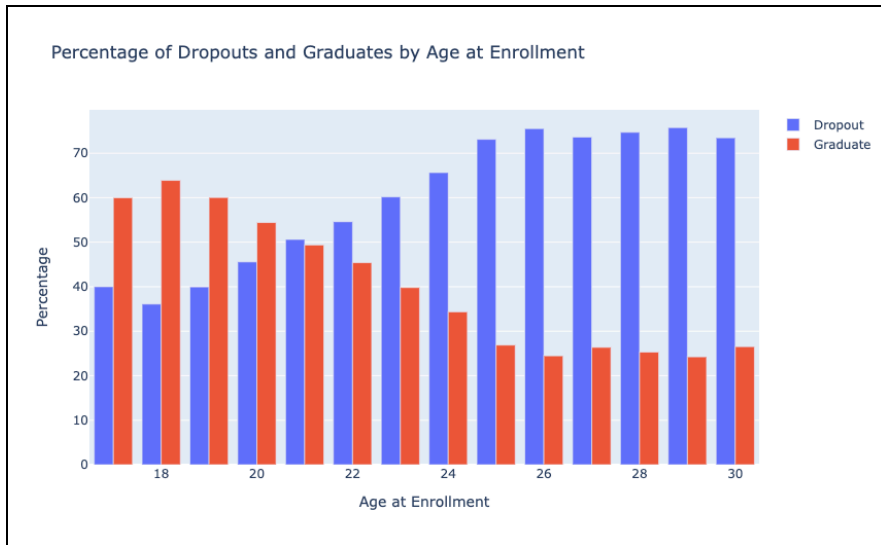

Fig 7: This graph illustrates the relationship between age at enrollment and dropout rates, showing a descending trend in dropout rates as the age of enrollment increases.

Hypothesis 6: Lower the number of curricular units obtained by the student in the first and second semester, higher are his chances of dropping out.

Explanation: It is a common conception that if a student excels academically and in college, his chances of dropping out reduce significantly. This hypothesis aims to unravel the truth behind this conception and use statistical and data analysis to test out the theory.

Findings: Analysis shows that the dropout rate decreases significantly from nearly 98% to 32% as the grade of curricular units earned in the first semester increases from 10 to 15. A similar but more profound trend is seen for the second semester where the dropout rate decreases from 96% to 27%. This is clear evidence that the number of curricular units obtained and the dropout rate have an inverse relation. The coefficient of correlation between curricular units earned in the first and second semester to the dropout rate were 0.52 and 0.61 respectively.

Conclusion: The hypothesis is true. A student who has earned more curricular units is much less likely to drop out.
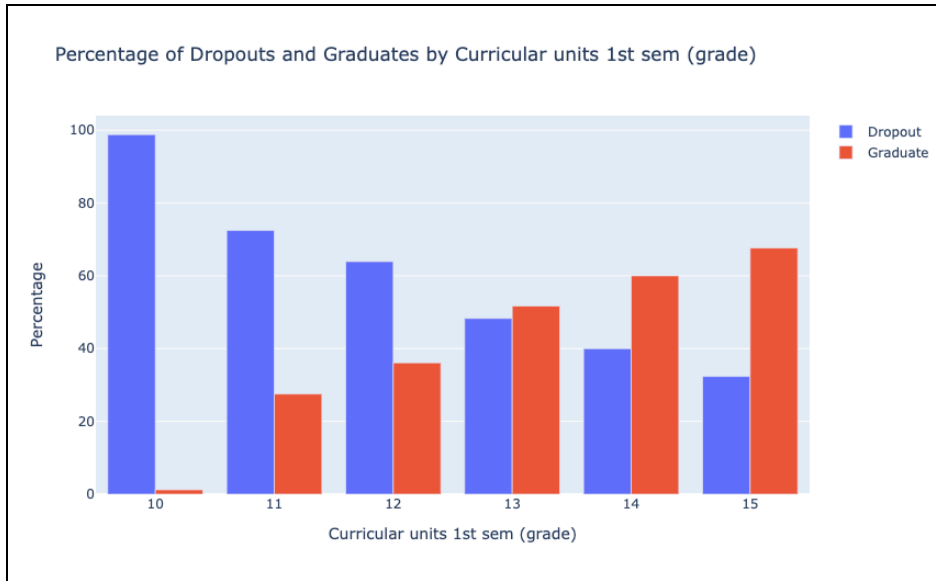
Fig 8: This graph illustrates the relationship between curricular units earned in the first semester and dropout rates, showing a descending trend in dropout rates as the grade of curricular units increases.
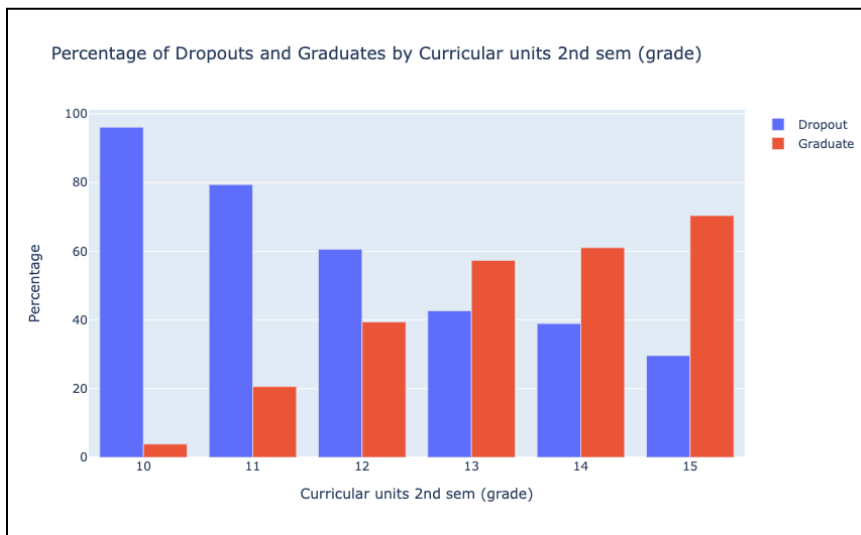

Fig 9: This graph illustrates the relationship between curricular units earned in the second semester and dropout rates, showing a descending trend in dropout rates as the grade of curricular units increases.

Conclusion

The factor which is the strongest predictor of student attrition is the number of curricular units earned by the student. This is in accordance with the current consensus. Furthermore, we have found that debt and gender may also play a role in a student's decision to drop out of higher education, with males tending to have lower dropout rates than their female counterparts and

debt being directly proportional to the chance of dropping out. Contrary to our assumption, whether a student is displaced or not appears to have no significant effect on their decision to drop out. Surprisingly, older students tend to have higher retention rates than younger ones. This may be due to a variety of factors such as emotional maturity and financial stability. Overall, this analysis can help better understand a variety of factors leading to student attrition, helping both in policy making and institutional planning. While many studies already exist analyzing student dropout rates, more are still necessary, especially those concentrated to specific regions or communities.

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