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Welcome to the 6th issue of Scholarly Review, a multi-disciplinary journal providing emerging scholars with the opportunity of being published in a quality, open access peer-reviewed student journal. Scholarly Review is now well-established, and readers know to expect well-written essays on a range of topics. Contributors to the current issue should be congratulated for having met the standard and achieved success in an increasingly competitive environment. In this issue, we redress the balance from previous issues with the majority of papers on humanities rather than STEM subjects.

Jocelyn Wang's highly original paper explores whether and how congenital amusia (a condition whereby an individual has reduced ability to perceive and distinguish pitch) is influenced by speaking a tonal language, such as Chinese, where pitch is used to convey meaning.

Seongwon Lee explores the financial performance of technology companies during and after the Covid-19 pandemic, when the basic lifestyle of many people changed, making greater use of advanced technology, thereby creating significant wealth for a small number of companies.

Bian Yunlin discusses historical antecedents to the complex international relations that exist between China, Japan, and the USA. The paper, which focuses on the World War 1 period (1914-1918), examines geopolitical considerations when discussing who should join the war and who should not.

Grace Tao tackles issues of religion, history, and social values in the context of sexual and reproductive health policy, comparing China and the USA. Access to sexual and reproductive health is an important indicator of social and political attitudes toward women.

Angel Guo explores how political relationships and economic motivations shaped the experience of Chinese NBA Players in the USA in the early 21st Century, highlighting ways in which sport can be used as a way to navigate the complexity of global affairs.

Harrison Huang writes about the philosophy of law, examining how the concept of moral luck can exert an influence over criminal justice proceedings where there is no criminal intent, for instance, by drawing distinctions between different categories of manslaughter.

Abby Zhang reviews the literature on active music therapy, which can be used to help children with Down Syndrome. Research suggests that the therapy can help stimulate the development of young children with Down Syndrome, improving both language skills and social and emotional development.

Tiffany Tu tests different algorithms for their efficiency in terms of 'Distributed Denial of Service' to help detect cyber-attacks by using machine learning algorithms to enhance security measures and help protect the critical digital network infrastructure.

Aurna Mukherjee writes about logic, challenging the philosophical concept of logical monism, which posits that only a single logical system can adhere to accepted principles of validity. The paper concludes by suggesting that logical monism cannot offer realistic explanations and that logical pluralism offers a better alternative.

Michael Ma considers how Python simulations using the Chi-square test are generated to examine the effect of multiple variables influencing statistical power. Using computer simulations, the Chi-square test is shown to be very sensitive.

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What Makes Music, Music? A Look At Congenital Amusia Expression In Tonal Language Speakers

By Jocelyn Wang

Author Bio

Jocelyn Wang is currently a senior studying at Ridley College High School in Canada who has been curious about the intersection of neuroscience and musicianship for as long as she can remember. How do musicians hone their craft? Why is music so inexplicably tied to emotion? And what makes music, music? These are the types of questions she hopes to answer in the future.

Abstract

Research advancements in recent decades have given rise to the notion that there exist specialized brain structures to facilitate music perception independently of other mental processes. The study of pitch-related congenital amusia, a disorder wherein an individual has a reduced ability to perceive and distinguish pitch, has allowed significant contribution to the development of this music-specific brain model. This paper aimed to find how, if at all, congenital amusia expression is affected by the speaking of a tonal language – a language that relies on pitch as one distinguishing factor for lexical meaning – as well as implications for the music-specific brain model that arise from said effect. A literary review was conducted, with a focus on literature published in the past decade. It was conversely found that congenital amusia affects tonal language processing, with the difficulties in musical pitch discrimination extending to language-related pitch discrimination. This finding provides further insight for the workings of the music-specific brain in that the overlaps between musical and lexical pitch could suggest either that pitch is fundamentally not a solely musical characteristic, or that tonal language has an inherent musical aspect. Future research on this subject should seek to clarify this understanding. Additional research in neighbouring fields, including cultural and emotional psychology, linguistics, and music therapy, is also discussed.

Keywords: Congenital amusia, tone deafness, tonal language, music-specific brain, pitch discrimination, music processing, semantic pitch

Introduction

It has long been understood that there is something "special" about music and the human relationship to it. Babies are born from the womb with the mechanisms that allow for basic pitch distinction (Mampe et al., 2009) and the ability to "feel the beat" (Winkler et al., 2009). As we grow from there, music only becomes more of a core factor accompanying the development of our cultural and personal identities (Folkestad, 2002). Clearly, music is a crucial component of the human experience, and everything down to our neural structure reflects this.

However, within such a musical world, there are a select few who are born without the ability to distinguish pitch, rhythm, or sometimes both. Individuals born with these musical disorders have what is known as congenital amusia. Affecting around 2% of the population, individuals with this disorder – amusics – are unable to distinguish pitch, rhythm, or other musical characteristics to the same precision that the majority of the population can (Peretz, 2016). What arises is a contrasting musical experience where, due to their difference in perception, amusics are unable to engage with and appreciate music to the same degree as their non-amusic peers (Omigie et al., 2012). This unique experience has led to extensive studies on those with congenital amusia to isolate the brain structures and pathways that allow for processing of musical elements. The confirmation of such structures would support the idea of a music-specific brain. However, within the substantial research to determine the underlying neural mechanisms of congenital amusia arises a lack of literature looking at the inherent expression of congenital amusia and how – or if – that expression is modified by other experiences. These experiences include speaking a tonal language from birth, which necessitates definitive understanding of specific differences in pitch in order to communicate clearly.

Under this precedent, this paper proceeded with the primary aim of finding the degree to which expression of congenital amusia is affected by speaking a tonal language, and a secondary aim of discussing the implications for the music-specific brain model that arise from said effect. A literature review was conducted to accomplish these aims, with the focus being on papers published in the recent 15 years (the recent quindecennial) in order to most accurately highlight the current state of research in this field.

Tonal and non-tonal languages

As previously mentioned, tonal languages require an understanding of specific pitch differences for communication. This, though, seems to raise a discrepancy in that technically both tonal and non-tonal languages use pitch for communication. However, the difference comes in the fact that tonal languages use pitch for a more particular and defined purpose than non-tonal languages.

The specific distinction between tonal and non-tonal languages is multifaceted. From a linguistic perspective, a tonal language is one that uses pitch to distinguish meaning and/or grammar (Yip, 2002). It is important to note that all languages, including non-tonal languages, have intonation, but only tonal languages have tone. In other words, all languages use pitch to communicate some form of meaning – for instance, rising tone to show a question – but only tonal languages use specific pitches to communicate specific meanings. In fact, tonal languages often have a concrete number of tones that words could take, where differing tones on the same sound signify a change in meaning. Examples of tonal languages can be seen in many Asian languages, including Mandarin, Vietnamese, and Cantonese, as well as African languages such as the Hausa language (Newman, 1996).

Accordingly, tonal and non-tonal languages are also distinct neurologically. In order to process intonation, all language speakers activate the right frontal area and left fronto-parietal regions (Figure 1). In tonal language speakers, however, brain activation is further seen in bilateral temporo-parietal semantic areas and subcortical regions (Chien et al., 2020). This region (Figure 2) seems to be exclusively activated for semantic pitch processing of language tones and is interestingly not a primary part of the circuit of musical pitch processing that is affected in congenital amusia.

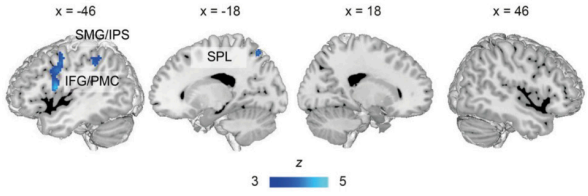

Figure 1. Right frontal area and left fronto-parietal regions activated in language speaking (Chien et al., 2020).

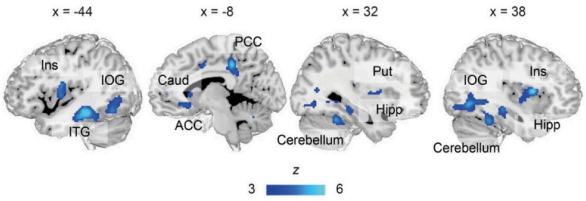

Figure 2. Bilateral temporo-parietal areas activated in tonal language processing (Chien et al., 2020)

Congenital amusia and the music-specific brain

Fundamentally, congenital amusia is a disorder of music perception. Peretz (2016) defines congenital amusia as any "lifelong musical [disability] that cannot be attributed to intellectual disability, lack of exposure, or brain damage after birth". It should be noted that the term 'congenital amusia' itself is more of an umbrella term than a specific disorder. It covers any musical disability, among them the disorders of pitch perception and of rhythm perception. These two variants – pitch-related and rhythm-related congenital amusia – are currently the two most well-understood types of congenital amusia. For the purpose of comparing tonal language with congenital amusia, this paper focuses only on the pitch-based variant – however, it should not be overlooked that rhythm-based congenital amusia has also been studied extensively, particularly in the recent quindecennial, and has resulted in an equally intriguing collection of research.

The study of congenital amusia has, notably, allowed significant development of the music-specific brain model. Spearheaded by Isabelle Peretz (Peretz et al., 2002; Peretz and Hyde, 2003; Peretz, 2013), the model poses that there are structures in the brain with the sole function of processing music independently of other mental processes. As such, the study of pitch-related congenital amusia – a disorder of musical pitch perception – has helped researchers isolate possible musical pitch-specific structures in the brain. These structures have been collated to, specifically, the right inferior frontal gyrus or right IFG (Hyde et al., 2010). Additionally, there is evidence pointing to the possibility that the pathway between the right IFG and the auditory cortex is also implicated in musical pitch processing based off of the study of the brains of amusics (Peretz, 2016). Both of these structures can be seen in Figure 3.

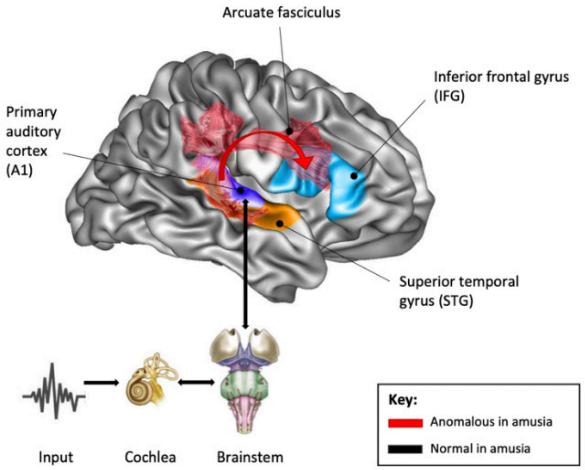

Figure 3. Outline of structures implicated in pitch-based congenital amusia (Peretz, 2016).

Tonal language modification of congenital amusia expression

The biological basis

The core justification behind the modification of congenital amusia expression by tonal language speaking is the biological proximity. As previously described, the primary neural structure activated in tonal language speakers specifically for language tone processing is the bilateral temporo-parietal areas (Chien et al., 2020), and the structures most implicated in the disorder of musical pitch perception in amusics are the right inferior frontal gyrus (Hyde et al., 2010) and the pathway between that area and the auditory cortex (Peretz, 2016). With such similar functions and close proximity, there must be some interaction between the three areas. Finding the direction of the interference, however, requires a deeper look at studies that focus on specific cognitive functions relating to music and tonal language perception.

One study that combines a cognitive and biological research approach to find a direction of interference is Zhang et al. (2017). In this study, 11 Cantonese-speaking amusics and 11 Cantonese-speaking non-amusics participated in Cantonese tone distinction and musical stimuli processing tasks while being scanned with fMRI. The experiment resulted in two main findings. Firstly, the amusic group performed worse in both the tone distinction and musical processing tasks. Secondly, the right superior temporal gyrus (part of which is associated with the temporo-parietal area activated during language tone processing) was shown to be deactivated in amusics but activated in non-amusics during these tasks. It was concluded that the "neural deficits in tonal language speakers might differ from those in non-tonal language speakers, and overlap partly with the neural circuitries of lexical tone processing (e.g. right STG)". The result implies that, biologically, tonal language speaking is affected by congenital amusia, and not the other way around. However, with such a small sample size, this statement will need triangulation from other studies to become more established.

The cognitive basis

The cognition-based literature is much more varied and much more conflicting. There are, in fact, two groups of papers: those that either directly or indirectly support the idea that tonal language speaking should mediate the expression of congenital amusia, and those that either directly or indirectly support the idea that conversely, it is the presence and expression of congenital amusia that adversely impacts tonal language processing. Both groups have a significant amount of research supporting them; however, as will be further explained, it is the latter that seems to be the most likely circumstance.

Argument 1: tonal language mediates congenital amusia

There is a vast amount of research indirectly supporting Argument 1, most of which is research on tonal language speakers without amusia. Many studies, including Bidelman et al. (2013), Peng et al. (2013), and Pfordresher and Brown (2009) have shown that tonal language experience increases pitch discrimination ability in non-amusics.

Interestingly, Bidelman et al. (2013) conducted a three-way comparison between musicians', Cantonese-speaking non-musicians', and English-speaking non-musicians' performance on various auditory perception tasks. Their study found that, as suspected, musicians performed the most accurately, but Cantonese speakers also showed "comparable perceptual enhancements" in comparison to the performance of the English-speaking participants. As such, the results of Bidelman et al. (2013) support that tonal language speaking, even without musical experience, is enough to enhance musical perception in non-amusic adults. With a participant size of 54 (18 in each category), this study alone isn't strong enough to prove this idea, but the experimental design allows for extremely valuable isolation of the specific tonal-language and musical perception relationship.

The notion that tonal language experience can help develop greater pitch distinction ability is further corroborated by Peng et al. (2013) and Pfordresher and Brown (2009). The former conducted an extensive

analysis of hundreds of Mandarin-speaking and non-Mandarin-speaking musicians and non-musicians, finding that "language experience affects auditory perception" and that native tone-language-speaking musicians were more likely to have perfect pitch. The latter, similarly, found that native tonal language speakers performed better than native non-tonal language speakers in pitch discrimination and reproduction tasks.

The literature supporting Argument 1 is promising but is missing an incredibly crucial focus. All of the aforementioned studies have compared tonal language speakers with non-tonal language speakers in pitch discrimination, but none have studied tonal-language-speaking amusics. By missing this direct comparison between tonal-language-speaking amusics and non-tonal-language-speaking amusics, only hypotheses and indirectly possibilities can be concluded. Among these indirect possibilities, however, include the possibility that tonal language experience mediates congenital amusia symptoms, since it can be seen from the above evidence that tonal language experience increases pitch distinction ability in non-amusics.

Argument 2: congenital amusia disrupts tonal language processing

On the contrary, there are also many studies that show the amusic group performing worse than the non-amusic group despite a tonal language being spoken. Some studies that support Argument 2 include Nan et al. (2010), Liu et al. (2012), and Tillmann et al. (2011). In one way or another, all of these studies show that congenital amusia-related musical pitch processing deficits may be extending to language pitch processing. Both Nan et al. (2010) and Liu et al. (2012) focused their experiments on Mandarin speakers. Nan et al. (2010), out of a participant pool of 117 Mandarin speakers, matched 22 non-amusics and 22 pitch-related amusics in both rhythm and pitch processing tasks, finding that the amusics still showed a pronounced deficit in pitch processing "despite early exposure to speech-relevant pitch contrasts". On top of that, six of the amusics had difficulty discerning lexical tones, showing symptoms akin to lexical tone agnosia. Liu et al. (2012) undertook a similar design, matching 13 non-amusics to 13 amusics, having participants complete a more language-focused set of tasks including word discrimination and tone distinction. They found that amusics performed equally to non-amusics on all tasks, except for those that "relied mainly on pitch sensitivity".

Tillmann et al. (2011) took a slightly different approach to their research, instead focusing on non-tonal-language-speaking amusics. In this study, participants (amusics and matched controls, both non-tonal-language-speakers) were asked to distinguish between different tones in Mandarin and Thai, two tonal languages. Results showed that amusics consistently performed worse than non-amusics, leading the researchers to conclude that even non-tonal-language-speaking amusics might have a compromised "ability to process and learn tonal languages".

Like in the Argument 1 group, the literature under Argument 2 is also missing research directly comparing tonal-language-speaking amusics with non-tonal-language-speaking amusics. Without this comparison, it is impossible to make a direct correlation,

much less a causal statement, about the true effects of tonal language speaking on congenital amusia. However, Argument 2 still seems to be the stronger argument for two reasons. Firstly, the research under this group does directly compare tonal-language-speaking amusics and non-amusics – one step further than the Argument 1 research; and, secondly, Argument 2 is corroborated with concrete biological evidence from the earlier mentioned Zhang et al. (2017).

Implications

One through-line shared between both Argument 1 and Argument 2 is the idea that tonal language speaking and musical pitch perception are overlapping functions. Under Argument 1, this can be seen in the studies assuming – and proving – that experience with semantic pitch can translate to enhanced musical pitch perception. Under Argument 2, studies showed that a deficit in musical pitch perception, such as that of pitch-based congenital amusia, can interfere with semantic language tone processing as well.

The results of these studies show that there might be some aspect of pitch that is shared neurologically between music and tonal languages. For the music-specific brain model, this has two conflicting implications. For one, this may mean that tonal language is thus inherently musical. Alternatively, though, it may mean that pitch is not a solely musical characteristic at all, but rather a human one that is used in both music and tonal language communication. Nan et al. (2010) makes note of this too, stating that their "observed association between the musical disorder and lexical tone difficulty indicates that… congenital amusia is not specific to music or culture but is rather general in nature". From the current literature (including that covered in this paper), it is still unclear which, if any, of these implications is the most likely. As such, future research should focus more specifically on the nature of tonal language within amusics – in other words, comparing tonal-language-speaking amusics with non-tonal-language-speaking amusics, as described previously. By doing so, a greater understanding can be achieved regarding both the nature of the congenital amusia-tonal language relationship and the nature of these implications.

In addition, one of the most promising aspects of this field is the potential for interdisciplinary research. Aside from the neurological approach, research looking at the nature of musical and language-related pitch can be approached from psychological, linguistic, or music therapy lenses as well. For instance, research on this topic through cultural psychology could study tonal-language-speaking cultures to see if those of such cultures show a different relationship with music. The results of such a study would provide greater clarity as to whether or not musical pitch is inherently intertwined with semantic pitch, thus supporting or contradicting one of the aforementioned implications.

Conclusion

This paper aimed to look at the expression of pitch-related congenital amusia, how said expression is influenced by tonal language speaking, and the implications for the music-specific brain model from that connection. The relationship between tonal

language and congenital amusia was analyzed from both biological and cognitive lenses. From the biological lens, it was shown that the proximity of the three structures involved in language tone processing and congenital amusia – the bilateral temporo-parietal areas, right inferior frontal gyrus, and the pathway between the right IFG and the auditory cortex – means that there must be some interference, and Zhang et al. (2017) suggested that the deficits in congenital amusia-related structures extend to language tone-processing structures. Cognitively, literature on either side was explored – Bidelman et al. (2013), Peng et al. (2013), and Pfordresher and Brown (2009) supported the notion that tonal language mediates congenital amusia, and Nan et al. (2010), Liu et al. (2012), and Tillmann et al. (2011) supported the notion that congenital amusia conversely disrupts tonal language processing. The latter argument, due to corroboration from Zhang et al. (2017) and having studies with more focused experimental designs, seems to be the most likely circumstance.

From these findings, possible implications for the music-specific model include either tonal language being inherently musical or pitch being not a musical characteristic but a human one. In future research, whether in this field or in neighbouring fields, investigating these implications further can both serve as valuable starting points and provide crucial clarity to our understanding of this topic.

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Financial Performance of Tech Companies in the Pandemic and Post-Pandemic Eras

By Seongwon Lee

Author Bio

Seongwon Lee is a junior student at Korea Christian International School. Seongwon has a variety of academic interests. He took courses in Advanced Placement (AP) Environmental Science, AP Macroeconomics, and AP Microeconomics in his first year of high school, and he took courses in AP Statistics, AP Calculus BC, AP Biology, and AP World History in his sophomore year of high school, achieving a cumulative Grade Point Average (GPA) of 4.21. Seongwon is interested in learning statistics and economics, as well as managing those data using computer science. Seongwon is especially passionate about learning how the market functions in various situations, how statistics can be used in different fields, and how those data can be organized using computational methods. Currently, Seongwon has the goal of studying advanced economics and statistics, combined with computer science, in college.

Abstract

The existence of COVID-19 was revealed at the end of December 2019 and was declared a global health emergency in March 2020. Due to its strong ability to disseminate, the pandemic spread all over the world. Because of COVID-19, the basic lifestyles of people changed: online stores, online entertainment, and other online services flourished. During the pandemic, seven tech companies, namely Apple, Amazon, Netflix, Google, Facebook, Tesla, and Microsoft, were able to adapt to the new global trend; therefore, the seven companies grew rapidly. This research paper focuses on analyzing two factors: the performances of the seven companies during the pandemic and after the pandemic, and the future challenges that the companies must face. To assess the performances of the companies during and after the pandemic, Yahoo Finance and Profitspi were used to collect the price/earnings (P/E) ratio, daily stock price, market capitalization, and revenue of the seven companies from 2019 to 2022. The data revealed a general trend in the stock prices, in which the prices of the stocks increased from 2019 to late 2021 or early 2022. Unfortunately, the prices of the stocks declined after 2022. These findings show that the performances of the companies were constantly rising until the peak of COVID-19, and started to decline after the peak of the pandemic. These results also indicate that the strong performance of tech companies during the pandemic may not be sustainable after the pandemic, particularly given the challenges of increased competition and more stringent regulations.

Keywords: Amazon, Apple, Big Tech, COVID-19, Facebook, Finance, Google, Meta, Microsoft, Netflix, Stock Market, Tesla

Introduction

Every year, thousands of companies are launched and plenty of companies fall. While there are innumerable public and private companies in the United States, there are only a few companies that can influence the whole market and every other company. FAANG is an excellent example of those highly influential companies. FAANG stands for Facebook, Apple, Amazon, Netflix, and Google, which historically have been five of the highest-growth tech stocks in the United States. As of January 2023, the combined market value of the FAANG companies is $3 trillion. For comparison, the total market capitalization of the Standard & Poor 500 (S&P 500) is $31 trillion; this index includes 500 of the largest companies listed on stock exchanges in the United States. Therefore the five FAANG companies are worth approximately 10 percent of the entire stock market of America (FAANG Stocks, 2023). Other well-known companies that influence the whole market include Microsoft and Tesla. One common characteristic of these companies is that they are all tech or tech-related companies; even though Tesla is a car manufacturing company, the vehicle is highly dependent on software, and the market valuation of Tesla is comparable to that of tech companies and far exceeds that of other automotive companies.

The tech or tech-related companies had a huge turning point: COVID-19. The COVID-19 pandemic started in December 2019, became a global health emergency as declared by the World Health Organization in January 2020, and completely changed the world. With the virus' ability to readily spread through the air, along with the high case fatality rate, about 102 million Americans contracted COVID-19 and about 1.1 million Americans died (CDC Covid Data tracker). Due to the COVID-19 pandemic, people started to change their lifestyles. People began to spend more time on entertainment and started to use online stores instead of retail stores for food purchases (Li et al., 2021). The amount of time people spend online increased to 16 hours per day, up from 12 hours per day pre-pandemic (Wolf, 2020). In addition, the way people work changed dramatically. The keyword for the new working trend was 'teleworking'. Instead of going to a company building, people chose to work at home. To conduct conferences and meetings, employees started to use online meeting services such as Zoom. Since people began teleworking, the amount of time people spend at home has increased drastically.

Because the lifestyles of ordinary people changed, companies had to adjust to the new trend. The seven tech companies (FAANG plus Tesla and Microsoft) were the companies that were able to adjust to the new trend quickly and efficiently. While many businesses that relied on in-person services faltered during the pandemic, these seven tech companies not only survived but thrived. The purpose of this study is to examine the trajectories of these seven tech companies before, during, and after the COVID-19 pandemic, and identify potential factors that contributed to the companies' successes and failures. Specifically, this study will examine the stock price, market cap, and revenue of the selected seven tech companies before, during, and after the COVID-19 pandemic. The research focuses not only on how the seven companies were able to adapt to the new trend and grow during the pandemic but also on how the companies performed after the peak of the pandemic.

Methods

Performance data were gathered for seven companies according to their stock symbols: Amazon(AMZN), Apple (AAPL), Google (GOOGL), Facebook (Meta), Microsoft (MSFT), Tesla (TSLA), and Netflix (NFLX). To measure performance, the daily opening prices, daily highs, daily lows, daily closing prices, and trading volumes for shares of the seven companies and the S&P 500 were tracked from January 1, 2019, to December 31, 2022, in Yahoo Finance (Yahoo Finance). Based on these data, the average, standard deviation, variance, coefficient of variation, and index of dispersion were computed for each metric on a yearly basis from 2019 through 2022.

Using data from profitspi (profitspi), the market capitalizations, revenues, and price-to-earnings ratios were tracked on a quarterly basis for each of the seven companies from the first quarter of 2019 to the fourth quarter of 2022. Quarters in which these metrics exhibited high volatility were identified. Financial news updates about each of the companies were examined to determine possible causes for volatility, high performance, and poor performance.

Results

Table 1 shows the yearly statistical measures of the seven companies and the S&P 500's closing prices. The equation for the coefficient of variation is Standard deviation over mean. As the coefficient of variation increases, data points are more dispersed from the mean. The equation for the index of dispersion is variance divided by the mean.

The average prices of the companies showed a constant rise from 2019 to 2021. Nevertheless, in 2022, the average prices decreased for many tech firms. Only Apple and Tesla had higher average prices in 2022 than in 2021. The statistical analysis also highlights periods when particular companies experienced more price variability and volatility. Specifically, in 2020, Tesla's stock price showed a higher coefficient of variation and a higher index of dispersion than that of any other tech company in our analysis. However, in 2022, Netflix's stock price showed a higher coefficient of variation and a higher index of dispersion than that of any other tech company in our analysis. Therefore, the analysis reveals that while general trends in the tech space are evident, each tech company has experienced its challenges and pattern of stock price variability.

2022	closing							
AVERAGE	4,098.51	126.10	154.84	114.76	180.19	268.92	263.09	284.64
ST DEVIATION	291.83	23.90	13.06	16.11	56.66	25.76	57.81	94.54
VARIANCE	85,164.87	571.42	170.46	259.50	3,210.23	663.67	3,342.50	8,938.15
Coeff Variation	0.07	0.19	0.08	0.14	0.31	0.10	0.22	0.33
Index Dispersion	20.78	4.53	1.10	2.26	17.82	2.47	12.70	31.40
	S&P 500	**AMAZON**	**APPLE**	**GOOGLE**	**FACEBOOK**	**MICROSOFT**	**TESLA**	**NETFLIX**
2021	closing							
AVERAGE	4,273.39	167.19	140.99	124.23	321.17	275.94	260.00	558.22
ST DEVIATION	287.44	8.00	14.66	18.33	34.85	36.94	53.74	56.00
VARIANCE	82,623.95	64.03	214.90	336.06	1,214.80	1,364.58	2,887.91	3,136.27
Coeff Variation	0.07	0.05	0.10	0.15	0.11	0.13	0.21	0.10
Index Dispersion	19.34	0.38	1.52	2.71	3.78	4.95	11.11	5.62
	S&P 500	**AMAZON**	**APPLE**	**GOOGLE**	**FACEBOOK**	**MICROSOFT**	**TESLA**	**NETFLIX**
2020	closing							
AVERAGE	3,217.86	134.04	95.35	73.95	234.55	193.03	96.67	446.83
ST DEVIATION	319.23	27.29	21.81	8.76	38.57	23.00	56.33	65.61
VARIANCE	101,905.34	744.64	475.67	76.71	1,487.32	528.80	3,173.28	4,305.02
Coeff Variation	0.10	0.20	0.23	0.12	0.16	0.12	0.58	0.15
Index Dispersion	31.67	5.56	4.99	1.04	6.34	2.74	32.83	9.64
	S&P 500	**AMAZON**	**APPLE**	**GOOGLE**	**FACEBOOK**	**MICROSOFT**	**TESLA**	**NETFLIX**
2019	closing							
AVERAGE	2,913.36	89.46	52.06	59.56	181.64	130.38	18.24	328.87
ST DEVIATION	150.67	5.07	8.64	3.99	16.05	14.90	3.54	34.49
VARIANCE	22,700.94	25.66	74.56	15.92	257.66	222.03	12.50	1,189.53
Coeff Variation	0.05	0.06	0.17	0.07	0.09	0.11	0.19	0.11
Index Dispersion	7.79	0.29	1.43	0.27	1.42	1.70	0.69	3.62
	S&P 500	**AMAZON**	**APPLE**	**GOOGLE**	**FACEBOOK**	**MICROSOFT**	**TESLA**	**NETFLIX**

Table 1. Analysis of daily closing prices for seven tech company stocks and S&P 500 from 2019 to 2022. The average, standard deviation, variance, coefficient of variation, and index of dispersion are shown.

Tech. companies comparison								
closing price ($)	Stock Price 12/31/	Stock Price 12/31/	Percent Change	Stock Price 12/31	Percent Cha	stock price 12/	Percent Chan	closing price
S&P 500	3,230.78	3,756.07	16.26%	4766.18	26.89%	3839.50	-19.44%	S&P 500
Amazon	92.39	162.85	76.26%	166.72	2.38%	84.00	-49.62%	Amazon
Apple	73.41	132.69	80.75%	177.57	33.82%	129.93	-26.83%	Apple
Google	66.97	87.63	30.85%	144.85	65.30%	88.23	-39.09%	Google
Facebook	205.25	273.16	33.09%	336.35	23.13%	120.34	-64.22%	Facebook
Microsoft	157.7	222.42	41.04%	336.32	51.21%	239.82	-28.69%	Microsoft
Tesla	28.09	235.22	737.38%	352.26	49.76%	123.18	-65.03%	Tesla
Netflix	323.57	540.73	67.11%	602.44	11.41%	294.88	-51.05%	Netflix
			2019 to 2020		2020 to 2021		2021 to 2022	

Table 2. Yearly closing stock prices for seven tech companies and the S&P 500 from 2019 to 2022. Percent changes from previous years are shown.

Table 2 shows the closing prices of the seven companies and the S&P 500 on December 31 from 2019 to 2022. It shows how much the company or the market grew compared to the previous year. It is shown that every one of the seven companies experienced a huge increase from 2019 to 2020, outpacing the S&P 500. While S&P 500 increased only 16 percent from 2019 to 2020, all seven companies increased at least 30 percent. In 2021, S&P 500 increased by about 27 percent compared to the price in 2020. The overall market was having positive growth. Even though the seven tech companies had an increase in stock price from 2020 to 2021, their increase was not as dramatic as that of the previous year except for Microsoft and Google. However, in 2022, the stock price of the seven companies dropped dramatically. The table shows that during the pandemic, the performances of the seven companies were above the market. However, as the pandemic drew to a close, the prices of the seven companies decreased even more than the market did; while the market declined 20 percent, each of the seven companies declined at least 26 percent. Facebook and Tesla decreased by approximately 65 percent, the highest decline out of the seven companies.

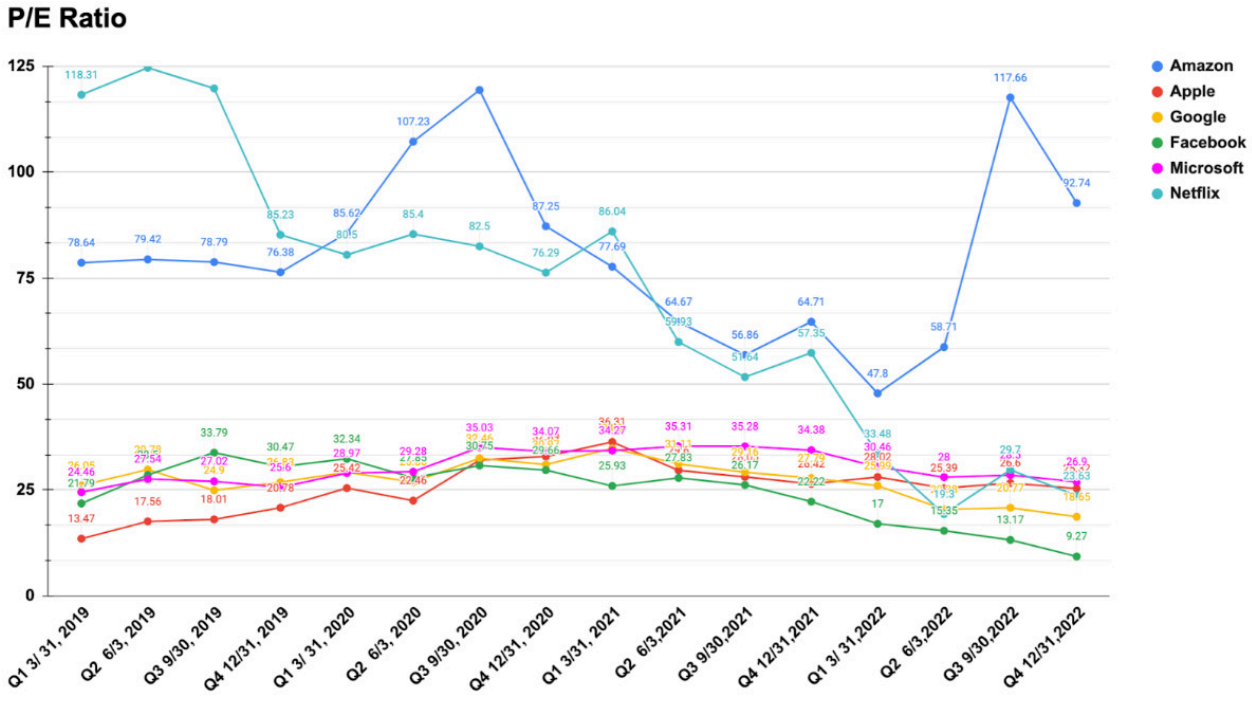

Figure 1. Quarterly price-to-earnings ratios of six tech companies from 2019 to 2022.

Figures 1 and 2 show the price-to-earning (P/E) ratios of the seven companies. The P/E ratio is the ratio of share price to earnings per share. If the P/E ratio is extremely high, it indicates that the company is overvalued. However, at the same time, a high P/E ratio also means that the investors have huge confidence in the company.

Figure 1 shows that Apple, Microsoft, and Google had a similar trend in the P/E ratio. The three companies experienced a constant rise in the P/E ratio before and during the pandemic. However, after the peak of Covid-19 (end of 2021 and the beginning of 2022), each of these companies experienced a slight decline in the P/E ratio. Facebook (Meta) initially looks like it follows the trend of the three above-mentioned companies. However, the peak of Facebook's P/E ratio was in the third quarter of 2019. After the peak, it constantly decreased for 3 years. The peak of Facebook's P/E ratio was about 34, but at the end of 2022, it was only 9. Out of six companies, Amazon and Netflix were the ones that had the highest volatility in the P/E ratio. In the first three quarters of 2019, the P/E ratio of Netflix was above 110. During the pandemic, Netflix demonstrated increases in its P/E ratio, in the first and fourth quarters of 2021. However, the overall trend in Netflix's P/E ratio was downward, and the P/E ratio reached 24 at the end of 2022, a greater than 80% drop from its 2019 peak of 125. Amazon experienced a dramatic increase in P/E ratio twice: in the third quarters of 2020 and 2022. Each of these increases was followed by a decline.

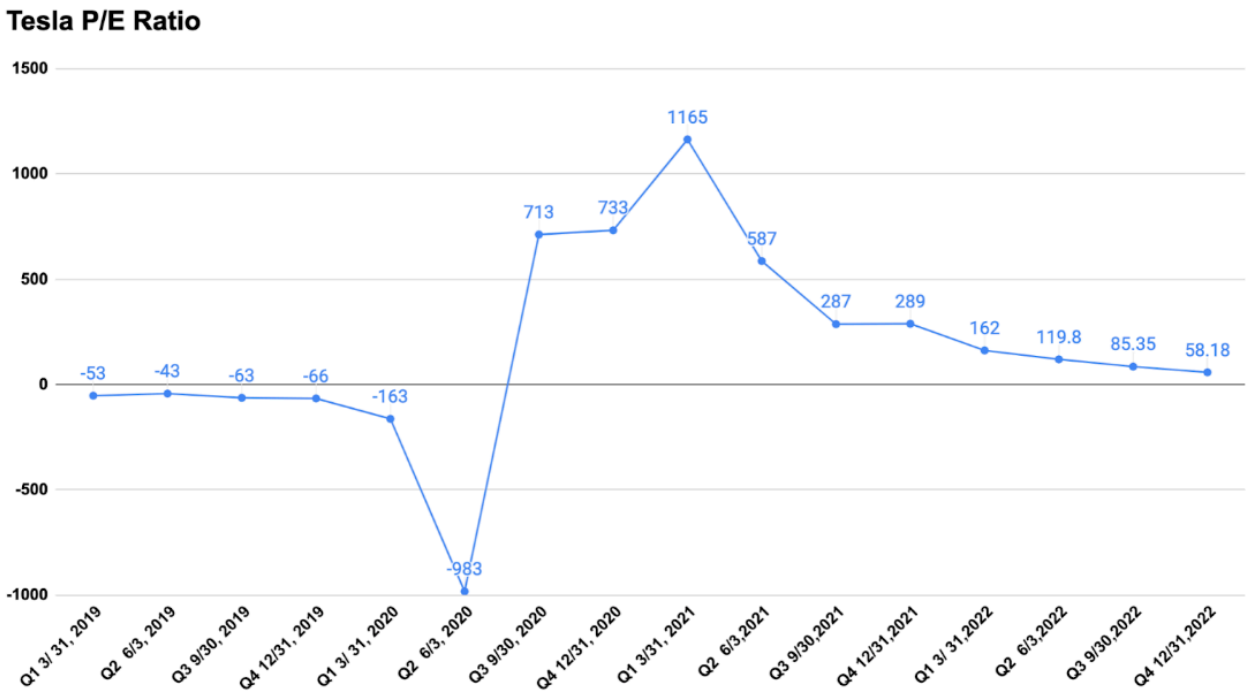

Figure 2. Quarterly price-to-earnings ratios of Tesla from 2019 to 2022.

Figure 2 indicates that among the seven companies, Tesla had the most dramatic changes in the P/E ratio, and its P/E ratio trend is shown on a separate plot for this reason. In 2019, Tesla maintained its P/E ratio of about -50, indicating that the company was not profitable. When Covid-19 shocked the American economy in the second quarter of 2020, Tesla's P/E ratio dropped to -983. However, from the third quarter of 2020, Tesla's P/E ratio started to rise dramatically and eventually reached a peak of 1165 in the first quarter of 2021. Beginning in the second quarter of 2021, the P/E ratio consistently declined. By the end of 2022, Tesla's P/E ratio was 58, a substantial 95% decrease from its peak value.

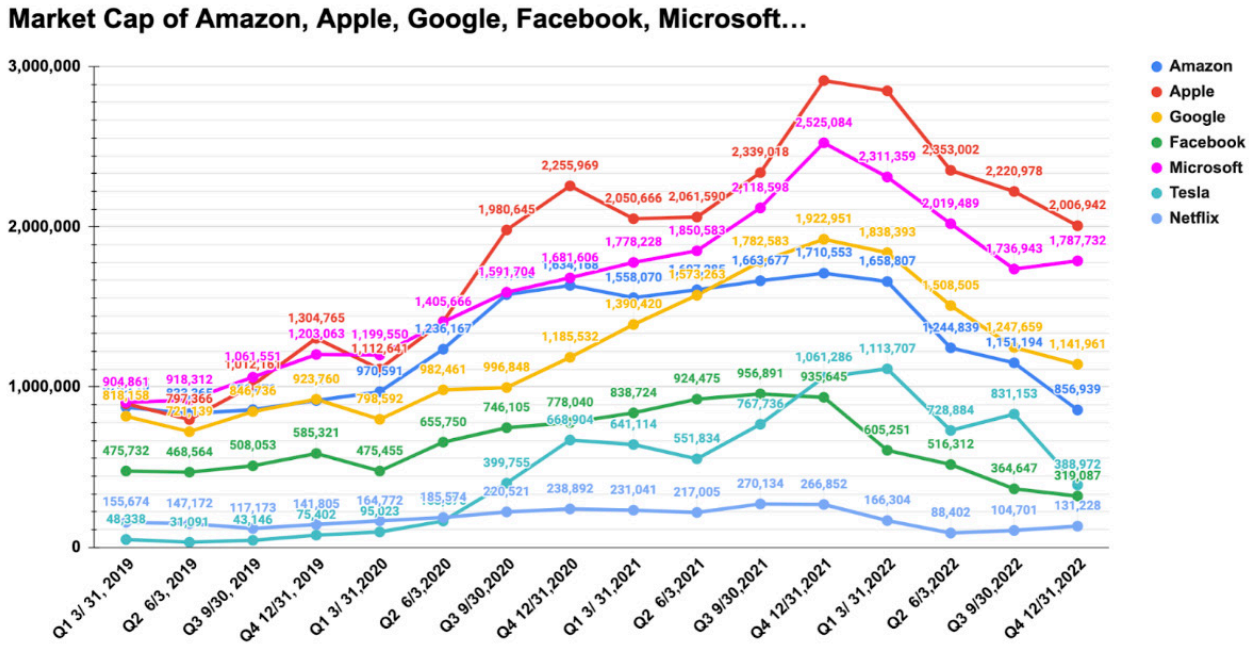

Figure 3. Quarterly market capitalizations (millions) of seven tech companies from 2019 to 2022.

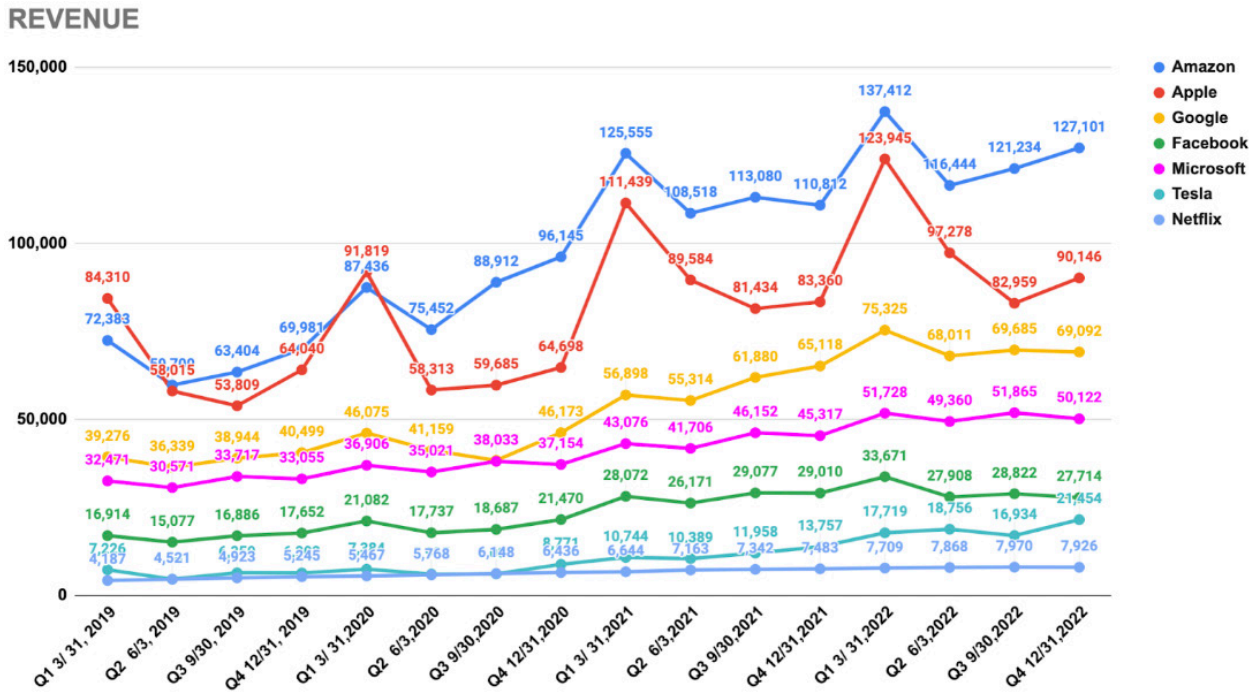

Figure 4. Quarterly revenues (millions) of seven tech companies from 2019 to 2022.

Figure 3 shows the market capitalizations of the seven companies by quarter. The market capitalizations of Netflix, Facebook, and Amazon decreased between the first quarter of 2019 and the last quarter of 2022. Out of the four other companies, Tesla had the biggest increase. The four biggest companies in market cap (Apple, Microsoft, Google, and Amazon) had their highest market cap in the last quarter of 2021. Facebook and Netflix had their peak in the third quarter of 2021, and Tesla had its peak in the first quarter of 2022. Every company had its market cap peak between the end of 2021 and the start of 2022, corresponding to the peak of the COVID-19 pandemic. After the peak of the pandemic, the overall market capitalization of each firm started to decline.

Figure 4 indicates the quarterly revenues of the seven companies. The quarterly revenue of each of the seven companies showed an overall increasing trend from 2019 to 2022. In terms of percentage rise, Tesla had the biggest rise in revenues from 2019 to 2022, an increase of 340%.

Based on Figure 4, there is a general trend on the revenue graph of the seven companies where the revenue of all seven companies increases in every first quarter from 2019 to 2022, and the revenue falls in the second quarter. This trend is especially evident with Amazon and Apple.

Discussion

The FAANG companies now face challenges from rising interest rates, market saturation, intensifying competition, and revaluations for tech stocks in 2023. In particular, Netflix has lagged behind other FAANG companies with regard to reputation and growth.

The market capitalization and the revenue of the seven companies indicate that most of the seven companies successfully adjusted to the new trend caused by COVID-19. However, as the world entered the post-pandemic, new challenges have risen for the seven companies. These challenges include increased competition, price sensitivity of consumers, technological shifts toward artificial intelligence, and an uncertain regulatory landscape, particularly with regard to anti-trust policies and laws. Future research should examine the performance of the stock prices of these tech firms, to determine the long-term impacts of the pandemic and its aftermath on tech companies.

Netflix and the Challenge of Growing a Subscriber Base

Out of seven companies, Netflix is currently facing the most complex challenges: account sharing and subscriber loss. According to GlobalData, even though 322 million households are watching Netflix, only 222 million users pay for monthly subscriptions. As a solution, Netflix has been trying to charge additionally for users who share their passwords. According to The Spinoff, standard accounts could pay an extra $7.99 per month for one extra sharing member, and premium users could pay an extra $15.98 per month for two extra members. Therefore, for one person to share his account with two other people, he has to pay a total of $40.97 per month which is the most expensive monthly streaming fee in the market. In addition, while Hulu, Spotify, and Amazon provide advantages for student users, the new account policy of Netflix will burden students (NSheidlower, 2023). Currently, the new policy of Netflix for password sharing could not easily lighten the problem. High inflation rate and extreme streaming service competition is causing subscriber loss. In conclusion, for Netflix to overcome new challenges in the post-pandemic era, Netflix must maintain its subscribers and provide a new policy that could solve account sharing.

Facebook, the Metaverse, and the TikTok Threat

Facebook(Meta) is also facing various challenges. To begin with, TikTok, a short video platform launched by ByteDance in 2016, became a strong competitor of Facebook, and TikTok has been gaining attention from a younger user base. As demonstrated by Bankless Times, TikTok has quadrupled its active users since 2018, and in 2023, it is predicted that Tiktok will overtake Facebook within four years(Mukuhi, 2023). While Facebook had an increase of 103 million users from 2021 to 2022, Tiktok had an increase of 319 million users over the same period. In addition, while the main identity of TikTok remains as an entertainment application, it is also functioning as a news source and as social media, so it directly competes with Facebook(Sherman,

2022). As mentioned by Reuters, during the Russian invasion of Ukraine, the number of videos with a #Ukraine tag has increased from 6.4 million to 40 million in Tiktok, informing the world about the situation in Ukraine(Chon, 2022). In October 2022, Facebook announced that its revenue fell four percent due to extreme competition against Tiktok and other companies. Even without the extreme competition, Mark Zuckerberg's miscalculation regarding the metaverse has brought negative consequences. According to Forbes, during the post-pandemic, Mark Zuckerburg assumed that the increasing rate of online usage would persist even after the pandemic(Marr, 2022). Based on his misconception, Zuckerburg made risky investments. During the pandemic, Facebook invested in Reality Lab and XR(Extended Reality). However, the overall performance of Reality Lab was not satisfying for investors. By September 2022, they lost $13.7 billion, and Facebook is expecting to have a greater loss on functioning Reality Lab in 2023 (Vanian, 2023).

Microsoft and Google in an Era of AI and Antitrust

The two major challenges for Microsoft, Google, and other big tech companies will be new antitrust laws and the appearance of generative AI. According to Harvard Business Review, the American government is focusing on two antitrust issues: Microsoft's acquisition of Activision and Google's advertising businesses(Levin & Downes, 2023). Moreover, the government already tried to regulate Meta's acquisition of VR startups. Even though proving the cases is very difficult, since the government must prove that the actions of the companies are harming the market, it is not necessary for the government to win in order to substantially impact the companies' future outlook. Antitrust issues could damage companies' reputations and operations greatly just by mentioning the possibility of regulation. The antitrust law will make it difficult for companies to have aggressive growth strategies. Not only will the American government try to regulate big tech companies, but also the EU has already constituted laws to regulate the companies. On November 1, 2022, the EU passed the Digital Markets Act. According to the European Commission, the law prevents a few companies that are regarded as 'gatekeepers' from favorably promoting their businesses and providing disadvantages to third parties. The law's primary purpose is to block tech companies from abusing their market position. If the companies violate the law, the companies must pay fines that go up to 10 percent of their global revenues. The Digital Service Acts could also strongly influence big tech companies. By the Digital Service Acts, companies must clearly show how they determine illegal content. The companies must share their algorithm. The EU believes that the Digital Service Acts and Digital Markets Acts could stimulate companies' competition and growth in the global market, and provide basic rights for the consumers.

The competition between Microsoft and Google on generative AI could be both a challenge and an opportunity for the companies. According to Bloomberg, Google's revenue of $283 billion mostly comes from advertising and its leading position as a search engine(Milian, 2023). It means that the revenue of Google could greatly decline if Microsoft could present a better search engine. To win the search engine competition, Microsoft will incorporate its generative AI into Bing by using Chat GPT technology. Microsoft has already invested $10 billion in OpenAI, the maker of Chat GPT. In addition, according to CNN, in March 2023, Microsoft introduced Microsoft 365 Co-pilot which incorporates the technology of Chat GPT into Excel, Word, and PowerPoint(Kelly, 2023). Co-pilot will transcribe meeting notes, summarize emails, create specific charts in Excel, and turn Word documents into presentations in seconds. During the week when Microsoft introduced Chat GPT, Google also announced that it would also provide an AI technology that incorporates its third-party applications such as Gmail, Google Docs, and Google Sheets(Novet, 2023). Overheated Competition in the electric vehicle industry, and Consumers' Response to Elon Musk's Actions

The pandemic might have influenced the company, but not as much as other companies had. It was because Tesla was characterized as a meme stock, not because of the pandemic, but because of Elon Musk. As one of the most famous meme stocks throughout the pandemic, Tesla showed huge volatility. Similar to the situation during the pandemic, the future performances of Tesla will heavily rely on its competitors and Elon Musk's actions.

Tesla is facing intense competition from other companies. Currently, the three largest battery electric vehicle manufacturers are Tesla, Volkswagen, and BYD. BYD, a Chinese vehicle company, may be poised to exceed the sales of Tesla on battery electric vehicles. According to InsideEVs, in the third quarter of 2022, Tesla increased its quarterly sales to 343,830 units (up 42% year-over-year), while BYD increased its quarterly sales to 258,610 (up 182% year-over-year); the gap between the two companies is closing rapidly(Kane, 2022). Not only do BYD and Volkswagen present a threat to Tesla, but other manufacturing companies such as General Motors, Ford, and Hyundai are also focusing on electric vehicle production, which will eventually force Tesla into more competition. The overall situation of the market is not as positive as it used to be before the pandemic; as stated in NPR, while car manufacturers were not able to produce cars due to a lack of parts in 2022, the new challenge in 2023 is that consumers are not willing to buy cars because of high-interest rates(Domonoske, 2023).

There is no doubt that the actions of Elon Musk, especially his purchase of Twitter, will highly affect Tesla. To purchase Twitter, Elon Musk had to sell $3.95 billion worth of Tesla stock, and as a consequence, the stock price of Tesla declined(Isidore, 2022). Moreover, purchasing Twitter will constantly hurt the image of Tesla in the future; as proof, according to Morningconsult, from October to December 2022, the favorability of Tesla decreased by about 6.2 percent points among U.S. citizens(Marlatt, 2023). More specifically, the favorability declined by about 20 percent among consumers who identified as Democrats, while favorability increased by 4 percent among Republicans. The Twitter purchase has hurt Tesla's brand image in two ways. First, many consumers equate Tesla with Elon Musk, so any decline in consumer perceptions of Musk will necessarily lead to a decline in consumer perceptions of the Tesla product. Second, many investors are concerned that the Twitter purchase will distract Elon Musk from his management responsibilities at Tesla, and the Twitter purchase may create the perception that Tesla is mismanaged. If the brand image constantly worsens due to consumer and investor misgivings about Elon Musk, these concerns will eventually lead to a decrease in the total sales of Tesla.

Amazon and its Rising Competitor

The way people could buy products so quickly and the variety of products consumers could buy allowed Amazon to grow rapidly. Due to its rapid growth, Amazon has been able to take most of the market share of E-commerce, a service where consumers can buy or sell their products online. However, from the beginning of the post-pandemic, Amazon has started to face a strong competitor, Walmart. According to CNBC, to compete against Amazon, Walmart started to use their offline shops as delivery centers that could sell products as well(Repko, 2022). While Amazon does not have plenty of offline infrastructure, Walmart is trying to provide quick delivery service by using its offline infrastructure, drones, and automated system. As a comparison, according to Walmart, by February 2023, it had 4,700 stores and 600 Sam's Clubs all around the United States. However, according to Forbes, Amazon only provides 38 Amazon Fresh and 28 Amazon Go stores(Loeb, 2023). In addition, while the stock price of Amazon decreased 45 percent from November 2021 to November 2022, the shares of Walmart increased about 5 percent over the same period. For Amazon to maintain its position as the leader of the E-commerce business, Amazon must constantly provide a better service than any other competitors, especially Walmart.

However, not only rising competitors will be a challenge for Amazon, but also antitrust law issues will be a burden for the company just like other giant tech companies. Currently, Amazon provides various services including digital content, delivery, retail goods, and even driving. Due to its influence and power in the market, Amazon blocks competition in various fields. That is why the Federal Trade Commission(FTC) is constantly warning Amazon for its antitrust law issues. In September, the FTC sued Amazon for its illegal actions to maintain its influence(Graham, 2023). For Amazon to survive, Amazon must solve a dilemma: to maintain its position, Amazon constantly has to be in various fields, but the government would not allow Amazon to act as a monopoly in different fields.

Apple and its App Store Policy

While Microsoft, Google, and Facebook have been criticized for their antitrust violations, Apple

has been criticized by various companies for its App Store policies. According to Theverge, its criticism started in 2019 with Spotify's first complaint about the policy(Vincent, 2023). Spotify insisted that while Apple could provide services with subscriptions without any costs, Spotify and other applications that provide subscriptions must pay 30 percent of their subscription revenue to Apple(Lovejoy, 2023). In 2023, other CEOs in various tech companies started supporting the complaint of Spotify. Not only Spotify and other tech companies criticize Apple for its policy, but also the game industry criticizes Apple.

A famous instance of the battle between the game industry and Apple is the trial of Apple and Epic Games. On August 14, 2020, Apple announced that Fortnite, a game published by Epic Games, will be deleted from the App Store. The reason for Apple's decision was that Epic Games decided to run its own store so that the users of Epic Games could directly purchase items from Epic Games. Epic Games claimed that users could buy their products at 20 percent lower prices than before(Saifi, 2020). Epic Games started running its store because paying 30 percent of its revenue to Apple was a huge loss for the company.

As a consequence, Epic Games announced that they will going to sue Apple for Anti-trust laws. The first court started on May 3, 2021. Filed on September 13, 2021, case number 21-16506, lawyers for Epic Games stated that Apple has been charging supercompetitive prices for companies, leading to high profits(Epic games, inc.. V. Apple, Inc., no. 21-16506 (9th cir. 2023)). The lawyers also claimed that while other companies are charged heavily by Apple, Apple could maintain its service at a constant price. Therefore, Epic Games strongly argued that Apple has monopoly power.

However, Even though Apple won the case, the battle between Epic Games and Apple was a global issue. It, therefore, made politicians and other companies consider Apple's policies as a monopoly. If Apple maintains its App Store policies in the future, it will cause more incidents similar to that of Epic Games, and affect the brand image of Apple.

Conclusion

The purpose of this research was to analyze how giant tech companies in America performed before the COVID-19 pandemic, during the pandemic, and after the pandemic, to evaluate how effectively the giant tech companies will survive the post-pandemic market. The research primarily focused on examining the companies' stock performance and future challenges that the companies must face. The analysis of stock prices reveals that all seven tech companies experienced constant, rapid growth from 2019 to 2021 (when COVID-19 was at its peak) and started to decline rapidly from 2022 (when COVID-19 started to weaken throughout the world). During the pandemic, all seven companies successfully adapted to the new changes. However, after the pandemic, the stock performance of each company began to decrease, suggesting that the companies' successes could not be sustained after the pandemic. Tech companies must be able to solve future challenges, such as increasing competition, regulatory changes, and technological innovations so that these companies can recover their financial performance.

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Entangling Alliances: America, Japan, and China in the Wake of WWI

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Abstract

In 1914-1917, the United States actively encouraged China to join World War I (1914-1918), but Japan firmly resisted China's participation in the war. At the end of the war, the attitudes of the United States and Japan switched. Japan tried to encourage China to join the war, whilst the United States tried to prevent China from participating. The change in the attitudes of the United States and Japan towards China is by no means a coincidence, but a concrete manifestation of the competition between the two sides for the dominance of their diplomacy with China. This essay discusses such a switch in their attitude with primary sources and the reason behind such switch. The first stage, starts from 1914 and ends in early 1917, is Japanese deterrence and American encouragement; the second stage, starts from early 1917, is Japanese encouragement and American deterrence.

Keywords: China; Chinese History; First World War; Chinese Diplomacy; Beiyang Government; Beijing Government; American Diplomacy; Japanese Diplomacy.

Introduction

On 28 July 1914, the First World War triggered by the Sarajevo incident broke out in Europe. Almost the whole of Europe broke into two opposing sides: the Entente and the Central Powers. The Entente was led by Britain, France, Russia and Serbia, whilst the Central Power was led by Germany and Austria-Hungary. On August 23, 1914, Japan declared war on Germany, igniting the fire of World War I to Asia.

Dispute over Shandong

The dispute over Shandong refers to the controversy over the ownership of the Chinese province of Shandong. The problem involved China, Germany, and Japan, and their respective claims to Shandong.
Shandong was a province of China. In 1898, Germany leased the Jiaozhou Bay area from China for 99 years and established a concession in Qingdao, a major city in Shandong. However, during World War I, Japan seized control of Qingdao from Germany in 1914 and occupied the area for the rest of the war.

Why did Japan Enter the War?

The casus belli for Japan to declare war on Germany was to fulfil the obligations of the British-Japanese Alliance, but Japan's major purpose was to seize German concessions, including Qingdao, and sphere of influence in Shandong, China (Blake & Louis, 1993, p. 276). The war between Japan and Germany in Asia began rapidly. On November 7,1914, the German army in Qingdao surrendered to the Japanese army. Jiaozhou Bay, the German colony in Shandong, went under the control of Japan, and the whole province of Shandong was put under the Japanese sphere of influence.

China's initial attitude towards the war

From the very beginning of the outbreak of the First World War, China's rulers and senior officials were keenly aware that China should join this unprecedented war, improve its international status, and withdraw privileges seized by foreign powers. After Japan took Shandong by force, Duan Qirui, Premier of the Republic of China, realised that China need to participate in the World War, because only by joining the Entente to fight against Germany could the Shandong issue be included in the post-war peace conference, and China could also reclaim Qingdao(Gray, 2002, p. 168-169). However, Li Yuanhong, President of the Republic of China, suspected that Duan was taking advantage of the participation to expand his own power, and was thus unwilling to follow Duan and started the debate (Wang, 2005).

Concerning whether to join such an unprecedented war, there was a heated debate in Beijing: First, which side would eventually win the victory? Second, what actions would Japan take (since Japan did not join in the war immediately)? Eventually, the voice advocating severance of diplomatic relations with Germany outweighed the voice advocating neutrality in early 1917. Nevertheless, both because of the opposition and Japanese pressure, China did not join the Entente before early 1917.

Literature Review

Research on the diplomatic history of China and the First World War is a relatively weak field in China's modern history. When it comes to the modern history of China during the First World War I, historians pay more attention to several historical concepts or nodes such as the Beiyang Government, the Twenty-First Demand and the May Fourth Movement. However, the study of World War I in the context of diplomatic history is relatively weak.

After the war broke out, the Chinese government led by Yuan Shikai declared neutrality towards the European war on August 6, 1914. Most scholars concluded in the papers that China taking a neutral stand would have a negative impact on China. In recent years, a different perspective has emerged. The neutrality declaration of the Beijing government seemed to be a safe and timely countermeasure. Under ordinary circumstances, such countermeasures should not cause controversy. Nevertheless, China was confronted with a dilemma: First, both sides of the war owned concessions with the presence of garrisons; secondly, Japan, a strong neighbour, was likely to join the war because of its alliance with Britain. In order to maintain its neutrality, the Beijing government has made effort to seek a guarantee of neutrality among the United States, Japan, and Britain, although in vain (Wang, 2005).

Some historians believe that the Yuan Shikai government's neutrality position was declared at the outbreak of the First World War, not when Japan attacked Shandong. In addition, historians generally believe that the Beijing government continued to maintain a policy of neutrality when Japan sent troops to Shandong, abandoning Shandong that China could have recovered. But the Chinese people at that time, mainly intellectuals, generally supported the decision of Yuan Shikai's government (Chen, 2005).

Regarding the debate over China's participation in the war, historians, particularly Chinese historians, have long believed that such debate reflected the competition among imperialist powers for supreme rights in China. All factions in China wanted to take advantage of the participation to obtain assistance from a foreign power in order to consolidate their respective domestic strength. Foreign powers also want to use their support for the Chinese factions to expand their colonial rights in China (Wu, 1990).

Some studies have focused on the role of certain individuals in promoting China's participation in the war, such as Duan Qirui, Liang Shiyi, and George Ernest Morrison (Yang, 1993). Scholars believe that there was political and economic consideration behind Duan Qirui's insistence of participation. First, it is based on his own understanding of the situation at home and abroad; Secondly, he wanted to postpone the payment of boxer indemnities, raise tariffs, borrow foreign debts, solve his government's financial difficulties, and maintain normal rule by participating in the war, rather than the result of being influenced by Japan. Japan's support had a certain influence on Duan Qirui's participation in the war, but it was not a decisive factor. The close relationship between Japan and Duan Qirui began after the Zhiwan War in 1920. Morrison played a certain role by advising the Chinese government, passing various information about China's participation in the war to Western powers, and lobbying senior Japanese politicians (Cai, 2009). Liang Qichao actively advocated that China join the Entente to declare war on Germany. Because this was consistent with Duan Qirui's policy of participating in the war, it caused criticism from the contemporaries (Liu, 1999).

This paper, however, pays less attention to the disagreement among the individuals in Beijing and focuses more on the comparison between Japanese and American diplomatic strategies towards their stand on China's participation and the motivations behind their stand. Primary sources from these three countries would be adopted to help present the analysis.

First Stage: Japanese deterrence and American Encouragement

Beijing's hesitation

As mentioned, Beijing's hesitation in the very beginning was due to two contradicting views between Duan, who advocated participation, and Li, who was unwilling to follow Duan and join the war.

The first time the Beijing government moved to join the war was before Japan captured Jiaozhou Bay. At that time, Zhang Guogan, the former secretary-general of the State Council, proposed to Duan Qirui that China should declare war on Germany. "Concerning the Qingdao issue, if Japan preempts us under the pretext of the Anglo-Japanese alliance, it will be extremely difficult to deal with, and there will be more entanglements in the future"(Xu, 1954, p. 51). But this claim has not attracted enough attention. Although Duan Qirui was also in favour of declaring war on Germany, other military and political leaders, represented by president Li Yuanhong, did not advocate getting involved, so the discussion was shelved.

When Japan was about to send troops to Shandong, Liang Shiyi, then tax supervisor, advised Yuan Shikai that before Japan sent troops, China should reach an agreement with Britain about Qingdao as soon as possible. He suggested that while negotiating with the German envoys, China should send troops simultaneously to besiege Qingdao and compel Germany to return Qingdao. "If Qingdao falls into our hand, how would Japan be able to send troops (to Shandong)? This is not to prevent Japanese aggression, but to prevent future troubles" (Jin, 2006, p. 51). In response to the suggestions of Liang Shiyi and others, the Beijing government had "seriously considered the policy of declaring war on Germany," (Jin, 2006, p. 5) but no final decision was made due to the contradiction between Duan and Li. Japan also warned that "Now that China has already declared neutrality, there shall be no reason to participate" (Wang, 2005, p. 43), thus the hawks had no choice but to give up.

Japan's Deterrence of China's Participation:

After Japan had seized Shandong and proposed the Twenty-One Demands, there were once again appeals within the Beijing government to join the war to resolve Sino-Japanese disputes. Now, the Entente also anticipated China's joining the Entente. In November 1915, the envoys of Britain, Russia and France to China advised China to join the alliance, hoping that China would "sell the munitions to the Russian army" and "prevent the Germans from using China as their base to smuggle munitions to India" . This piece of message aroused great concern in Japan. The Japanese Minister to China, Hioki Eki, was ordered to go to the Chinese Ministry of Foreign Affairs to inquire whether this was true. Japanese newspapers angrily condemned Britain's intentional alienation of Japan on the issue of China. On November 23, the ambassadors of Britain, France and Russia to Tokyo formally requested Japanese Foreign Minister Ishii Kikujirō to cooperate in this regard and work with the governments of the three countries to persuade China to join the Entente. Ishii, however, opposed this plan and frankly stated that Japan must treat China carefully, and declared: "Japan can hardly be calm when China organises an elite army for it to enter the war. Additionally, Japan cannot help being worried about the economic liberation of a country with a population of 400 million." (Morse & MacNair, 1931, p. 563) In the face of Japan's tough attitude, China had to postpone participation in the war again. British Foreign Minister Gray ordered Ambassador Green to visit the second official of the Japanese Foreign Ministry on November 27 to guarantee that Britain would never ally with China unless they discussed that with Japan (Tao, 1958, p. 140-141).

Proposals of Beijing to participate in the First World War were all stranded, and the biggest international resistance came from Japan. However, due to the intimidation of Japan, the Beijing government has kept this secret. The cause for China's reluctance was not officially revealed until the request for the abolition of the Twenty-one Demands was submitted to the Paris Peace Conference:

"If it were not for Japan's attitude, China would have already joined the Entente to fight against enemies in Central Europe. Japan's attitude is that it was eager to inherit Germany's privileges in Shandong. In August 1915, the Chinese government declared that it was ready to fight against Germany and attack the German garrison in Qingdao. At that time, we hesitated precisely because some people in the government believed that doing so would easily lead to disputes with third countries. By November 1915, the Chinese government expressed several times its desire to join the alliance and participate in the war, but it was still rejected by the Japanese government."(Zhongguo Shehui Kexue Chubanshe, 1984, p. 192)

These words demonstrate China's emphasis on the factor of Japanese deterrence in preventing China from joining the Entente before 1917 so that China had a greater chance to withdraw the privileges of Japan in Shandong because Japan emphasised its great contribution and casualty compared with those of China during the war.

Motivations behind Japanese deterrence

The direct reason for Japanese deterrence was that Japan inherited Germany's privileges in Shandong through a rapid assault against Germany at the beginning of the war. If China joined the war, it would inevitably demand abolishment in the post-war peace conference, and the peace conference might have led to the return of Shandong, which was not benefiting Japan. This is the result that Japan does not want to see anyway, so Japan must do everything possible to prevent China from participating in the war to create a situation that is beneficial to its own country.

And the root cause of Japan's resistance to China's participation in the war is that after the outbreak of the war. The European powers were mired in the quagmire of war and were unable to take care of the Far East, while Japan took the opportunity to reap a series of "achievements" that were beneficial to itself in China, and gained the "supreme" right to speak on China's issues. In order to declare its "special status" in China to the big powers, Japan wanted to resist China's participation in the war when the Entente preferred China's participation in the war, and in this way extorted as much profit as possible from the Entente.

Concern from the US on Japanese Arrogance

Japan's growing arrogance over other countries, including both the Entente and Central Powers, in China affairs has caused deep concern in the United States. US Minister Paul Samuel Reinsch in China reported to the State Department that the British position in China was increasingly isolated due to Japanese actions. Japan is becoming the most active power in affecting China's diplomacy. Reinsch stated that, along with European interests, the US interest in China was also harmed by Japan (U.S. Department of State [DOS], 1940, p. 429-430). Upon learning of Reinsch's report, US President Wilson quickly instructed Secretary of State Robert Lansing that it is time to warn Japan in a friendly and frank way that they were closely watching its attempt to further control China (DOS, 1940, p. 430).

Reinsch's Effort in promoting China's entering the war

On February 3, 1917, the United States broke diplomatic relations with Germany due to Germany's resumption of unrestricted submarine warfare against the Allies, and at the same time suggested that other neutral countries take joint action with it. Reinsch regarded this action of the United States as a good opportunity to compete with Japan for political dominance in China, and immediately launched active diplomatic activities in China. On the same day, he visited Beijing President Li Yuanhong and Prime Minister Duan Qirui, and then visited military and political officials, pointing out that the severance of diplomatic relations with Germany represents the side of justice, and that participating in the war can prevent China from continuing to be trapped in factional struggles; China would also have a say in post-war conference (Wang, 1988, p. 101). The Beijing government conducted a careful study of Reinsch's proposal, and at the same time asked the United States to give corresponding economic assistance. Unauthorised assurance to China: If the Chinese government agrees with the US President's proposal to break off diplomatic relations, the US government will take measures to allocate the required funds... and the United States can also use most of the boxer indemnity to support the Chinese government (Reinsch, 1982).

After receiving such assurances, the Beijing government submitted a formal statement to Reinsch on February 9, stating that it was determined to take concerted action with the U.S. government, and promised that if the U.S. government deemed it sufficient to declare war on the German government, the Chinese government would at least serve diplomatic relations with Germany (Cheng, 1988, p. 278-279). On the same day, the Chinese government submitted a document to Germany protesting its unlimited submarine warfare.

Motivations for America to Advocate China's Participation

The US encouragement in the first stage was mainly due to the need to compete with Japan for political dominance over China. For a long time, the United States has pursued an open-door policy in China. The essence of this policy is to maintain equal business opportunities in China and safeguard the integrity of China's territory and sovereignty. During the First World War, Japan implemented a series of acts that undermined the open-door policy in China, such as forcibly seizing Germany's leased land and sphere of influence in Shandong, and proposing the Twenty-One Demands aimed at monopolising privileges in China, which aroused strong dissatisfaction in the United States. And Japan's increasing superiority over other poor countries on the China issue has made the United States even more anxious. Therefore, the United States wanted to take the opportunity of announcing the severance of diplomatic relations with Germany to win over China to take concerted actions with it, so as to gain the initiative in diplomacy with China.

Second Stage: American Deterrence and Japanese Encourage

Discrepancy between Reinsch and US state department

It was not until after China lodged a formal protest against Germany that Reinsch received instructions from the State Department that he had gone too far in urging China to cooperate (Reinsch, 1982, p. 190). He was also told not to give (China)

any promises or guarantees, and not to take any other actions before receiving further instructions (DOS, 1940, p. 408). Immediately afterwards, Lansing ordered Reinsch to inform China that the U.S. government highly appreciated China's position, but did not want to lead it into a dangerous situation. It regrets that it is practically impossible to give China any guarantees. Therefore (with regard to diplomacy with Germany) China should seek the opinion of the Entente, and Japan's attitude should also be taken seriously (DOS, 1940, p. 408).

Japanese Response of China's Condemnation

After learning that China followed the United States in submitting a document of protest to Germany, Japanese Foreign Minister Moto met with Chinese Minister Zhang Zongxiang on February 9 and blamed China: "For China's protest against Germany, we deeply regret that China did not contact Japan beforehand. Now that the two countries are trying to bridge the gap." At the same time, he also suggested that "just protesting will not help to improve China's international status, it is better to immediately announce the severance of diplomatic relations with Germany." (Cheng, 1988, p. 278-279) On February the 12th, Japanese Minister Yoshizawa told Prime Minister Duan Qirui in person, again hoping that the Beijing government would ignore Germany's reply and immediately cut off diplomatic relations with Germany (Wang, 2005, p. 84). Since then, Japan has repeatedly urged China to break off diplomatic relations with Germany and even join the First World War, and agreed in principle to China's proposals such as increasing tariffs and easing compensation (Wang, 2005, p. 85). Japan also lured Duan Qirui, and the loans Japan provided to China could be used by him to wipe out other factions in the country (Xu, 1954, p. 51).

Motivations for Japan to Advocate China's Participation

One of the reasons for Japan to prompt China to join the war is that when it saw that China followed the United States in protesting against Germany, it had to adjust its strategy in time to prevent the United States from further gaining a leading position in China's diplomacy. As Kizo Nishihara pointed out to the Japanese government many times: "If we just sit back and watch (China) be drawn into the Entente by the United States, it will also cause cracks in the hard-won foundation of Sino-Japanese friendship." (Wang, 2005, p. 72)

The second reason is that when Germany implemented unrestricted submarine warfare, the Entente's materials became scarce, and they eagerly hoped that China would join the war to take advantage of China's manpower and food resources. Under such circumstances, it is impossible for Japan to go its own way and completely ignore the opinions of the Allies.

The third reason, which is also the most important one, is that Japan has already handled the Shandong issue at this time, and signed a series of secret treaties with the Entente, which can reverse the adverse effects that China's participation in the war can bring to it. The former, such as January 18, 1915, Japan brazenly threw out the Twenty-One Demands to China. The Twenty-One demands were divided into five parts, and the first part is about the Shandong issue. It required the Chinese government to promise that any agreement on the transfer of Shandong rights that Japan planned to sign with Germany in the future would be fully recognized. After negotiating for a long time with Japan, China finally signed the Minsi Treaty with it, and basically accepted the conditions proposed by Japan on the Shandong issue. This paved the way for China to raise the Shandong issue at the peace conference in the future. For example, in January 1917, when Britain begged Japan to send a destroyer to escort the Mediterranean Sea, Japan told Britain that if Britain was willing to support Japan's demands for Shandong and the Pacific islands north of the equator at future peace conferences, then Japan would fulfil British wishes.

Although the price was very high, Britain agreed to this quid pro quo(Wang, 2005, p. 72-73). Afterwards, Japan followed the same pattern and conducted approximately the same negotiations with France, Russia, and Italy, and reached a mutual secret treaty on the Shandong issue. These wartime transactions constituted the "reef of the Shandong issue" (Wang, 2005, p. 73) at the peace conference. At the same time, the conclusion of the understanding between Japan and Britain, France, Russia, and Italy also meant that the members of the main Entente except the United States were unanimously siding with

Japan on the Far East issue, tacitly acquiescing Japan's dominance in diplomacy with China. Under these circumstances, it is not surprising that Japan supported China's entry into the war.

Shift of American Attitude

When Japan turned from boycotting China to urging China to fight, the United States turned from supporting China's entering WWI to opposing China's entering WWI. On February 10, Lansing instructed Reinsch to tell the Beijing government that the United States did not want to see China participate in a world war; then Reinsch was instructed to say that Europe does not need China to participate in the war, and the Chinese government "should not take further action" before consulting with the US government (DOS, 1940, p. 412).

Motivations for America to Block China's Participation

However, why did the United States oppose China's participation in the war later? Obviously, the change in Japan's attitude towards China's participation in the war forced the United States to make corresponding adjustments in its attitude towards China's participation in the war. Japan's more active involvement has frustrated the United States' desire to act as the leader of China's policy toward Germany, and the United States' support for China's participation in the war has lost its original meaning. Furthermore, the United States found that if China joined Japan in the war, China would be clearly placed under Japan's control, and the outcome would be that China would actually have to accept the Twenty-One Demands proposed by Japan two years ago (Wilson, 1986, p. 61). In this context, it is logical that the United States turned against China's participation in the war.

Dispute between President and State Council

The different attitudes between the United States and Japan caused fierce disputes within the Beijing government. President Li Yuanhong worried that Duan Qirui would further expand his power in the name of participating in the war, so he opposed participation in the war with the support of the United States; Prime Minister Duan Qirui advocated participation in the war with the support of Japan out of considerations such as borrowing foreign debts and expanding the army. This led to a struggle between the president Li Yuanhong and the State Council headed by Duan Qirui. However, the behind-the-scenes manipulators of this power struggle are the United States and Japan respectively. After a series of conflicts, the Duan faction gained the upper hand, and the Beijing government decided to follow Japan's suggestion to break off diplomatic relations with Germany.

Severing Diplomatic Relation with Germany

On February 14, the State Council and the Ministry of Foreign Affairs of the Beijing government jointly called Minister Zhang Zongxiang to Japan, ordering him to tell Japan: "The government has decided that if a German submarine hits a neutral ship, China will break off diplomatic relations with Germany." In addition, the representative of China said that this action would "cost a lot", and hopes that the Entente can "allow China to increase tariffs at its discretion, and ease or extend the term of Boxer indemnity." (Wang, 2005, p. 84)

The Japanese government took the opportunity to step in. On February the 17th, the field said to Zhang Zongxiang: "Japan is in favour of raising taxes and easing compensation, but after China breaks diplomatic relations with Germany, Japan must deal with other countries on behalf of China." On March the 10th and 11th, the Beijing Senate and House of Representatives successively passed the case of severing diplomatic relations with Germany. On March the 14th, President Li Yuanhong issued a proclamation announcing that severed the diplomatic link between China and Germany.

Declaration of War

After China severed diplomatic ties with Germany, Japan and other allies urged China to declare war on Germany immediately so they could discuss proposals such as increasing tariffs. However, the United States opposed China's entry into the war. On March 13, the US State Department told China not to take any further action until the US joined the war. With support from the US and Japan, the Dispute between the President and State Council reached its climax.

In late April, Duan Qirui tried to force the National Assembly to pass the war entry bill. On May 1, the Japanese envoy threatened political turmoil if the proposal was rejected, and Li Yuanhong agreed to submit the case to the National Assembly for debate. The National Assembly postponed the discussion in mid-May. Duan Qirui asked Li to dissolve the National Assembly, but Li refused. In late May, Li dismissed Duan after secret discussions with the US Minister. Duan's subordinates declared independence, and provincial governors asked Li to resign. Li ordered Zhang Xun to mediate, leading to Zhang's coup on June 30, declaring Puyi emperor the next day. With Japanese support, Duan sent troops against Zhang Xun. Zhang fled to the Dutch embassy on July 12, and Puyi abdicated. Duan officially declared war on Germany on August 14, after clearing obstacles.

Conclusion

Fearing China's potential demand of reclaiming Shandong and attempting to show its supremacy over Chinese diplomacy, Japan initially blocked China from entering WWI. In accordance, America initially encouraged China's participation to contain Japan's growing influence over China (which is consistent with its open-door policy) and keep its own influence. Nevertheless, both countries shifted their attitude in early 1917. Japan turned to supporting China's participation because of the influence of the US, the need for Chinese resources from the Entente, and the guarantee of Japanese interest in Shandong from its allies. In contrast, the US turned to blocking Chinese entry because the US found itself no longer able to be the leading power in terms of Chinese diplomacy, and China would have to accept Japanese demands harmful to America if China followed Japanese advocation.

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Religion, History, Values, and Sexual and Reproductive Health Policy in China versus the U.S.

By Grace Tao

Author Bio

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Abstract

The UN's 17 Sustainable Development Goals (SDGs) lay a roadmap to better environmental sustainability, living standards, social equality, and more across developed and developing nations. Among those were goals designed to address gender inequality and promote female autonomy by ensuring widespread access to sexual and reproductive healthcare. However, a solution cannot be implemented before determining potential roots or agitators to the issue. This essay, through a comparison of policies in the U.S. and China, explores the correlation between a nation's culture and its citizens' access to sexual and reproductive healthcare. The outcome of this analysis suggests that American cultural values (Christianity, individualism, democracy, and openness) sometimes lead to reduced access to reproductive healthcare. Eighteen American states have enacted some form of termination ban, though contraceptives remain constitutionally protected. On the other hand, Chinese cultural values (collectivism, totalitarianism, utilitarianism, and privacy) correlate with increased access, as terminations and contraceptives are both legal and widely accessible. Prevalence rates of contraception and terminations in China result in fewer unmet family planning needs.

Keywords: American/Chinese culture, contraception, contraceptive prevalence, termination prevalence, birth control, religion and birth control, Christianity and birth control/terminations, American/Chinese Revolution, Mao Zedong, birth control policy, etc.

Introduction

Without proper access to sexual and reproductive healthcare, citizens become more prone to unintended pregnancies, which may have disastrous physical and psychological effects on both the mother and the child (CDC Jun. 2021), and by extension, harm future generations. Furthermore, restricting abortion access by law does not necessarily drive women to stop having abortions altogether– some may be "[compelled] to risk their lives and health by seeking out unsafe abortion care," said Ana Langer, Professor of the Practice of Public Health and coordinator of the Women and Health Initiative at Harvard T.H. Chan School of Public Health (Roeder Dec. 2021).

Beyond the social consequences of unwanted pregnancies remains the fact that access to terminations and contraceptives is, as established by the UN, a human right (UN News, Jul. 2022). A subgoal of SDG 3 (well-being for all), SDG 3.7, is specifically aimed at ensuring universal access to sexual and reproductive healthcare services (family planning, education, etc.) Similarly, SDG 5.6, a subgoal of SDG 5 (gender equality) focuses on "[ensuring] universal access to sexual and reproductive health and reproductive rights" (UN). Yet how does the UN plan to execute such goals? Perhaps one approach could begin with an examination of a nation's culture– one especially prominent and influential factor regarding policy.

The objectives of this paper were to define either the presence or absence of a correlation between culture and access to sexual and reproductive healthcare, using corroborating trends extracted from research on both the U.S. and China. It is vital to examine the potential for a correlation between culture, and sexual and reproductive healthcare policy to clarify the variables that either support or hinder reform to best foster change.

For clarity, in this research paper, a nation's culture is defined by its religious beliefs, historical values, and attitude toward women. "Access" to sexual and reproductive health is defined by the laws regarding contraceptives and terminations, citizen sexual education, and the likelihood that the population will use the sexual and reproductive healthcare accessible to them.

Methodology

This essay includes a sample literature review of sources from the Google Scholar search engine, in which a qualitative analysis method was used. A quantitative analysis was used as well to address data gathered from the search engine Google Dataset search.

Discussion

Culture

As culture is an incredibly broad topic, and the differences between American culture and Chinese culture are vast, this paper aims to deduce the essence of both cultures by examining each nation's religion, history, and history values, and view of women in society.

Religion.

To determine the differences in culture between China and the US, one must first examine one especially influential aspect of culture in the contraceptive/termination debate: religion. As evidenced by American debates over sexual and reproductive healthcare, religion is one prominent aspect of culture that influences not only a society but also its policies. The Pew Research Center, a nonpartisan think tank based in Washington D.C., conducted a Religious Landscape Study of the U.S., surveying over 35,000 Americans in 2007 and 2014 with a broad range of religious and political affiliations. Although the debate over contraception has generally calmed throughout the states, policy over terminations remains an interstate conflict, with most termination bans taking place in Southern states (Haines, et al. Dec. 2022). Through this study, one can examine the link between such sectional political divides and differences in religious beliefs. The findings are as follows: states with full bans including Texas, Oklahoma, West Virginia, Kentucky, Missouri, Arkansas, Alabama, Louisiana, and Mississippi, had a population that on average was 79.89% Christian (meaning Catholic, Evangelical Protestant, Mainline Protestant, Historically Black Protestant, and Mormon) and only 2.11% Atheist. Within these states, there appears little trend regarding the popularity of each branch, with the exception of Evangelical

Protestantism, which is usually dominant. The rate of Christianity is 9.29 percentage points greater than the mean rate of the United States as a whole, whereas the rate of Atheism is approximately 1 percentage point less than the national average. For clarity, Atheism is characterized by the belief that there is no divine power. This is not to be confused with Agnosticism, which is characterized by uncertainty as to whether or not there is a god or divine power. Meanwhile, states that provide unlimited legal access to termination, such as California, Washington, Oregon, Alaska, New Mexico, Minnesota, Illinois, New York, New Jersey, Maryland, Massachusetts, Vermont, Maine, and Connecticut had on average a population that was 64.64% Christian and 4.07% Atheist. The rate of Christianity is nearly six percentage points lower than that of the U.S. average, while the rate of Atheism is nearly 1 percentage point above the national average (Pew Research Center). Through this examination of religion in America, it becomes evident that higher Christianity rates generally correlate with lowered access to terminations, as the Christian population votes for legislators they deem to share their values. Beyond this, such a correlation also indicates how religion, namely, Christianity, might spur certain social taboos surrounding terminations that impact citizen access to sexual and reproductive healthcare.

China demonstrates, in contrast to the U.S., the role of atheism in influencing access to terminations, given that, as previously established, terminations at all stages of gestational development are legal in China. In terms of religion, Article 36 of the Chinese Constitution states that "citizens of the People's Republic of China enjoy [the] freedom of religious belief. No state… public organization, or individual may compel citizens to believe in, or not believe in, any religion; nor may they discriminate against citizens who believe in, or do not believe in any religion," and that "the state protects normal religious activities," which are essentially any of five religions recognized by the Chinese Communist Party (CCP): Buddhism, Daoism, Islam, Catholicism, and Protestantism. There are certain boundaries on religious practices, however ("No one may make use of religion to engage in activities that disrupt public order, impair the health of citizens or interfere with the educational system of the state").

The CCP itself is an atheist body, and although five separate religions are recognized, it appears that the influence of the CCP is strong. Published by Pew Research Center, Committee of 100 (C100), an independent organization composed of Chinese-American citizens, reported on a 2007 study conducted by Horizon Research Consultancy Group, which revealed that only around 14% of Chinese adults were religious, the majority of which were Buddhist (at 12%). 2% were Christian– evenly divided between Catholic and Protestant, and less than 1% of adults identified as Daoist or Muslim (Pew Research Center May 2008). However, despite these numbers, it's important to note that some Chinese citizens may uphold values embedded in religion, while not identifying or attaching themselves to any religious institutions. Unlike the U.S., the Chinese government is not democratic, therefore the values reflected in its policies are those of its Atheistic governing party, not its citizens.

With Atheist-to-Christian rates so polarized between the two nations, one can conclude major differences in culture, and by noting nearly equally polarized legislation on terminations, one can conclude both that the religious aspect of culture may find a correlation with such health policies, and that a greater Christian population will generally pair with limits on terminations.

Of course, religion is not the sole determinant of the consensus or divide over policy– a nation's values also influence its society. Though having seemingly lost significance over time, a look at a nation's founding may reveal the values and principles behind its government structure.

History and Historical Values.

In China, after the Civil War established national control of the Chinese Communist Party (CCP), party leader Mao Zedong took charge, brutally and tyrannically enforcing policies for the budding nation centered around the Communist values of collectivism and authoritarianism, often to disastrous avail. Mao focused on rapidly industrializing and modernizing the nation, enforcing harsh quotas upon citizens, indicating a budding utilitarian outlook (The Life Guide Dec. 2021). As a result, women's lives dramatically changed under Mao, as they began involvement in the workplace– a role that greatly contrasts the culturally patriarchal nation China was before (Gao Sept. 2017). Though Mao's reign ended

in the late 1970s, the mark he left on Chinese culture lingers– what remains is a value for the community, the greater good– and although the power of an individual ruler has somewhat subsided since, the Chinese citizenry is still subject to an undemocratic, authoritative government, which influences society through its legislation (The Life Guide Dec. 2021).

The modern United States still adheres to the government structure and principles designed by its founding fathers 240 years ago. Wary of the dangers of a monarchical rule, writer of the Constitution James Madison drafted a democratic government system, where the citizenry would have power on an unprecedented level during the 18th century. But with this newfound democracy would come a rigorous legislative process, which required a two-thirds majority vote from elected legislative bodies to pass laws, slowing the process as a value for the people's favor trumped action– a conflict that still plays a role in modern-day policy debate. Individualism is also a key characteristic of American culture, borne from the expectations of the Bill of Rights– a document securing American individual rights over the government (Brinkley 2017). In summary, modern Chinese history suggests a societal value for the community, while American history indicates a general value of the individual.

Women's Role in Society

Data may offer insight into the general societal view of women in a nation, which is integral to assessing how that nation's culture might influence access to sexual and reproductive healthcare. The World Bank found that while mothers in China are not guaranteed the same workplace position after maternity leave, while American mothers are offered more protections (The World Bank), indicating a difference in women's values– in China, it seems as if women are pressured to remain in the workforce rather than pursue motherhood, whereas, in the U.S., workplaces offer women more support in pursuing motherhood. Furthermore, though neither nation explicitly mentions gender in its Constitutional nondiscrimination clause, women from China and women from the U.S. play an active role in government, with the percentage of legislative seats being occupied by women at 24.2% and 19.4% respectively (The World Bank Aug. 1998).

Though the culture of either nation cannot be summarized quickly, as it pertains to this research paper, the essence of American culture tends to be more individualistic and Christian, whereas China is more collectivistic and Atheistic. American society seems to place greater emphasis on women as mothers, whereas Chinese society appears to pressure women to fulfill the role of workers.

Accessibility to Sexual and Reproductive Healthcare

To determine true citizen accessibility to sexual and reproductive healthcare, namely birth control, this paper examines the legality, education policy, and usage regarding contraception and terminations.

Legality

One must first assess the legality of widespread access to contraceptives and terminations to determine accessibility. In China, the law surrounding sexual and reproductive healthcare is simple: Contraceptives (condoms, IUDs, sterilizations, etc.) are not only legal, but free of charge (Perkins, et al. 1980), and terminations are legal with no suggested gestational limit (Center for Reproductive Rights). The history of birth control legislation hints at a general trend of accessibility: Shortly after an overpopulation crisis, the CCP enacted the first of three family-planning policies in the late 1970s– the infamous one-child policy (per family), which effectively controlled Chinese population growth and fostered economic recovery through its strict enforcement. However, such strictness prompted widespread forced abortions, sex ratio imbalances, and female infanticide (Hesketh Jun. 1997). In 2015, the one-child policy would evolve to become a two-child policy to deal with population aging, before the CCP would enact the three-child policy in May of 2021. Two months later, the CCP repealed all family-planning policies, but the history of these policies is not entirely irrelevant to China's modern state of termination and contraceptive usage (Fitzpatrick Jul. 2009).

In the United States, citizen access to contraception and terminations has been almost entirely dictated by landmark Supreme Court cases, each setting a legal precedent for Constitutional interpretation– as opposed to a legislative initiative, which amends the Constitution directly. The 1965 Supreme Court ruling of Griswold v. Connecticut determined that citizens were entitled to a Constitutional "right of privacy," marking the beginning of an era that would spur legal precedents in favor of federal access to sexual and reproductive healthcare, beginning with contraceptives and later extending to terminations with the Supreme Court ruling of Roe v. Wade in 1973. The Summer of 2022, would see an overturning of the latter case in Dobbs v. Jackson Women's Health Organization, reverting the individual right to terminations back to state legislatures, while federally mandating accessible abortions for cases of medical exceptions. As of November 2022, 13 states have enacted full bans on abortion, and 5 have enacted partial bans (20, 18, 15, and 6-week bans based on one's LMP, or date of one's last menstrual cycle) (The New York Times Nov. 2022). These states, as previously established, tend to be spread throughout the South and Midwest of the nation, and are far more religious (with a greater Christian population) than China. All other states have either blocked legislative attempts to ban abortion or retain either complete or limited legality by banning state abortion funding, etc. These states tend to be geographic to the North of states banning abortion, and, as previously established, have higher atheism rates than their legal opposites.

In essence, though contraceptives are legal and unchallenged in that legality, there is a great divide between the two nations in terms of termination policy, and even within the American states. Terminations are far more accessible in China than in the U.S., and within the U.S., accessibility varies in concurrence with state geography and religion.

Education

Accessibility is not purely limited to legality. Contraceptives and terminations are accessible in part due to education programs that make citizens aware of the sexual and reproductive healthcare available to them. By examining the state of sexual education in both nations, one can better assume the state of accessibility.

In 2008, China enacted a policy that required up to fourteen hours of health education per year at all educational levels, and within that, required sexual education. Objectives were to provide information on premarital sex, self-protection, sexual assaults, as well as HIV and AIDS– which of course are all vital in terms of raising student awareness of sexual and reproductive healthcare, however, a study found that given the lack of assessments in health subjects, Chinese schools tend to lightly cover such topics. Furthermore, evidence-based programs do not exist, and government evaluation of these health courses is insufficient (Leung, et al. Feb. 2019). Beyond school, a 2007 study revealed the following on adolescent sexual education: "Sources of sex knowledge among adolescents on various topics (puberty, sexuality, and STI/HIV/AIDS) differed by the level of taboo associated with these topics in Chinese culture. The percentage of adolescents obtaining knowledge for puberty, sexuality, and STI/HIV/AIDS from teachers declined by topic (45.4, 30.7 and 18.4 percent, respectively), while the percentage of adolescents obtaining knowledge from television/movie increased by topic (6.7, 12.2 and 27.5 percent, respectively). Adolescents obtained knowledge on topics with less taboo (e.g. puberty) from teachers and obtained knowledge on topics with more taboo (e.g. sexuality, STI/HIV/AIDS) from mass media, such as movies or TV shows. Parents were the primary source for sex knowledge on less taboo subjects. Doctors were the primary source for STI/HIV/AIDS knowledge. Sexually active adolescents obtained sex knowledge mainly from peers or mass media, while those adolescents who were not sexually experienced identified teachers and parents as the main sources of sex knowledge" (Zhang, et al. 2007). This clarifies the state of Chinese society regarding sex knowledge matters and hints that citizens are likely granted privacy when it comes to matters of sexual and reproductive health, furthering accessibility as people, though potentially misinformed by mass media, have personal autonomy in their decisions.

In America, the state of sexual education is slightly more complicated– there's no official federal policy, thus standards vary by state. Sexual education is often woven into Physical Education programs, and objectives include providing information on anatomy, human reproduction, sexual abuse, gender identity, sexually transmitted diseases, and infections. These programs also aim to promote healthy attitudes toward

human sexuality and empower youths to define and pursue healthy relationships. Abstinence and safe sex are also encouraged. Though similar to China, few evidence-based programs exist. Unlike China, America conducts strong evaluations of these courses (Leung, et al. Feb. 2019). Furthermore, there are seemingly fewer taboos around sexual education in American society, as a 2017 Guttmacher Institute report found that "In 2011–2013, 70% of males and 78% of females aged 15–19 reported having talked with a parent about [either]... how to say no to sex, methods of birth control, STDs, where to get birth control, how to prevent HIV infection [and/or] how to use a condom," and that "'Formal' sexual health education… generally takes place in a structured setting, such as a school, youth center, church or other community-based location [and] is a central source of information for adolescents" (Guttmacher Institute 2017), highlighting the culture around sexual education: American society seems less reserved (compared to Chinese society) when it comes to such discussions, with adolescents not only largely freely conversing with parents on the matter, but also learning primarily in public settings. However, this may also hint at how the American population is more subject to these outside influences (from schools, youth centers, churches, etc.) when it comes to making personal decisions.

In summary, standards of sexual education are slightly different in each nation, with China's societal taboos perhaps slightly influencing the nation's lacking sexual education compared to the US. Members of Chinese society seem less inclined to discuss matters of sexual and reproductive health compared to American society, thus potentially allowing its citizens more privacy regarding personal decisions. Meanwhile, in America, such taboos do not exist, perhaps indicating less autonomy and personal choice regarding contraception and terminations for its citizens.

Usage

Legality and education are all very important, however, nothing demonstrates accessibility more directly than citizen usage. If citizens are not using what's available to them despite legal and educational support in a nation, the country's societal influence becomes apparent.

In 2019, the UN, drawing from "contraceptive prevalence by individual methods for 164 countries or [areas] that [had] at least one survey estimate available since the year 2000," explained in its Contraceptive Use by Method 2019 Data Booklet that, based it's the latest survey of 342,920 Chinese women aged 15-49 in 2017, the contraceptive prevalence rate was 69.9% among the population in 2019. IUD was the most common form of contraceptive (at 26.2%), closely followed by male condoms (23.2%), then female sterilization (14.1%,) birth control pills (2.4%,), male sterilization and rhythm measurement (1.1%,), other methods not mentioned in the survey (0.9%,), withdrawal (0.6%), and implants (0.2%). There was no predicted prevalence of injectable contraceptives. That same study demonstrated that, based on the latest survey of 74,685 American women aged 15-49 in 2015, the 2019 prevalence rate of contraceptives among the same population was 61.4%, with female sterilization and birth control pills being the most common forms of contraceptive (13.7%) followed by male condoms (9.3%), IUDs (8.3%), withdrawals and male sterilization (4.3%), implants (2.7%), injectable contraceptives (2.3%), rhythm measurement (1.4%), and "other methods" (1.6%). The general trend between the two nations is that American women seem more reluctant to use contraceptives than Chinese women. Although women from both nations commonly use temporary methods of birth control (male condoms in China and male condoms and birth control pills in the U.S.), it appears that certain methods such as IUD and female sterilization are more prevalent in China, where women will not have to pay expenses.

With the influence of legislation set aside, the divide between the 2.4% of Chinese women and the 13.7% of American women who prefer the pill (a temporary and easily removable form of contraceptive) furthers the notion that the societal value of women as mothers is greater in America, as Chinese women seem to prefer more permanent or difficult-to-remove methods. A 2022 estimate by the World Bank calculated the rate of unmet contraceptive needs in percentage points for married or in-union Chinese women aged 15-49. The median value was 3.3%. As for American women of the same age and status, the study estimated that the median value was 5.5%. Among the same demographic, the median rate of women with unmet needs for family planning was 14.7%, and their Chinese counterparts faced a

far lower median value of 5.0% (The World Bank). The needs of women are not as different from the polarized nature of sexual and reproductive healthcare accessibility and culture between the two nations. It appears that these rates are a demonstration of such differences and their effects.

The number of abortions that occur in China trumps American numbers as well. While China averaged 9.7 million abortions per year from 2014 to 2018 (Liu, et al. Sept. 2021), America averaged around 630,000 abortions per year during that same frame (Kortsmit, et al. Nov. 2020) Given that these are numbers from years before the overruling of Roe v. Wade in America, the great difference between the two nations is evidence of individuals' reluctance, as opposed to legal restrictions.

Conclusion

In essence, it's evident that culture, particularly a nation's religious beliefs, historical values, and attitude toward women bears some correlation with access to sexual and reproductive healthcare (laws around terminations and contraceptives, widespread sexual education, and use of terminations and contraceptives). The U.S. demonstrates that widespread Christianity, individualism, and openness regarding sexual and reproductive health correlate with lessened access, if not at least controversial access. China demonstrates that widespread Atheism, collectivism, the value of women as workers, and reluctance towards conversations about sexual and reproductive healthcare correlate with greater access.

Limited access is damaging: not only will families be forced into futures unfavorable and potentially detrimental to them, but women, in particular, will face the dangers of either losing an amount of personal autonomy or opting for dangerous "back alley" procedures (Roeder Dec. 2021). Additionally, children born into families not yet ready to nurture them will face significant disadvantages. Overall, this is a matter of human rights– namely, the right to equal opportunity and treatment regardless of gender (SDG 5), and by extension the right of all to accessible contraceptives and terminations (SDG 3).

Yet even with this rationale present, it seems that little progress has been made as of late (regarding the U.S. Supreme Court decision, which overturned the federal right to terminations for at least the first semester). Rhetoric is powerful on parliament floors– but to truly incite change, one must understand the complexities and weight behind the issue. Evolving access to sexual and reproductive health either must include or result in some form of cultural change. And to acknowledge this is to understand what policy evolution ought to truly entail.

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New Home Court: How Political Relationships and Economic Motivations Shaped the Experiences of Chinese NBA Players in the United States in the Early 21st Century

By Angel Guo

Author Bio

A Bay Area native, Angel Guo is currently a senior at Phillips Exeter Academy in Exeter, New Hampshire. She is a writer, author, and researcher who is interested in the intersection of history, economics, politics, and race studies. Passionate about social justice and innovation in empowering marginalized communities and promoting diversity and inclusivity, she founded Bouncing Back, a youth-led social venture that uplifts underrepresented AAPI student athletes worldwide, while also serving as the Editor-in-Chief of its print magazine 'Beyond Boundary.' Angel is also an avid cook and sports fan enjoying exploring different recipes and reading ESPN in her free time.

Abstract

Like many other American businesses, The National Basketball Association (NBA) has gradually capitalized on China's enormous market potential since the establishment of the Open Door Policy. At the turn of the century, the NBA exploded in international popularity with the introduction of three native Chinese basketball players onto its rosters. This paper delves deeper into the dynamics between the NBA and the Chinese trio, Wang, Yao, and Yi, as not only foreign athletes, but as reflections of US-China relations. Through a chronological and correlational exploration of this relationship, the paper argues that while the NBA grew economically by expanding into Chinese markets, Chinese athletes in the NBA faced both political barriers exiting China and increased cultural pressures once in the United States. The experiences of these athletes serve as a microcosm of the intricate interplay between economics, politics, and culture in the context of international relations. This research concludes that the Chinese athletes were used both as economic pawns by the NBA and diplomatic pawns by China, highlighting the relevance of sports as a lens through which to navigate and understand the complexities of global affairs.

Keywords: Sports, Basketball, NBA, Asian American, China, United States, Global, Political, Economic, Cultural

Introduction

In October 2011, fifteen thousand Chinese citizens stood outside a venue at 9:00 am for a 4:00 pm event (Ding, 2017). When an entourage of black vans pulled up, the horde flocked to the vehicles, crying and kissing the windows. One would think the cars contained the Chinese president, a famous movie star, or even God, but it was Kobe Bryant, American National Basketball Association (NBA) champion of the Los Angeles Lakers. Equally passionately, Kobe embraced his fans, having visited China for eight consecutive off-seasons. Across the Pacific Ocean, Chinese native NBA player Yao Ming had been received with equal vigor by American fans in 2002. From coast to coast, American citizens donned the number eleven jersey of that year's first overall draft pick.

The above scenes demonstrate a strong US-China affinity based on the two nations' shared passion for basketball. This affinity would have been impossible without China's economic advances beginning in the late 1970s. After three decades lacking in formal international relations, Vice Premier Deng Xiaoping committed China to economic and political reform, "open[ing] its door and never clos[ing] it again" (Reagen, 1987). With the opening of lucrative Chinese markets to globalization, American political leaders sought to capitalize on the opportunity. In a 1984 speech, President Ronald Reagan noted that foreign investment priorities for the United States included the expansion of private corporate ventures with China (Reagen, 1984).

Like many other American businesses, the NBA strove to expand into China due to the economic potential presented by its vast population. The NBA, which was founded in 1946, first started interacting with China and its citizens in the 1980s through broadcasting its games across the Pacific (Zhang, 2017, p. 84). Over the next two decades, NBA Commissioner David Stern facilitated a strategic infiltration of Chinese media until the NBA became a daily TV staple for millions of Chinese citizens. At the turn of the century, the NBA exploded in popularity with the introduction of Chinese native basketball players onto NBA rosters. Seeing Chinese fans' attachment to American superstars such as Michael Jordan, NBA recruiters scouted China for hometown heroes—mostly notably Yao Ming, Wang Zhizhi, and Yi Jianlian.

The NBA's expansion into China created complex experiences for its Chinese athletes in the early 2000s; Yao, Wang, and Yi's careers reflect a long history of political and economic tensions between China and the US. While the NBA grew economically by expanding into Chinese markets and by showcasing and profiting from Chinese players, the athletes faced both political barriers exiting China and increased cultural pressures once in the US. Through their trials as prospects, experiences on American soil, and finally retirements from the NBA, the Chinese trio show how international political dealings and economic motivations pervade all industries, including professional basketball.

US-China Relations Before and After 1978

Prior to the 1980s, however, the two nations maintained a weak economic relationship due to a lack of formal political relations and China's isolationism. The Cultural Revolution, which lasted from 1966 to 1976, promoted nationalism while sacrificing living standards and self-expression. During the Mao-led revolution, Chinese businesses avoided interaction with the US. American products were often imported from other nations rather than bought directly, even if American companies offered superior bargaining (Guo, 2010, p. 163).

After this decade of national economic decline, Chinese leaders began to realize that imposed economic isolation would widen the gap between themselves and other leading nations. In 1978, newly-elected Vice Premier Deng Xiaoping proposed his "Open Door Policy," which would transform China's economy into one committed to reform and growing relations with outside nations (Huan, 1986, p. 1). Deng's policy established Special Economic Zones, which supported foreign trade and investment (Huan, 1986, p. 6). The following year, the US and China established formal diplomatic relations, ending a thirty-year period of estrangement (Guo, 2010, p. 19). This arrangement, which included a significant trade agreement, led to a swift and considerable expansion in bilateral trade. (Guo, 2010, p. 20).

Starting in 1980, the American government and economy capitalized on China's new stance, and

the following decades consisted of frequent state visits and partnerships. While economic negotiations were often halted by political hurdles such as the 1989 Tiananmen Square incident, American leaders remained dedicated to maintaining their newfound relationship with the eastern nation. President Bill Clinton, who served from 1993 to 2001, targeted US-China relations through a "strategic collaboration" approach (Guo, 2010, p. 19). During the Clinton administration, landmark trade developments such as China's long-awaited 2001 entrance into the World Trade Organization brought the two countries' economies closer. By entering the WTO, Chinese businesses gained access to worldwide economic expansion, and foreign companies were allowed to directly interact with Chinese companies without government intermediaries. This decision greatly expanded trade between the United States and China, with the percentage of American exports to China rising from $19.2 billion to $65.2 billion from 2001 to 2007 (Guo, 2010, p. 105). This 340% increase demonstrated that Chinese citizens were increasingly invested in American products and amenities.

Clinton's successor, President George W. Bush, initially presented a more strict 'strategic competition' framework regarding US-China foreign relations. After the 9/11 attacks, however, China collaborated with the United States in the War on Terror and Bush reverted to his predecessor's more synergetic stance on China (Roberts, 2011, p. 57). In 2006, President Bush and Chinese President Hu launched the U.S.-China Strategic Economic Dialogue (SED) to further expand political, economic, and social discussion. By 2010, after years of collaboration and competition, China had joined the United States as one of the most widely recognized global powers.

Basketball and the NBA in China

As the two countries joined in economic partnerships, professional sports sought to profit from this new relationship. In 1891, Educator James Naismith invented basketball in the Springfield, Massachusetts, Young Men's Christian Association (YMCA) by nailing a peach crate to a wall (Polumbaum, 2002, p. 184). YMCA dispersed around the globe, spreading reformist ideals and promoting both spirituality and athleticism. YMCA missionaries introduced basketball to China soon after in 1895 to 1896 as a way for young Chinese men to exercise their bodies alongside their minds (Polumbaum, 2002, p. 186). The game grew more popular in China over the years, surviving a civil revolution and the formation of a new republic. Chou En Lai, the People's Republic of China's first prime minister, publicly promoted basketball as it promoted both fitness and teamwork (Blinebury, 2016). During the Cultural Revolution of the mid 1900s, basketball was the most popular form of recreation for communist soldiers and had become the most widespread physical activity in China (Polumbaum, 2002, p. 197).

Basketball's professional side saw substantial growth with the NBA's increasing presence in China in the late 1900s. Professional sports leagues sought to capitalize on China's promising markets after the enactment of the 1978 Open Door Policy. To target China's rapidly-growing television industry, in the late 1980s, NBA commissioner David Stern offered free content to CCTV, China's government-run TV channel, to encourage media collaboration (Zhang, 2017, p. 84). Basketball especially appealed to younger viewers; one survey showed that it was the most popular spectator sport and sport played (Polumbaum, 2002, p. 202). In the 1990s, Chinese media began broadcasting all regular season, playoff, and All-Star games (Zhang, 2017, p. 84). To maintain support from the Chinese government, the NBA helped found the similarly-modeled Chinese Basketball Association (CBA) in 1995. During an interview, commissioner Stern noted that "we have committed to work every way possible [with] the CBA … to help it perform to its potential and develop young [Chinese] basketball players" (Polumbaum 2002, 204). By the turn of the century, the NBA's success in China fueled the league's globalization mindset to such an extent that the website unabashedly read: "The sun never sets on the NBA." (Polumbaum, 2002, 204).

The NBA's grip on China skyrocketed with the introduction of "hometown heroes." As the NBA's presence became pervasive in China in the 1990s, the world fell in love with Chicago Bulls guard Michael Jordan. Chinese fans and nonfans alike dubbed the superstar "the man who can fly" (Blinebury, 2016). Upon his retirement in January 1999, Jordan's face was plastered on over a quarter of China's newspapers' front pages (Polumbaum, 2002, p. 206). American companies noticed that Chinese fans were more devoted to players than the game itself and understood that profit was directly linked to exposure of heroes.

As a result, the NBA fervently scouted Chinese athletes in hopes of finding a national icon who could effectively appeal to American and Asian culture and increase the league's audience. Firms such as Nike and IMG, a sports marketing company, began to hold exhibition games in China in hopes of finding a future NBA player ("Boxed Out," 2010). In the 2000s, the NBA achieved its goal by drafting CBA stars Wang Zhizhi, Yao Ming, and Yi Jianlian to join the limited ranks of Asian NBA players.

Pre-21st Century Asian-American NBA Players

The world these Chinese players joined was historically inhospitable, as the NBA's relationship with Asian players reflected a long history of hostile racial attitudes in the US. Since Asians arrived on America's west coast in the 1800s to join the growing labor force, they have been subject to racial discrimination throughout daily life as well as in the legislature. Over the ensuing decades, distinct periods of racism towards certain Asians have prevailed: Chinese immigrants were excluded from the country during the 1800s, the Japanese were discriminated against and interned in camps during World War II, and South-East Asians were targeted during the Vietnam War (Lee, 2015, p. 2-3). Additionally, Asian athletes who played sports had to contend with stereotypes of physical inferiority such as the model minority myth, which paints Asians as having strong minds but weak bodies (Lee, 2015, p. 374). These stereotypes created additional obstacles for Asian athletes to overcome.

Prior to the twenty-first century, representation of Asian athletes in the NBA was minimal. Only three notable players made their mark in the league: Wataru Misaka, Raymond Townsend, and Rex Walters. Their careers were filled with struggles with racism and prejudice as they battled to defy stereotypes. Misaka, a Japanese-American, broke the NBA's color barrier in 1947 amidst strong anti-Japanese sentiment following World War II. Growing up, Misaka was called a "Jap" and told to "go home" (Goldstein, 2019). While playing collegiate basketball for the University of Utah, he was described in the New York Times as "a 'cute' fellow intercepting passes ("1944 NCAA," 1944). Such belittling language followed the five foot seven Misaka to the NBA in 1947 when he debuted with the New York Knicks, where he only played three games before being cut (Misaka Will Leave, 1947).

Twenty years after Misaka, Raymond Townsend, a Filipino-American, stepped onto the court. He grew up facing anti-South-East Asian sentiment primarily due to increased immigration levels after the rise of Asian communist regimes. Townsend, a star player at UCLA who was drafted twenty second overall by the Golden State Warriors in 1978, stated that "I could tell people I was Filipino all my life and nobody would believe me because Filipinos aren't good basketball players" (Iyer, 2020). Townsend's contemporary, half-Japanese player Rex Walters, did not face racial discrimination. A two-time All-Big Eight selection and sixteenth overall pick in the 1993 draft, Walters' white-passing appearance was likely a key factor as to why anti-Asian racism did not define his career ("Nets Make Walters," 1993). The experiences of Misaka, Townsend, and Walters serve as an important backdrop for the NBA's role in the intersection of race and politics.

Getting to America

Unlike these Asian-American trailblazers, the experiences of native Chinese players symbolized less these trends in racism but reflected US-China political and economic conflict. Hailing from a country with a vastly different political system and cultural background, the athletes found themselves caught in the crosscurrents of geopolitical tensions. Their presence in American sports became a reflection of the broader issues surrounding the United States' relationship with China, encompassing specific economic conflicts and overarching ideological differences. Despite their individual talents and achievements, the Chinese trio faced heightened scrutiny and pressure due to their nationality. Every success or failure on the field became a potential talking point in the larger narrative of US-China relations, demonstrating the relevance of using sports as a lens through which to view international dynamics.

Following the NBA's commitment to drafting Chinese native players, the league targeted CBA star Wang Zhizhi as the first national hero. Wang, who stood at seven foot one and was a star player on the Baiyi Rockets and Chinese national team, had won six CBA championships in the 1990s ("A Great Leap",

2001). Unlike other CBA teams, the Rockets were affiliated with the Chinese army, and Wang became a bargaining chip between American and Chinese interests. NBA teams understood that Wang needed release from the military, which did not want to let go of its best player, yet the Dallas Mavericks were willing to risk the loss of a draft pick if he were denied release. In 1999, the Mavericks drafted Wang at thirty-sixth overall despite his lack of clearance (Price, 1999, p. 55). When Mavs owner Ross Perot Jr. flew to Beijing, he was not even allowed to meet Wang, much less bring him to Dallas. Rockets manager Qian Limin addressed Perot, stating that "we can't let him go, because it's not the right time, either for our team or Wang himself." (Price, 1999, p. 55).

After two years of debate, however, the Chinese government relented as they sought positive publicity well in advance of hosting the 2008 summer Olympics, calculating that Wang would boost his nation's popularity. Triumphant, Nelson declared that Wang's permission to join the NBA could serve as a "model of how our two countries can get things done—by building trust and relationships" ("A Great Leap", 2001). The Mavericks' dedication to obtaining the NBA's first Chinese professional emphasizes how cultural and political disagreements can interfere when businesses seek to expand into China. Ultimately, while the CBA feared losing control of their best basketball athlete, they finally allowed Wang to play in the NBA due to external pressures in the increasingly global political climate.

Capitalizing on Yao Ming

After Wang departed for the U.S. in 2001, the NBA looked to Shanghainese hero Yao Ming. Born to two basketball stars, Yao joined the Shanghai Sharks CBA junior team at fourteen. Yao's international fame increased exponentially in the mid 1990s as he averaged over thirty points and eighteen rebounds per CBA game (Lago, 2002). As the 2000s approached, Yao was the most anticipated NBA prospect, with Commissioner Stern noting that "kids are going to want to be like Yao" (Fatsis et al., 2002).

In 2002, Yao's Sharks won the CBA championship. The Sharks announced that Yao would be allowed to join the NBA, forgoing the years-long negotiations that occurred with Wang. The disappointed CBA immediately passed a rule stating that "a player must use a Chinese agent to negotiate his way to another league" (Bucher & Ming, 2004, p. 76). While the ensuing talks were more streamlined, Yao stated he felt like the league "could control me, like I was something of theirs that could be sold" (Bucher & Ming, 2004, p. 77). Yao also noted that instead of being proud of a famous athlete, "the old CBA thought he'd be too hard to control" (Bucher & Ming, 2004, p. 92), reflecting the Chinese government's authoritarian tendencies. After weeks of discussion, Yao was ultimately given the green light at 2:00 am on draft day, and was chosen as the first overall pick of the Houston Rockets. Once across the Pacific, Yao began to serve as more than just a professional athlete.

American companies quickly saw that Yao's unique physique indicated his enormous economic potential. Yao exposed China's vastly-expanding economy to Western markets, bringing tremendous value for the NBA and American economy. In the United States, his regular-season games pulled in roughly 1 million viewers, but in China, they garnered as many as 30 million viewers, establishing the Houston Rockets as China's favorite team and the most-watched globally (Larmer, 2005). In 2002, "500 million Chinese tuned into Yao's NBA debut on television," and subsequent league viewership levels increased steadily (Keeler & Nauright, 2005, p. 204). Statistical evidence from 2012-2013 show that the NBA's Chinese website rose by 34% in page views, demonstrating that Yao left his mark on NBA viewership as a whole, as his influence even in his retirement continued to build upon the viewerbase he solidified (Cabral, 2010, p. 5). In 2003, Time Magazine named Yao one of the Top 100 most influential people of the year, and he was projected to become the world's most marketable individual athlete (Fatsis et al., 2002). In 2003 alone, Yao earned over $10 million from American endorsements through brands including American Express and Apple. Yao became an international superstar with global appeal and marketability catalyzing economic growth on both sides of the Pacific.

Furthermore, Yao embodied a mode of new global capitalism from China that benefited Chinese foreign relations. Yao became the figurehead of the China Global—a concept that promoted Chinese cultural superiority to boost the nation's international standing (Wang, 2004, p. 267-278). Yao, who towered over his American teammates at seven foot six, was

perceived as a spectacle of 'bigness' aligning with the demands of global capitalism and fulfilling China's nationalist aspirations. Yao changed the perceptions of an entire population, painting his home nation as a political and cultural powerhouse.

Even after retiring from professional basketball, Yao has continued to serve as an ambassador for basketball and promote US-China collaborations. In 2011, the Rockets scheduled Yao's jersey retirement coincidentally on the first day of Lunar New Year (Watkins, 2017). In 2014, Yao cemented himself as a political figure by attending the US-China SED, where he met with United States Secretary of State John Kerry and served as an intermediary between the two nations while discussing efforts to combat wildlife trafficking (Barron et al., 2021, p. 37). In 2017, Yao was elected as the chairman of the CBA and declared his primary goals to be expansion and globalization as well as furthering China and the CBA's relationship with the NBA (Cohen, 2019). The new NBA commissioner Adam Silver celebrated Yao's election as it would allow the NBA to expand into the "league's most lucrative foreign market" even further (Isidore, 2019). Silver's hopes continue to be fulfilled—in 2022, the number of Chinese NBA fans was more than double the number of American citizens (Deb, 2022). Yao Ming's trajectory post-retirement demonstrates how the Chinese NBA players become not only athletes, but arbiters of economic and political interests.

Experiences Marred by Political and Economic Tension

While they also were commodified by the NBA and other companies, Yao's counterparts Wang and Yi most prominently faced cultural and political struggles in America and upon return to China. In Dallas, Wang struggled to acclimate to the NBA's more aggressive style of play. Despite his towering height, Wang's teammates jokingly questioned his ability to dunk, asking, "Can he even get up there?" (Anderson, 2002). Although coaches and staff sought to make Wang comfortable, his language and cultural barriers eclipsed his athletic abilities and prevented him from making a tangible impact on the court. When Wang severed ties with China's national team in order to stay in the US, he caused an uproar in his home nation, with spectators characterizing him as a traitor of the state ("Unpatriotic Star," 2002). As China's presence on the global stage soared, so did Chinese patriotism, and upon the end of his unsuccessful NBA career and subsequent return to China in 2005, Wang was forced to issue an apology for abandoning his home country ("Expelled Basketball Star," 2006). On the CBA website, Wang's statement read: "I was young and immature … I made a very wrong decision … through these years of painful reflection and with the help of leaders of the army and the CBA, I have deeper recognition of the mistakes I've made in the past ("Expelled Basketball Star," 2006). This highly-politicized proclamation painted Wang as a possession of the Chinese government. Wang's Chinese nationality subjected him to special conflicts not imposed on international athletes from other countries.

Meanwhile, Yi's experiences differed from his elders, as his slightly later career subjected him to less control from the Chinese government but more pressure from fans on both sides of the Pacific. Due to Yao's success, Yi was strongly scouted by the NBA, even as a teenager. One shoe company executive admitted that, while Yi's appeal was "partly the Yao Ming effect," the young athlete was "so promising we would have pursued him anyway" (Larmer, 2003). In 2007, Yi declared for the NBA draft. Chinese officials, who had experienced the process previously with Wang and Yao, came up with a list of demands for the NBA, such as allowing Yi to stay in shape for the 2008 Beijing Olympics (Gardner, 2007). The second request, which coincided with Yi's personal demand—namely, to play in an American city with a significant Asian population—highlighted a cultural pride that has been rarely displayed by Asian professional athletes (Tadishina 2011). Yi was ultimately chosen sixth overall by the Milwaukee Bucks, and his selection was described as "another great example of cooperation between the CBA and the NBA" (Gardner, 2007). In 2008, after two successful years with the Bucks, Yi was traded to the New York Nets, fulfilling his wish of playing in a community with a large Asian population (Tadishina, 2011). The situation was a win-win, as the Nets were glad to use Yi to connect with Chinese fans.

However, Yi simultaneously faced intense pressure under the shadow of Yao. The elder statesman even fueled these flames, remarking that Yi "may be better than me" after the latter scored nineteen points and recorded nine rebounds in a game against Houston (Ludden, 2007). Although complimentary on the surface, these comments also may have invited greater

scrutiny — and greater stress for Yi. After Yao's celebrated retirement in 2011, Yi's burden increased, as he was the only Chinese national on the American court—a proxy for China's continued success on the world stage. Not only did he face pressure from millions of cross-national fans, but Yi's situation also positioned him as a target for multiple corporations to economically exploit—using his unique position to gain capital from China's market. Yi's experience aptly demonstrates the challenges faced by foreign athletes who serve as the sole representative of their entire countries.

Why there is a Modern Lack of Chinese NBA Stars

Following Yi's release from the NBA in 2012, very few Chinese-born athletes have joined the American league. Despite efforts to increase the NBA's popularity in China and relative media success, this recent lack of Chinese native basketball players has puzzled many industry insiders. In 2017, commissioner Silver noted that "it frustrates me that there are no Chinese players in the NBA right now… there's probably more basketball being played in China than anywhere else in the world. And more NBA basketball is being watched in China than anywhere else in the world" (Maloney, 2017).

One explanation for this lack of Chinese NBA players could be the increased tensions between China and the United States. Starting in the 2010s, China's economy had caught up with that of the United States, raising tensions between the two most powerful nations. The United States accused China of pursuing unfair trade policies and stealing scientific and technological knowledge and property ("A Quick Guide," 2020). Meanwhile, Chinese officials asserted that America ignored free trade rules to promote their own dominance ("A Quick Guide," 2020). As relations soured, a formal trade war began in March 2018 when President Donald Trump signed the "Presidential Memorandum Targeting China's Economic Aggression" (Rampton 2018). The two nations placed heavy tariffs on one another, which had major implications for the athletic industry. For instance, "the American government began collecting 15 percent of $112 billion in Chinese imports, on…basketball jerseys, basketball shoes, basketballs and even hoops" (D'Innocenzio 2020). Although the NBA expressed disappointment in the trade war, Commissioner Silver still noted that "we are at root an American company, and so we follow U.S. government policy" (Young, 2021). While the two nations agreed to roll back damaging tariffs in January 2020, the economic atmosphere remained tense. In May of 2020, the NBA looked to other nations, launching a high-potential Africa operation valued at $1 billion dollars (Young, 2021). Although this expansion does not constitute a divorce between the NBA and China, it may indicate a new era in which China, where the economy has plateaued and political friendliness cooled, is no longer the league's most favored market.

Additionally, individuals within the NBA furthered conflict with China by speaking out regarding a sensitive international issue. In 2019, Houston Rockets general manager Daryl Morey posted a message in support of the pro-democracy protests in Hong Kong (Deb, 2022). As retaliation, China pulled the NBA off state television, despite having broadcasted games since the 1980s. Although the league's leadership chastised Morey for his comments in an effort to placate Chinese interests, China kept NBA off the air until March of 2022. While Chinese fans still supported the American league through other streaming services during this hiatus, Chinese players were discouraged from interacting with the NBA.

One final possible explanation for the NBA's current lack of Chinese professionals could be the CBA's heightened appeal (and the NBA's lessened appeal) to Chinese-born athletes. In recent years, CBA salaries for domestic players have increased, providing an incentive to stay in China. For instance, Ding Yanyuhang, who played with the Dallas Mavericks summer league, would earn up to $280k in the NBA compared to $500k a year at home (Wong, 2017). Moreover, the CBA has been discouraging its athletes from joining the NBA. Sports journalist Alex Wong argues that "there's [no] financial benefit to CBA teams to nurturing these players with an eye to making them an NBA prospect" (Wong, 2017). If an athlete went to the NBA, the CBA the league would lose the profit and prestige attached to them. Perhaps, going to America is no longer the dream for Chinese basketball players. This phenomenon in the sports market reflects a larger trend in China's recent history, in which the nation is seeking to become more self-sufficient and an economic leader.

Conclusion

The NBA's strategic expansion into China starting from 1978 reflects the complicated yet increasingly interdependent—and perhaps recently distanced—relationship between the United States and China. The involvement of Wang Zhizhi, Yao Ming, and Yi Jianlian in the NBA provide a reflection of US-China political and economic relations, demonstrating shifting dynamics from the late 1900's to the present day. The political, economic, and cultural impact of these three athletes far exceeded that of any points, rebounds, or assists their athletic impact had on the league. Ultimately, the experiences of Wang, Yao, and Yi offer insight into how American businesses can use the professional athletics industry to promote positive relationships with China and other foreign nations. The Chinese athletes' presence in the NBA has become a reflection of the broader issues and interests surrounding US-China relations, highlighting the relevance of sports as a lens through which to view global dynamics.

Looking ahead, it is essential for all parties from the NBA to China to recognize the importance of adhering to the principles of international relations in order to forge meaningful progress. Recently, as bridge-building and alliances appear increasingly elusive, it has become imperative for sports organizations and figures to navigate the complex landscape of US-China relations with diplomacy. By upholding the rules of international engagement, fostering mutual respect, and seeking common ground, the two nations can continue to harness the power of sports as a unifying force, transcending political boundaries and fostering positive relationships. In doing so, they can pave the way for a future characterized by collaboration, cultural exchange, and shared understanding— on the courts and in the broader context of global affairs.

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Evaluating Resultant Moral Luck in Involuntary Manslaughter

By Zihan(Harrison) Huang

Author Bio

Harrison is a senior at Middlesex School in Concord, Massachusetts. Growing up in China and later coming to the United States to study, Harrison has experienced first-hand the differences between the two countries in their political, legal, economic, social, and cultural environment, differences that continue to inform him in his research and as a person.

Abstract

Humans are imperfect beings. Our success or failure in accomplishing something almost always depends to some extent on luck, an external factor beyond our control (Nagel, 1979). This paper examines different scenarios of involuntary manslaughter in which resultant moral luck, the moral luck concerning the consequences of an action, plays a role in affecting the outcome of an ordinary action, such as driving. The term "involuntary manslaughter" can be divided into three subcategories: unlawful act manslaughter (the defendant causing death with the specific intent for the relevant crime), gross negligence manslaughter (the defendant causing death due to gross negligence), and reckless manslaughter (the defendant causing death due to recklessness). While scholars agree that involuntary manslaughter often gets lighter sentences than murder, moral luck in all three types of involuntary manslaughter remain controversial topics in criminal law today (Mitchell and Mackay, 2011). The extent to which the luck and responsibility of the offender determines their culpability provides insights into criminal lawmaking and judicature.

Keywords: Criminal Law, Moral Luck, Involuntary Manslaughter, Differential Punishment, Legal Philosophy, Lawmaking, Judicial Review, Thomas Nagel, Andrew Ashworth, Barry Mitchell, R.D. Mackay

Introduction

Imagine two people driving on the streets. While one arrives safely at their destination, the other hits a pedestrian jaywalking across the street. The two drivers, albeit under the same conditions, face completely different outcomes. The lucky driver can enjoy their day, while the unlucky driver may face prosecution, fines, or imprisonment depending on the severity and culpability of the involuntary manslaughter and bear the guilt of killing a person. Now, would the justification for differential punishment change depending on whether they violated traffic rules? What if they were aggressive driving, an action that does not always constitutes criminal offense but violates the spirit of traffic rules?

Nagel, the American philosopher who studied legal philosophy and ethics and coined the term "moral luck," notes that giving a moral judgment is not to say an action is good or bad, but rather assessing the extent to which the outcomes of people's behaviors are their fault (Nagel, 1979). Following this logic, instead of giving a definite "yes" or "no" answer to the question of legal and moral culpability, I will approach the discussion of moral luck by analyzing whether two factors—1) ignorance of rules and 2) ignorance of circumstances—increase or decrease the culpability of an action. I will also create a standard for measuring culpability, the extent to which people should be blamed for the negative consequences of their actions, and using it as the basis for punishment. Because nuances in moral luck affect the outcome of people's actions, identifying them is critical to developing a criminal justice system that will better protect the public from harm in the future and the offender from being punished unusually harsh.

Thesis and Hypotheses

At its core, the debate on moral luck is a debate between two different schools of legal philosophy, consequences of the crime versus the state of mind of the offender (Mitchell and Mackay, 2011). A consequentialist who sees that the unlawful or harmful action has caused death, directly or indirectly, would argue that differential punishment is justified because harm has been inflicted on the victim. Even if the death is not causal, it is not completely due to bad luck because the offender has performed a risky action. On the contrary, to one who emphasizes the state of mind, or mens rea, of the offender, the offender may be excused from their crime given the unpredictable nature of the consequences of their action. If the offender does not have the malicious intent to kill the victim, they should not be blamed for the victim's death. Following this logic, only when the involuntary manslaughter arises from an unlawful action, the offender deserves differential punishment for their malicious intent. The gap between what the offender foresees or can foresee and death may at times be too large in gross negligence manslaughter and reckless manslaughter (Mitchell, 2008).

Acknowledging the consequence-state-of-mind divide between scholars, my paper proposes a practical legal framework that takes into account the conditions when differential punishment is more or less justified. In order to prove that less resultant moral luck should be considered in punishment and differential punishment is more justified when the offender is more conscious about the risks of their action and vice versa, I will first propose three hypotheses considering varying degrees of culpability in terms of moral luck in involuntary manslaughter.

Hypothesis 1 describes the moral dilemma at its most simplistic terms as a violation of the letter of the law:

H1: When involuntary manslaughter occurs under the disregard of the letter of the law, resultant moral luck is not considered in punishment and the tradition of differential punishment is justified.

Hypotheses 2 and 3 outline the relationship between the action and its respective punishment when the offender is not aware that there are laws or that their circumstances are risky:

H2: When involuntary manslaughter occurs under the ignorance of the letter of the law, resultant moral luck is considered in punishment and a lesser punishment is justified.

H3: When involuntary manslaughter occurs under the ignorance of circumstances, resultant moral luck justifies equal punishment and differential punishment is not justified.

Hereby I define the letter of the law as the written code of drivers that outlines the liabilities of drivers and protects road safety, i.e. one that punishes driving under the influence and the killing of another human being. An example of committing involuntary manslaughter while disregarding the letter of the law is to pay no attention to the law that one must not drive under the influence when the offender knows that they must not. And to commit involuntary manslaughter while ignoring the letter of the law would be to unknowingly violate the law. I define circumstances as risky conditions of driving that, when driving in, does not constitute criminal offenses, i.e. driving during bad weather. An example of committing involuntary manslaughter while disregarding circumstances is to knowingly plan for a trip that requires driving during a stormy day. And to commit involuntary manslaughter while ignoring circumstances would be to unknowingly engage in a risky driving condition that is not foreseeable. By differentiating between involuntary manslaughter with and without rule violations, this paper assesses the criminal liability of manslaughter under such conditions as follows:

Involuntary Manslaughter Violating Rules – Disregard or Ignorance of Rules

According to an unlawful theorist, harm, however unforeseen by the offender, has occurred. The culpability of the involuntary manslaughter is not affected by whether or not the consequence is foreseeable and that the offender knowingly engaged in harmful behavior. The death of an innocent person may not be the direct result of driving, but by engaging in risk-inducing behaviors such as driving under the influence, disregarding a traffic signal, running a stop sign, speeding, etc., the driver increases the chances that individuals in the surroundings will be hurt. The Control Principle, the principle which states that people are only morally assessable when what is morally assessed is within our control, is compatible with the punishment of the offender. In this case, the judge is morally assessing the factors within the offender's control and the law is punishing the negative excesses of human nature, i.e. crimes, not human nature itself.

The only criminal liability that could result from involuntary manslaughter should be attributed to the unlawful or harmful act committed. To determine whether or not this criminal liability should apply in cases of involuntary manslaughter, we can use awareness of the risk of serious harm (Ashworth, 1991). Because we are measuring the extent to which resultant moral luck should be considered in the punishment of involuntary manslaughter, it is important to differentiate cases where the offender is more or less aware of the seriousness of their actions and existing laws by a clear standard. By introducing the level of awareness as a determinant for criminal liability, this paper creates a standard for measuring culpability, and the legal dilemma of moral luck with regard to unlawful act involuntary manslaughter could be solved.

Involuntary Manslaughter without Violating Rules– Disregard or Ignorance of Circumstances

The more complex part of the legal dilemma of moral luck lies in scenarios where there are no rule violations or causal links between the offender's action and the death of the victim. As for gross negligence manslaughter, differential punishment should only be justified when there is a causal link between the negligence of the offender and death. Unlike one who intentionally creates risk in unlawful act manslaughter, a merely negligent person whose actions would not typically cause death should not be expected to foresee that their negligence leads to the death of others. For instance, though drivers should be aware that there are blind spots in driving, their moral and legal responsibility should not exceed checking the blind spots before entering the car and starting to drive. In other words, the driver should not be responsible for hitting people when they are in the driver's blind spots.

Drivers should also not be charged with sentences as heavy as that of unlawful manslaughter under the disregard or ignorance of rules when driving in bad conditions, such as heavy fog, snow, or storm, when driving is the necessary means of transportation. To understand the differences in culpability in the ignorance of circumstances compared to the ignorance of rules, it is worth comparing two cases---case 84 and 88 in Mitchell and Mackay's empirical study on the culpability of involuntary manslaughter. Out of the 127 cases investigated, case 84 and 88, when put together, are promising examples of how differential punishment cannot be justified when resultant moral luck is involved.

Case 84 involves a hit-and-run scenario where the driver accidentally hitting the victim when driving during a heavily snowing day. The driver left the scene and later drove back, ignoring his surroundings and trapping the victim under his car, killing them. In case 88, the defendant and the victim had a "history of antagonism." The defendant attacked the victim with a table leg and knife, killing them. Both defendants in case 84 and 88 pled guilty not to murder, but guilty to manslaughter, and were sentenced to 4- and 5-years imprisonment, relatively modest sentences. In addition to what researchers suggested that high moral blame may not result in a high sentence and that the guilty pleas of defendants in both cases effectively reduced their sentence, extenuating circumstances play a critical role in the sentencing of involuntary manslaughter when there is no violation of the letter of the law. Compared to the violation of laws under disregard or ignorance, the punishment for the violation of circumstances under disregard or ignorance is far lighter and more consideration of resultant moral luck is given.

Insights into Criminal Law

The culpability of causing death varies from one case of involuntary manslaughter to another (Mitchell and Mackay, 2011). Despite this variation, we can navigate the gray areas of the legal landscape by considering law not just as words written on paper, but more broadly as a code that regulates and guides the morals and behaviors of ordinary people. By understanding that an action is both mental and physical, legislators and judges can deliberate based on whether the involuntary manslaughter involves the following six different scenarios:

1. Disregard of rules (the offender knows and violates the law),

2. Conscious ignorance of rules (the offender knows that they do not know the law and violates the law), 3. Unconscious ignorance of rules (the offender does not know that they do not know the law and violates the law),

3. Disregard of circumstances (the offender knows that circumstances are risky),

4. Conscious ignorance of circumstances (the offender knows that they do not know that circumstances are risky), or

5. Unconscious ignorance of circumstances (the offender does not know that they do not know that circumstances are risky).

The following diagram may conclude the insights of this paper into determining culpability of causing death in involuntary manslaughter:

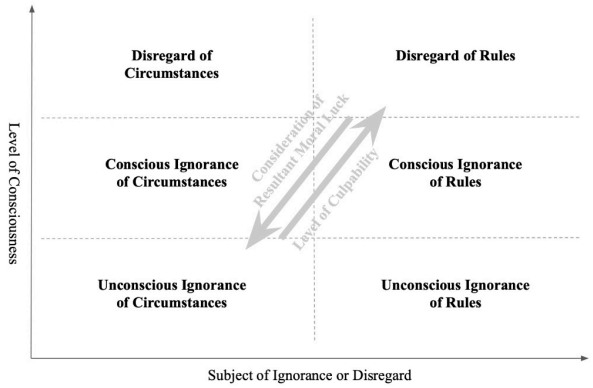

Figure 1: ***The coordinate plane of the culpability and punishment model of this essay.*** *Individual involuntary manslaughter cases would be represented by points on this plane. The x-axis and y-axis denote the subject of ignorance and the level of consciousness of ignorance or disregard, respectively——the further from the origin a point is the more culpable the act is, the less important resultant moral luck should be in the consideration for punishment, and the more justified differential punishment is. I have further divided the space into six quadrants, each representing a level of consciousness and a subject of ignorance or disregard.*

The model of this paper could also be used to gauge the extent to which doctors have fulfilled their responsibility in medical manslaughter cases. Rule violations and immoral practices can be monitored by regulatory bodies in the medical field to ensure the safety of patients (Hubbeling, 2010).

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Music as a Language: Assessing the Extent to Which Active Music Therapy Promotes Socialization Development for Children Under 12 with Down Syndrome

By Xinzhi (Abby) Zhang

Abstract

The number of children in western countries diagnosed with Down syndrome (DS), a disease caused by chromosomal abnormalities, is still increasing. The resulting delayed cognitive development also leads to deficits in social functioning in children under 12. Active music therapy (MT), as a natural intervention to achieve therapeutic functions through improvisation, performance, and singing, has been proven to promote the socialization development of children with DS. To get a better idea of the extent of the promotion and exactly what aspects it has improved, I conducted literature reviews and interviews with a music therapist. The results suggest that active MT can stimulate the socialization development of children under 12 with DS in three aspects: language skills, social-emotional development, and prosocial behavior. Although the improvement effect of active MT is better than that of passive MT, it requires the client to have a basis of music theory, that is, it requires higher requirements on the client, so the treatment method should be selected according to the severity of the client's DS or a combination of the two. Hence, future research could be aimed at finding the simplest interventions with sufficient client engagement and verifying the continuation of the effect of active MT.

Keywords: Active Music Therapy, Socialization Development, Children under 12, Down Syndrome, Intervention, Social-emotional Development

Introduction

Music is the art of time with organized sound movement, with a fixed period of time covering changes in melody and rhythm. People have tried for a long time to find the relationship between music and people's inner world. Music Therapy (MT) is a systematic process in which the music therapist uses various forms of musical experiences, as well as the therapeutic relationships that develop as the driving force of therapy to help the patient achieve health goals. It can be divided into two types according to the participation form of the client: active and passive. As shown by figure 1, the active MT discussed in this paper mainly adopts singing, instrumental performance, composition, lyric creation, and improvisation, while in passive MT, clients listen to, discuss and accept musical stimulation. It has been proven to be effective for clients with neurological disorders (Canicio, Guardiola, and Moreno 2017; Raglio et al. 2015) and autism spectrum disorder (Foley 2017; Gold, Wigram, and Elefant 2006). For example, in September 2022, I established a MT club in my school and held some MT courses for 7 autistic children. Through singing their favorite songs with them and teaching them to play kalimba, I noticed their increased engagement and willingness to speak.

Figure 1. Direct Difference between Active MT and Passive MT.

Down Syndrome (DS), which is caused by the presence of an extra copy of human chromosome 21, is a genetic diorder that affects approximately 1 in every 700 births, making it the most common chromosomal disorder. DS is characterized by intellectual disability, physical growth delays, distinctive facial features, as well as difficulties in socialization (Desai, 1997; Malak et al., 2015). Children with DS often face challenges that impact their social skills and their ability to communicate effectively with others. Traditional therapeutic interventions for children with DS often focus on speech and language development, occupational therapy, and physical therapy (Davis, 2008; Ruiz-González et al., 2019). While these interventions are essential, they may not fully address the socialization needs of children with DS. Therefore, there is a need to explore alternative therapeutic approaches that can effectively promote socialization skills in this population.

This paper will explore the use of active music therapy as a means of promoting socialization development in children under 12 with DS.

Background

Music Therapy

In clinical therapeutic activities, the biggest difference between MT and any other kind of therapy is that music therapists use music as their basic therapeutic medium. They use musical activities to achieve therapeutic goals, making the music and the therapist complement each other.

MT is a scientific systematic treatment process, not a simple, single, random and unplanned music activity. In the clinical practice of music therapy, a music therapist must complete three stages of work in a rigorous procedure: assessment, intervention, and evaluation. In the assessment stage, the therapist assesses the problems, conditions, symptoms, and even the growth process of the client, and proposes long-term goals, short-term goals, and treatment plans based on the results of the evaluation. In the intervention stage, the therapist uses various means according to the long-term and short-term treatment goals to promote the client to change in line with the treatment goals. During the evaluation phase, the therapist determines whether the previous intervention achieved the desired outcome (Gao, 2020).

In MT, music therapists use two factors simultaneously to promote therapeutic change: the musical experience and the therapeutic relationship. These two factors are mutually influencing and interdependent. Therapeutic relationships in MT are complex and diverse, and these relationships may be musical, physical, spiritual, behavioral, social, or psychological. However, the most basic relationships are the relationship between the subject and the music and the relationship between the subject and the therapist (Gao, 2020).

Down Syndrome's Social-related Symptoms

Children with DS under the age of 12 develop language at a slower pace than normal children due to inadequate cognitive skills. According to Pienaar (2012), "Children with DS have difficulties with auditory perception and processing, articulation problems, and difficulty learning language rules" (p. 37). They are late in saying their first words, about 18 months, and their vocabulary grows more slowly than in ordinary children (Buckley, 1993). Their vocabulary skills develop more quickly than grammar skills, as shown by their difficulty in sequencing words and their tendency to omit verbs and functional words (Buckley, 1999; Pienaar, 2012). The speech problem in children with DS under 12 is also a contributing factor to underdeveloped language skills. These speech problems are caused by congenital differences in vocal tract structure and frequent periodic hearing loss due to frequent otitis media.

Children under 12 with DS are more willing to interact and communicate and show strengths in gesturing than children without DS. They pay more attention to people and respond atypically to communications. In the process of therapy, their answers to questions may have nothing to do with the questions themselves; their eyes may wander around; they may be immersed in their own world; it may be difficult to switch and maintain attention; and they may talk to themselves. In this case, therapists often need to follow their topics and continue the conversation with them (Buckley, 1999). Besides, in social interactions, they may also have behaviors that are inappropriate and unacceptable. Such an abnormal way of dealing with interpersonal relationships can further lead to externalizing problems, "such as maladaptive behavior and antisocial behavior" (Barati et al., 2012), and internalizing problems, "such as lack of confidence, anxiety, and depression" (Barati et al., 2012).

Socialization and Down Syndrome

Socialization is a fundamental aspect of human life, and children under 12 with DS are no exception. It enables them to develop essential social skills, such as sharing, taking turns, and cooperating with others. Socialization also helps children under 12 with DS to build friendships, develop a sense of belonging, and enhance their self-esteem. Individuals with strong social skills have better mental health and higher academic achievement. The significance of socialization development for children under 12 with DS is mainly reflected in three aspects: 1) Through socialization, they can build a positive self-identity, develop a positive view of themselves, and improve confidence and self-esteem. 2) Socialization helps them build connections, and thus better adapt to the social environment. It gradually expands their social sphere from their therapists to family members to the community. 3) Building social support networks, increased sense of well-being, and reducing feelings of isolation and depression. Children under 12 with DS often face challenges in socialization due to cognitive and language delays, physical limitations, and difficulties in understanding social cues. These challenges can lead to social isolation, limited communication, and reduced opportunities for inclusion in mainstream environments. It is crucial to address these challenges and provide appropriate interventions to enhance their socialization skills.

Methodology

Due to the severity of COVID-19, I was unable to participate in a formal music therapy session; thus, I mainly used literature review and interview as my research methods. Sources of literature review include Pro-Quest, PubMed, Jstor, Google Scholar, and Journal of Music Therapy. Considering the timeliness and pertinence of my research, I chose to restrict the start date of the literature around 2000 and to include groups with Down syndrome no older than 12 years of age. Meanwhile, research of MT are slightly different between countries due to cultural elements, so the authors of references were mainly from European and

North American countries. Keywords used to search the corresponding literature were "music therapy and Down syndrome", "socialization", "Down syndrome", "social behavior", "social-emotional development", and "musical play". Since socialization development was expressed differently in literature, I classified and summarized the factors that affect socialization in children with DS under 12. In addition, I invited Hongyu Chen, a master student of music therapy at Montclair State University and a music therapist, as the interviewee. He graduated from the Central Conservatory of Music. He has practiced music therapy at the International Brain Research Center, the Seasons Hospice & Palliative Care, the Oncology and Gastroenterology Department of Peking Union Medical College Hospital, and the Beijing Our Home Special Children's Center. He once worked in the special needs children's institution for one year and has been in contact with some children with DS. Questions asked during the interview: 1) Please describe any active music therapy methods that you use. 2) What social skills are you hoping will improve in children with DS following music therapy? 3) For children under 12, which age do you think is most responsive, and how do the children benefit? 4) Please describe any particular challenges doing music therapy sessions for children with DS.

Discussion

To explore the various changes in the socialization of children under 12 with DS before and after receiving active MT, I referred to previous research and organized expert interview. Active MT is a non-invasive and engaging means of promoting the socialization development of children under 12 with DS in three aspects: language skills, social-emotional development, and prosocial behavior. The demonstration in this section will relate to the impacts of active MT from these three perspectives.

Language Skills

Music and language complement each other, and some of their laws are in common. In any learning process, including language learning, repetition helps people acquire information. Children are unaware that they are repeating some words over and over again. Even fetus can absorb the musical qualities of language that it hears through its mother's body: the tone, rhythmic patterns, melody, tempo and dynamics (Wylie, 2006). Music evokes emotions and engage individuals on an emotional level. Emotional engagement can enhance motivation, attention, and memory, which are important for language learning. According to Barker's study in 1999, singing provides children with DS with a more enjoyable way than speech alone does. Apart from that, the flow of the music is often enhanced by the flow of the music, because the division of sentence components in lyrics is often the same as in everyday communication. The combination of melody and lyrics enables children under 12 with DS to construct the phrases and sentences they are using, making the syntactic structure more memorable. In other words, the process of placing words into rhythmic patterns enables them to develop a slightly different skill, essential for singing and still reinforcing their use of language (Barker, 1999). Active MT also encourages children to express themselves through singing, improvisation, and songwriting. This creative expression can enhance their expressive language skills and promote self-confidence in communication. On the other hand, active MT provides opportunities for children to listen and comprehend song lyrics and verbal instructions. This can enhance their receptive language skills, including understanding grammar, syntax, and comprehension of spoken language. Furthermore, active MT enhances children's phonological awareness, for they have to sing every syllable with musical notes. There is a connection between music and eurhythmy: music increases the vocal production of teenagers, integrating a vocal and rhythmic response (Loewy, 2004). The musical experience was associated with an improvement in psycholinguistic skills such as comprehension, auditory association, verbal expression, and verbal memory in children under 12 with DS.

Not only can active MT play a stimulating role, but it can also promote language development in children with DS from a physiological perspective. Singing and playing instruments require greater mouth movement and better articulation (Barker, 1999). The rhythmic structure of music can improve oral motor skills, leading to improved articulation and speech clarity in children with DS. Singing and vocal

exercises in active MT can strengthen the muscles involved in speech production (Gemma et al., 2020). Additionally, active MT can help children with DS synchronize their movements and gestures with the beat (Pienaar, 2012). This synchronization can enhance their motor skills, including oral motor skills, which are crucial for speech production. Moreover, music provides auditory stimulation that can enhance auditory processing skills. Children with DS often have difficulties in auditory processing, and active MT can help improve their ability to perceive and discriminate sounds, which are essential for language development (Barker, 1999).

Social-emotional Development

Specifically, joint musical improvisation, which is the group form of active MT, is mainly aimed at cultivating qualities that children under 12 with DS themselves need to socialize. It increases children's emotional sensitization, meaning that their own personalities will be enriched. Moreover, there are some social and emotional components contained in the long-term artistic competencies (formed by joint MT sessions) such as the development of emotional self-regulation, responsibility, empathy, self-expression, and self-criticism, and thus enhances children's cooperation skills, confidence, and sense of group belonging. They will be more willing to participate in social activities and promotes their acquisition of values. In general, joint MT sessions promotes children's social-emotional development based on The Prism Theoretical Model of Social-Emotional Learning: the first level is social and emotional skills such as emotion knowledge and self-regulation; the second level presents indicators of social success, which means, in particular, improvising or performancing a complete piece or song and maintaining healthy relationships with peers and adults; and the third level is related to social competence, meaning to effectively and positively interact with others.

Furthermore, group active MT enhances the connection between children with DS and the external world. In the infancy stage, along with the recovery of cognitive function brought about by musical acquisition, social interactions of infants with DS are also improved, especially those between infants and parents (Gerry et al., 2012; Wylie, 2006; Bradford, 2021). Positive communication between parents and infants promotes the acquisition of earlier use of prelinguistic communicative gestures (Gerry et al., 2012). The parent-child relationship is the basis for more complicated social relationships in the future. Joint MT sessions establish social relationships, maintain social bonds, and build trust between clients through collective production (Váradi, 2022). Research shows that in the experiment, subjects who sang in a group scored higher on the measure of trust than those who engaged in nonmusical activities such as reading poems (Váradi, 2022). According to MacDonald (2013), "Musical improvization provides opportunities for negotiating differences through creative colla- boration and understanding the unique musical, mental, individual and social processes" (p. 10). Thus, children under 12 with DS who are relatively cognitively functional will have less conflict with children around them than those who don't attend group MT sessions.

Prosocial Behavior

Several studies have shown that active MT enhances children's prosocial tendencies towards the interaction partner. Active MT session provides a safe and non-threatening environment for children under 12 with DS to express and regulate their emotions. Music has the power to evoke and amplify emotions, allowing children to explore and express their feelings through various musical activities. Through active engagement in music-making, children can learn to identify and regulate their emotions, leading to improved emotional well-being and self-awareness, which results in a concomitant reduction in antisocial behaviors. Specifically, joint musical activities need joint attention and coordination to achieve the shared goal of making music, which may create a stronger sense of commitment (Buren et al., 2021). The joint music-making process creates the periodic pulse, which contributes to the synchronization of children's body movements. This has been proven to produce positive feelings that weaken the boundaries between themselves and the group, and thus strengthens group trust, social cohesion, and sympathy (Kirschner, 2010; Schellenberg et al., 2015). Moreover, this similarity of movements between children might give rise to prosocial reactions such as helping behavior and attention to others' needs. Hence, active MT should be considered to have a prosocial effect on children under 12 with DS.

Interview

During my research process, since the interviewee led real MT sessions previously, his feedback is worth considering when determining whether active MT can promote the socialization of children under 12 with DS. It has been proved that results of his practice are consistent with my hypothesis. Hongyu Chen mentioned a case of a 12-year-old boy with DS. At the beginning of treatment, he was relatively shy, looked away, and often did not respond. For children with Down syndrome, parents often choose to keep them at home or in special education schools, where they do not have much contact with the outside world, which leads to shyness and fear about socializing with strangers, so there will be some difficulties in communication at the early stage. First, a personal assessment is made of the client in terms of physical, emotional, social, and verbal aspects. Secondly, the intervention plan is developed by the music therapist, which clarifies the long and short-term goals. There is no specific kind of music for children with DS, and music can only be selected according to their personal preferences. Then, music therapists should make further contact with children in the way of music composition to establish a more harmonious relationship, which is important. Hence, another challenge is to establish his connection to the music and the relationship between the music therapist and him. This is a gradual process, and there may not be a lot of interaction in the first five sessions, which requires long and short-term goals and cognitive and social interventions based on his step by step changes. This child gradually made more eye contact with the therapist, was more willing to speak, and had improved language skills. Generally, it takes 10-20 sessions to see children's improvement.

Limitation of Active MT and Recommended Approach

As mentioned in the introduction, active MT requires clients to participate in music creation, such as singing and playing instruments, so the requirements for their musical capacity will be relatively strict. Clients with no basis in music theory do not respond well to active music therapy, though research shows that active MT leads to a substantially more positive outcome than passive MT does (Buren et al., 2021), as shown by figure 2. Meanwhile, the severity of cognitive deficits in children with DS also affects the intervention of MT. For children with serious cognitive and intellectual problems, it's reasonable to use passive music therapy. Conversely, as for those who with DS in the early stage or mild DS, a combination of passive and active MT can be used.

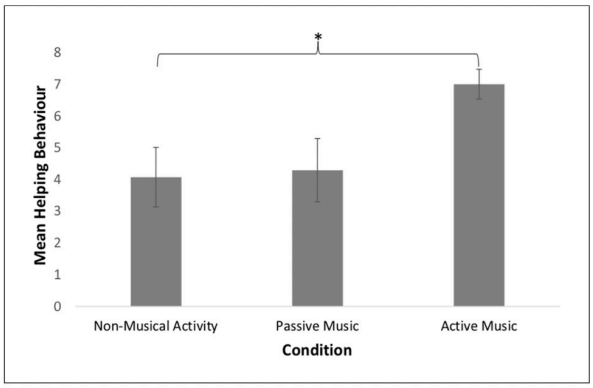

Figure 2. Mean helping behavior (a kind of prosocial behavior) across three conditions (Buren et al., 2021)

Conclusion

DS, which derives from the trisomy of human chromosome 21, is characterized by growth deficiency, mental deficiency, and nervous system anomalies, making patients' socialization development lag behind that of ordinary people. Children under 12 with DS often have a passive style of interaction with the environment. For example, they may have difficulties with clear word production and maintaining attention, struggle with grammar, and interact with others with little eye contact. As an art form of social non-verbal communication, music has proven to be an effective intervention for people with DS. Specifically, active MT is a medium to support the expression of emotions and ideas and an engaging, multisensory social activity; it provides improvisational communication through music. Therefore, language skills, social-emotional development, and prosocial behavior are enhanced by active MT among children under 12 with DS. Although active MT has a promoting effect on the socialization development of these children, such influence is individualized and will be different due to children's personalities, growth experience, and severity of symptoms. Some children may progress significantly in 10 sessions, but it may take 20 sessions before others can make eye contact with music therapists.

Based on the high demands of active MT on clients' abilities relative to passive MT as stated above, future research could measure and compare the effectiveness of different instruments or different methods of music creation for active MT in children with DS, to identify the easiest for use and ensure their participation in music creation. Additionally, the long-term effects of active MT on the socialization of children with DS are worth exploring. Follow-up assessments conducted several years after the intervention can provide insights into the sustainability of the intervention's effects and its impact on the overall development of these children.

Acknowledgments

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DDoS Analysis and Detection with Machine Learning Algorithms

By Tiffany Tu

Author Bio

Tiffany Tu is a senior at Bellevue High School in Washington state. She hopes to study computer science with a focus on cybersecurity, combating emerging digital threats utilizing machine learning with more projects in the future.

Abstract

Distributed Denial of Service (DDoS) attacks, where compromised systems are used to flood a target with an overwhelming amount of traffic, pose a significant threat to the availability and security of digital networks. As these attacks continue to evolve in sophistication and scale, there is a pressing need to develop effective DDoS detection techniques to mitigate their impact. Utilizing a dataset of benign and dangerous (DDoS) network flows, this research paper evaluates and compares various machine learning techniques for the detection of DDoS attacks to identify the most accurate methodologies to contribute to the security of networked digital infrastructure. The study conducts feature deduction and variable transformation on the dataset and subsequently build and trains multiple different machine learning models. The findings of this research quantify the effectiveness of each machine learning method tested in identifying DDoS attacks. Random Forest (99.24%) performed the best in terms of detection accuracy. Decision Tree was also accurate (98.68%) in detecting DDoS flows, and Logistic Regression was the least precise (71.81%). These results exhibit the importance of selecting appropriate machine learning models to enhance the resilience of network security systems from DDoS attacks. Furthermore, the research underscores the need for further exploration using additional machine learning models to develop more effective and robust detection strategies. Ultimately, the outcomes of this paper contribute to the efforts to detect DDoS attacks and enhance the overall security posture of digital environments.

Keywords: DDoS, DDoS attack, cybersecurity, network flows, machine learning, random forest, decision tree, logistic regression

Introduction

In today's interconnected digital landscape, the magnitude and significance of cyberattacks are skyrocketing, making them an ever-increasing threat. Cyberattacks are malicious actions that target computer systems, networks, or data to compromise, disrupt, or gain unauthorized access (Li & Liu, 2021). They encompass a range of malicious activities, from data breaches to ransomware attacks to phishing scams. However, distributed denial of service (DDoS) attacks have emerged as a particularly formidable menace. These attacks involve overwhelming a target system or network with an enormous volume of traffic, rendering it inaccessible to legitimate users and disrupting critical services (Rubin et al., 2000).

The identification of malicious traffic on computer systems can be achieved by utilizing machine learning algorithms in DDoS attack analysis and detection to enhance computer network security (Kaur et al., 2017). DDoS attack detection modules analyze collected data to assess the security risk posed by network connections, while machine learning algorithms, trained on previous tasks and feedback, enhance their predictive capabilities through adaptive changes (Sarker, 2021).

This study explores different machine learning techniques for detecting and analyzing DDoS attacks while examining and comparing their respective accuracies and suitability. This analysis is conducted in order to (1) safeguard computer networks and online services from disruptive and potentially damaging cyberattacks, (2) protect data integrity, and (3) maintain the overall stability and functionality of the digital ecosystem.

This paper first discusses the technicalities of how a DDoS attack works. Next, it provides a real-world DDoS attack example. Then, it details a relevant dataset and explores methodology along with visualizations. This paper concludes with the performance evaluation and analysis of study results.

Background

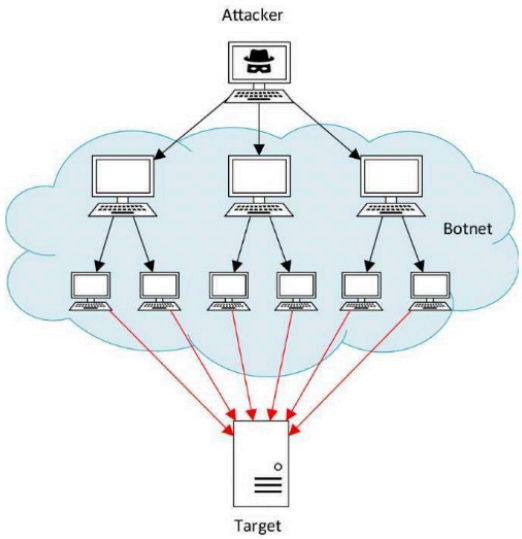
DDoS attacks represent a prevalent and disruptive form of cyberattack, designed to overwhelm and paralyze targeted computer systems or networks. The main technique employed in DDoS attacks involves flooding the target with an overwhelming volume of traffic, rendering it incapable of functioning properly and denying access to legitimate users (Cloudflare, 2023).

As shown in Figure 1, DDoS attacks leverage the power of multiple compromised devices, forming what is referred to as a botnet. These devices have been previously infected with malware, allowing attackers to control them remotely. The attackers command the botnet to send an enormous amount of traffic to the targeted system, exploiting its limitations and overwhelming its resources (Fortinet, 2023).

The traffic used in DDoS attacks can take various forms, such as HTTP requests, UDP or TCP packets, or even illegitimate requests to specific services. The goal is to exhaust the target's processing power, bandwidth, or other critical resources, ultimately causing service degradation or complete unavailability.

The scale and complexity of DDoS attacks have grown significantly over the years, making them a formidable challenge to combat (US Department of Homeland Security, 2023). Mitigating these attacks requires proactive monitoring, detection, and analysis that can identify and filter out malicious traffic while allowing legitimate traffic to reach its intended destination.

Figure 1
DDoS Attack Process



Note. How a distributed denial of service attack works, from the attacker to the target. From A Hybrid ML Approach for Detecting Unprecedented DDoS Attacks, by Mohammad Najafimehr et al., n.d. (https://www.researchgate.net/figure/A-diagram-of-a-DDoS-attack-performed-with-a-botnet_fig1_357168204).

Case Study

In 2018, GitHub, a widely used code hosting platform, experienced one of the largest and most significant DDoS attacks in history (Microsoft, 2023). The attack targeted GitHub's infrastructure, disrupting its services and causing a ripple effect across the internet. The incident shed light on the scale and severity of DDoS attacks and their potential to disrupt even highly resilient online platforms.

The attack on GitHub reached an unprecedented peak traffic volume of 1.35 terabits per second (Tbps), surpassing any previously recorded attack (Kottler, 2018a). It was executed by leveraging a botnet, a network of compromised devices under the control of malicious actors. The attackers harnessed this botnet to flood GitHub's servers with an overwhelming amount of spurious traffic, aimed at exhausting the platform's resources and rendering it inaccessible to legitimate users (Newman, 2018).

The attack on GitHub served as a wake-up call regarding the security vulnerabilities in digital ecosystems and the potential for them to be harnessed for large-scale attacks. Moreover, the GitHub attack underscored the interconnectivity and interdependence of online services. The disruption caused by the attack extended beyond GitHub's own platform, impacting other services that relied on GitHub for code hosting and collaboration. High-profile websites and organizations, including popular streaming services, experienced performance issues and service disruptions due to their reliance on GitHub's infrastructure (Kottler, 2018b).

The consequences of the GitHub DDoS attack were far-reaching. The attack prompted widespread concern and discussion about the state of cybersecurity and the need for enhanced DDoS mitigation strategies. The incident also highlighted the importance of collaboration between online platforms, internet service providers, and security organizations to swiftly identify and mitigate such attacks.

Dataset

This study utilizes data provided by the Canadian Institute for Cybersecurity (CIC) of network flows, sequences of data packets exchanged between a source and destination (Goldberg et al., 1989). DDoS flows that were extracted from different public CIC Intrusion Detection System datasets produced in different years were combined with "benign" flows extracted from the same base datasets and made into a single large dataset used in this study. The dataset used within this research has a total of 12794627 datapoints (rows) and 85 features (columns). Each datapoint corresponds to one network flow (forward or reverse) that is either benign or is part of a DDoS attack (Kaggle, 2019).

The DDoS attack scenarios to create experimental flows in this study's dataset included 50 machines in the attacking infrastructure and 420 machines with 30 servers on the victim side (CIC, 2018).

This study's dataset has no missing or duplicate values. Each feature (variable) in the dataset has a data type of either integers or floats, apart from identifier attributes and the target variable that are string objects. The identifiers provide context about flows, including Flow ID, Source IP, and Destination port. Because identifiers bear little information suitable for building machine learning models in this case, it is not necessary to dig up the data within them, so they can be removed from the predicted variable list.

Continuing with the dimension reduction of our dataset to reduce features not valuable for machine learning models while maintaining the same degree of accuracy, the statistical description of each column was analyzed. The variables with a standard deviation lower than 1 are dropped to reduce homogeneity in the dataset. Additionally, the target variable was changed into binary format to remove all string objects from the dataset, with 0 representing "benign" and 1 representing "DDoS" flows, since this study sought to predict DDoS attacks. The columns that contained an inf (infinity) value were dropped to make machine learning model building more straightforward later. In the process of features extraction, 26 total features

were dropped, and the study moved forward with a dataset with 59 columns, including the target variable.

Visualizations

To visualize the distribution of the study's target variable and display its amount and percentage within the dataset, a histogram was plotted, and a pie chart was created. DDoS = 1; Benign = 0

Figure 2a

Target Variable Distribution: Histogram

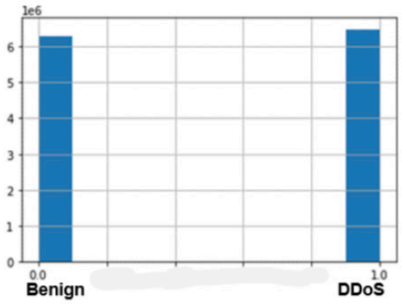
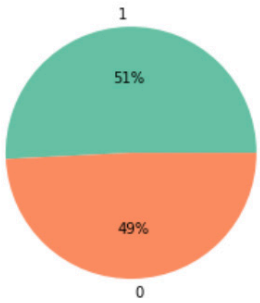


Figure 2b

Target Variable Distribution: Pie Chart

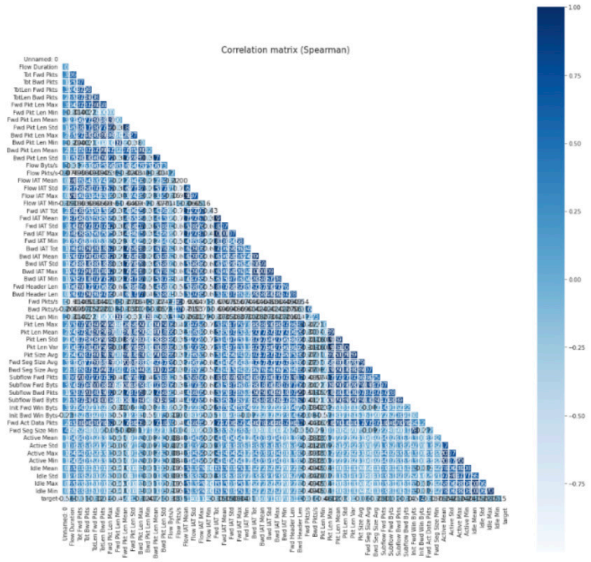


Note. A visual of the target variable's distribution.

To visualize the correlation between the independent variables (features) and the target variable of the dataset, a heat map was created. A heat map shows correlation utilizing colors instead of numbers, with darker colors indicating a higher correlation and lighter colors indicating a lower correlation.

Figure 3

Heat Map of Correlation

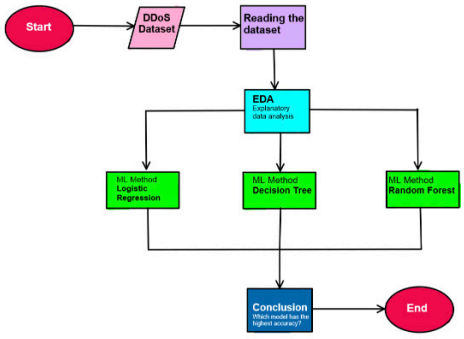


Note. The relationship between independent features (columns) and the target variable.

Methodology

In this research paper, the process of DDoS detection using machine learning algorithms that are appropriate for classification problems is presented, highlighting the different steps and components involved. The methodology for this study is outlined in Figure 4, and to enhance comprehension of the machine learning approach, it illustrates the process from beginning to end.

Figure 4
Methodology Process



Note. The process for the methodology of this study from start to finish. Own work.

Because the data cleaning and EDA process was previously conducted (including feature deduction and variable transformation), the data can be used to train a variety of machine learning (ML) models. Since this research is a classification problem, this study builds several ML algorithms to detect DDoS flows:

Logistic Regression: A machine learning method used for binary classification tasks. It models the relationship between input features and the probability of a specific outcome, employing a logistic function to estimate the likelihood of class membership. It is widely utilized for its simplicity, interpretability, and effectiveness in various domains (Xu et al., 2023).

Decision Tree: A versatile and interpretable machine learning algorithm that uses a tree-like structure to make predictions by recursively splitting the data based on feature values. It creates a series of if-else rules that lead to classifying or predicting the target variable (Xu et al., 2023)

Random Forest: An ensemble ML algorithm that combines multiple decision trees to make predictions. It creates a diverse set of trees by using random subsets of features and samples from the training data. The final prediction is determined by aggregating the predictions of individual trees (Xu et al., 2023)

Although there are existing studies that predict cyberattacks using machine learning techniques, some take fewer input attributes into account to form conclusions. Because this study's machine learning models are trained on datasets that have more than 50 independent variables, a broad range of factors are considered that can lead to more precise predictions about whether a flow is malicious (DDoS) or benign (Khalaf, 2019).

Performance Evaluation

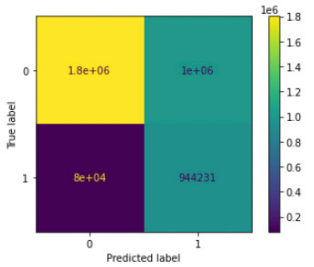
This study utilized machine learning algorithms and classifiers to examine network flows that were either benign or DDoS. After creating each machine learning model, the results of their respective accuracies in detecting DDoS attacks and confusion matrices are below. Accuracy scores are calculated by the ratio of the True Positives (model predicts DDoS as DDoS) and True Negatives (model predicts benign as benign)—the top left and bottom right boxes of the matrix—with the number of total cases.

Logistic Regression

Accuracy score: 71.81%

Figure 5a

Confusion Matrix: Logistic Regression



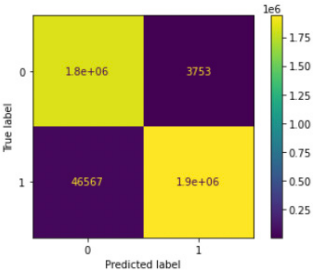
Note. The counts of true positive, true negative, false positive, and false negative predictions of the LR model.

Decision Tree

Accuracy score: 98.68%

Figure 5b

Confusion Matrix: Decision Tree



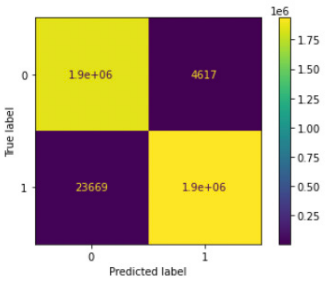
Note. The counts of true positive, true negative, false positive, and false negative predictions of the DT model.

Random Forest

Accuracy score: 99.24%

Figure 5c

Confusion Matrix: Random Forest



Note. The counts of true positive, true negative, false positive, and false negative predictions of the RF model.

The accuracy scores and confusion matrices illustrate that Random Forest has the highest accuracy (99.24%) in predicting if flows are DDoS. However, the accuracy score of Decision Tree is very close to that of Random Forest, standing at 98.68%. Logistic Regression has the lowest accuracy, with a score of 71.81%.

This research highlights the comparative performance of different machine learning techniques in DDoS attack detection. Through analysis of the machine learning accuracy scores, this research shows that Random Forest has the best performance for DDoS detection strategy, with Decision Tree coming at a close second for the detection and identification of DDoS flows. The weakest technique, logistic regression, stands in third place among the techniques tested due to its lowest accuracy score. Thus, Random Forest and Decision Tree can identify flows as part of a DDoS attack in the most accurate manner and are better choices for DDoS detection.

This research provides insights into the selection of appropriate machine learning models for DDoS detection. Those involved in the field of cybersecurity can leverage these findings to make informed decisions regarding the choice of machine learning algorithms for DDoS detection systems, enhancing their ability to identify and mitigate DDoS attacks promptly and accurately, bolstering the overall security of the network infrastructure (Bhuyan, 2014).

Conclusion

DDoS attacks are growing in impact and frequency, and networks and online services are under the threat of disruptive and damaging cyber-attacks (Zargar et al., 2013). Using a single dataset with flows extracted from the Canadian Institute for Cybersecurity's datasets from various years, this research paper seeks to investigate various machine learning techniques for the detection and analysis of DDoS attacks (the identification of dangerous versus benign network flows). The study also pursues the comparison and evaluation of their accuracies, with the aim of identifying the most appropriate techniques to utilize to contribute to the defense of online systems.

The results show that Random Forest (99.24%) performed the best in terms of detection accuracy. Decision Tree was also accurate (98.68%) in detecting DDoS flows, and Logistic Regression was the least precise (71.81%). This analysis highlights the usefulness of different machine learning methods for identifying DDoS; however, further research with a broader range of machine learning models (KNN, SVM, Naïve Bayes, XGB, etc.) is needed to gain a comprehensive understanding of their capabilities and limitations. Exploring diverse techniques can lead to the development of more effective and robust detection tools and strategies. Analyzing and detecting DDoS attacks with machine learning algorithms is key to enhancing proactive security measures and establishing the security of services, critical network infrastructure, and the overall digital realm.

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Challenging Logical Monism

By Aurna Mukherjee

Author Bio

Aurna Mukherjee is in 12th grade at Liberal Arts and Science Academy, a highly-ranked magnet high school in Austin, Texas. She became interested in Philosophy and Logic in 10th grade and received a scholarship to participate in the Cambridge Center for International Research in 2023. She has been working with Dr. Owen Griffiths from Cambridge University as part of her research project on logical monism, and recently presented her paper at an undergraduate conference (Perspectives About Truth 2).

Abstract

Logic is loosely regarded as a key factor that drives our decisions. However, logic is actually separated into different systems, such as intuitionistic logic and classical logic. These systems can be explained by different theories, such as logical monism and logical pluralism. This paper aims to challenge logical monism, which posits that only a single logical system adheres to the principles of validity. It explains this on the basis of different systems held as equally strong in terms of their ability to establish definitive conclusions, and adhere to systems of validity relative to each system.

Keywords: Logical Monism, Validity, Logic, Logical systems, Reasoning, Rules of Validity, Logical pluralism, Intuitionistic logic, Classical logic.

Introduction

What is logic? In everyday discourse, it is held as a set of rules to reach a certain outcome. For example, in order to have a chance at winning the lottery, it would be logical to buy more tickets than others to have a better chance at this. In philosophical terms however, it is accepted as the study of arguments made with correct reasoning. The formal definition offers some clarity into what makes up "correct reasoning." When considering the word formally, it is the study of reasoning conducted by rules of validity. This raises the question of what validity is. Roughly, an argument is considered valid when there is no case with true premises or propositions that serve as the basis of an argument, which leads to a false conclusion.

More broadly, a conclusion must follow from its premises (Shapiro & Kissel, 2018). It is not entirely clear what "follows from" means in this context, or when the case of true premises and a false conclusion arises. However, there are several different logical systems, each associated with individual rules of validity, where this case can occur. Two of these theories are classical logic and intuitionistic logic, which are both associated with individual definitions of validity (Moschovakis, 2023). In classical logic, any conclusion in the form of P or not-P is valid, regardless of what the premise is. In this case, P or not-P means that something must either be true (P) or false (not-P) and having one of the two outcomes is regarded as true in classical logic (Plantin, 2021). Intuitionistic logic does not follow this notion. Which one is correct? Is it possible that both intuitionistic and classical logic can be? These questions are addressed by the notions of logical monism and logical pluralism.

To explain the difference in validity that several logical systems can have, monists hold that only one logical system suffices as valid, which I will argue against (Clark-Doane & Peacocke, 2022). Pluralists have a separate interpretation, maintaining that all logical systems are considered "equally strong" under their different definitions of validity (Beall & Restall, 2000). The meaning of "equally strong" is elaborated later. The definition of validity becomes relative to the logical system, so this overarching meaning of validity is not enough.

Validity in Logical Systems

As mentioned before, the definition of validity varies when considering two logical systems, classical logic and intuitionistic logic. Classical logic is often held as the one true logic that monists follow, meaning that other logical systems, such as intuitionistic logic, are not correct (Shapiro & Kissel, 2018). This is because the rules of validity are relative to each system. As Stanford Encyclopedia of Philosophy author Joan Moschovakis describes, intuitionistic logic excludes two laws that are established in classical logic, making it a subset of the classical logic system (2023). Because of this, certain arguments can be considered valid in classical logic. Two of the laws used to establish validity are not assumptions in intuitionistic logic, so these same arguments can be invalid in intuitionistic logic. Beyond various logical systems, the traditional definition of validity aligns in mathematical practice. In this lens, the conclusion of an equation must follow from the mathematical operations being utilized. This is similar to the formal definition of validity in the context of arguments, where the conclusion must follow from its premises (Shapiro & Kissel, 2018). Because of these differences, if we approach the question of whether logical monism or logical pluralism is accurate from the perspective of logical monism being an incomplete view of validity, we gain a new understanding. I argue that logical pluralism is a more accurate way to understand why different types of logic may lend themselves to various outcomes.

Classical Logic

As mentioned previously, logical monists regard classical logic as the most accepted system. It arose from Aristotle, making it one of the oldest and most well-established logical systems that exist (Shapiro & Kissel, 2018). In the view of a logical monist, other logical systems are not valid. Camillo Fiore and Lucas Rosenblatt describe the definition characteristics of the classical logic system in a separate paper (Fiore & Rosenblatt, 2023). Classical first order logic uses individual contexts and variables to donate specific objects and express generality – it involves a distributive lattice with logical operators, meaning that distributivity laws in mathematics are satisfied. For example, $p \Lambda (q V r)$ can be distributed as $(p \Lambda q) V (p \Lambda r)$. These basic distributive laws

are intuitive and relevant to several logical systems. It is the additional principles of classical logic that differentiate it from some other logic systems, such as intuitionistic logic. As Christian Plantin asserts in An Art of Thinking, it has certain foundational principles, such as non-contradiction, the excluded middle, and the identity "a=a" (2021). With these principles assumed to be true, they shape the validity of arguments under classical logic. Non-contradiction is the principle that a proposition cannot be both true and false, as this would be contradictory. Only one of these two options makes logical sense. The excluded middle asserts either P or not-P. If P is true, then not-P is false. If P is false, then not-P is true. This establishes that the proposition must either be true or false. The identity "a=a" means that each variable must be equal to itself. The concept of double negation is present, where $^{3}\neg\neg P \equiv P$. $\neg$ means not in this context. If P is false, $\neg$P is true, and $\neg\neg$P is false. If P is true, $\neg$P is false, and $\neg\neg$P is true, and this is the only other outcome possible, proving this conjecture (Plantin, 2021). In more simplistic terms, let us consider ice cream. If someone says they do not-not have ice cream, classical logic would simplify this to they do have ice cream. With these assumptions, classical logic can establish validity with these laws in place, whereas other logical systems cannot. In the example established above, the logical system of intuitionistic logic would not consider the statement valid. Along with this, the use of conditionals can establish false premises under classical logic.

For example, if P and not-P is a premise, this is deemed false under classical logic (Shapiro & Kissel, 2018). Consider ice cream again - if someone says that they both have and do not have ice cream, this would be held false. While seemingly counterintuitive, the definition of validity previously mentioned asserts that any argument with false premises is valid, so in the case of both having and not having ice cream, the argument would have to be valid with the false premise. This logical system provides a basis for deductive reasoning, which is the process of progressing from general ideas to specific conclusions, consistent with the definition of validity, where the conclusion follows from the premises of an argument (Bhandari, 2022). Under the concept of logical monism, this is a logical system that holds relevance and is considered valid, so only propositions established in classical logic should remain valid.

Intuitionistic Logic

A clear counterargument to the position of logical monism holding classical logic to be the "one true logic" is intuitionistic logic, as only one of the two can be true (Bezhanishvili & Jongh, 2010). Nick Bezhanishvili and Dick De Jongh describe the principles of the intuitionistic logic system. It is a separate type of logical system that builds its arguments as a constructive proof. It is the foundation of advanced mathematical systems, which allows for quick computing of complex integrals and derivatives. It is normative, as it uses a standard value of an argument, rather than enforcing any assumptions, as classical logic would (Bezhanishvili & Jongh, 2010). In order to use this standard value, it centers around building upon assumptions, rather than destroying constructivity (Moschovakis, 2023). What does constructivity mean? It refers to mathematical objects at face value and derives conclusions based on this (Mints, 2020). This means that laws which assume one of two truth values, rather than considering all possible outcomes, are rejected. The law of the excluded middle and the law of double negation elimination are not included in intuitionistic logic (Mints, 2020). Let us consider double negation. $\neg\neg P \equiv P$ would result in a false outcome, as double negation is not established in this logical system. In classical logic, the double negation operator would lead to either "true" or "false," but this is not assumed in intuitionistic logic. Under logical monism, the explained reason for this is that there is only one type of logical system that is valid.

Equally Strong

However, this seems highly unlikely, considering that other types of logic do exist, with the two described being intuitionistic logic and classical logic. Both are considered "equally strong." By the phrase "equally strong," I assert that we must look to a view that reaches a conclusion valid relative to its logical system. Author Boaz Schuman presents the Clean Divide View in the context of a separate logical system called Buridan logic, where there are two versions, one being the stronger and another being the weaker (Schuman, 2021). The stronger view provides a clear interpretation of the system, while the other asserts that an outcome is "probably technically false," meaning it does not provide full insight into how

Buridan logic works. More generally, I interpret this principle to mean that within two views, if one reaches a definitive conclusion and demonstrates a reasonable function of its logical system, whereas the other does not, the former is the "stronger" logical system.

Suppose that there are two situations: in one logical system, conclusion B follows from premise A, yet in the other, the result of premise A is inconclusive. We can maintain that the former logical system is "stronger" than the other as there is certainty in the conclusion. In this situation, the systems are not "equally strong," However, in the case of intuitionistic logic and classical logic, both are equally capable of this, meaning that both are equally strong. Classical logicians may refute this by asserting that classical logic can establish validity in places where intuitionistic logic cannot, and therefore, the system is more accurate. For example, consider the conclusion that I have or do not have ice cream. In addition, intuitionistic logic is a subset of classical logic, meaning that all conjectures proven in intuitionistic logic can also be established in classical logic (Moschovakis, 2023). The opposite is not true, which is why the law of double negation and excluded middle have different truth values in both systems. An easy way to understand this is considering squares and rectangles: squares are a subset of rectangles, yet not all rectangles are squares. The best explanation for the difference in validity between intuitionistic logic and classical logic is that the truth of an expression is relative to the logical system, so asserting one single type of logic does not account for these differences. Authors Camillo Fiore and Lucas Rosenblatt describe this principle as logical faithfulness: the theories being used should correspond to the logical system at hand (2023). Therefore, we can argue that there are multiple logical systems outside of classical logic that are just as important, and simply fall under different notions of validity.

Goldbach Disjunction

Logical pluralism is not only applicable to formal arguments but also in mathematical practice. Critics assert that logical monism is true by considering the Goldbach Disjunction (Clark-Doane & Peacocke, 2022). The Goldbach conjecture is the claim that every natural number greater than two is the sum of two prime numbers. The Goldbach Disjunction is the disjunction of the Goldbach conjecture and its negation. Classical logicians assert that the disjunction is true, by assuming that either the conjecture or its negation must be true (Clark-Doane & Peacocke, 2022). This is consistent with the law of the excluded middle, where either P or not-P is true (Plantin, 2021). This is met with disagreement from intuitionists, who argue that the disjunction cannot be established, as neither the conjecture nor its negation can be proven, so neither outcome can be clearly established (Panu, 2013). Both situations need to be constructed and proved, for intuitionists to treat the disjunction as true. Logical monism supports classical logic, meaning that the notion of intuitionism is disregarded altogether. In contrast, logical pluralism supports both theories. They are simply different logical systems, and attempting to compare the two which are made of different rules is a futile task. Even though in one system, the disjunction is considered valid, it is reasonable that in another it is not, because validity is relative to the logical system at hand.

Counterargument

Logical monists will argue that certain arguments are valid on their own, and classical logic is the only system that satisfies these arguments. On its own, there is no case in which the conclusion of P or not-P is false, so the argument is valid – classical logic correctly identifies this argument to be valid. Intuitionistic logic cannot establish this, although it seems obvious. However, this argument is rather limited. Arguments on their own cannot objectively be valid or not valid; they are valid relative to the logical system they belong to. Multiple logic systems have independent rules of validity, so classical logic is valid in relation to its system, and intuitionistic logic is valid in relation to its system. The counter argument being made aligns with the rules of validity in the classical logic system, so it fails to look beyond this system. Therefore, it is imprecise to assert that the rules of classical logic are arbitrarily true.

Conclusion

Logical monism is described as a widely accepted logical system. However, it does not incorporate the idea that there are various rules of validity relative to other logical systems, all of which are equally strong. Intuitionistic logic and classical logic are two such logical systems that have different rules of validity, but are equally strong relatively. A way to understand this is through logical pluralism, which holds that multiple logical systems exist with different rules of validity, which are equally strong, so assuming only one type of logical system that suffices is a feeble task. Based on these findings, it is clear that logical monism does not offer a realistic interpretation of the various logical systems that are existent. Logical pluralism is the best alternative to consider.

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Construction of the χ^2 Goodness-of-Fit Test

By JunYang (Michael) Ma

Author Bio

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Abstract

The goal of statistical tests is to use data to learn about the nature of the system from which it is collected. It is an important bridge between raw data and interpreting its meaning/ drawing conclusions from it. One recent use of statistical tests is in COVID-19 tests, where statistics is used to determine the false positive rate of such tests to assess their accuracy.

In this paper we will focus on one of the most used statistical tests, the Chi-square test, first published by Karl Pearson in 1900 to investigate the 'deviations from the probable'.[6] We will first discuss the general procedure of hypothesis testing, followed by the construction of an appropriate estimator for statistical models before finally, finding the limiting distribution of the estimator. Using these properties, we will construct the Chi-square distribution and discuss its relevance to hypothesis testing. Python simulations using the Chi-square test will be generated to investigate the effect of multiple variables on its statistical power.

Keywords: Chi-square, Goodness-of-Fit test, Hypothesis testing, Multinomial distribution, Maximum likelihood estimation, Fisher information, Central limit theorem, Monte Carlo Simulation, Mendelian inheritance, Overparametrisation

Table of Notations

Symbol	Meaning
θ_*/θ	True value of parameter θ
$\hat{\theta}$	MLE of parameter θ
p and $\hat{p}$	True probabilities and estimated probabilities respectively
Ω	Sample space
Θ	Parameter space
X_i	Random variable with index i
Y_j	Number of observations of category j

Hypothesis Testing Framework

The goal of this paper is to rigorously conduct statistical tests. To do this, we need to have clear definitions for each part of the test, from collecting the data to extracting information from the data. The collected data points are realisations of random variables that represent the outcome of an experiment. In statistical terms, the possible outcomes of the random variable come from the sample space, which is the set of all possible outcomes. Since random variables are randomly drawn, we can only calculate the probability of a specific outcome. The data collected are then used to construct a statistical model: a collection of probability distributions, which try to describe the true distribution that the data originate from.

The procedure of statistical tests is structured around H_0 (the null hypothesis) and H_1 (the alternative hypothesis). H_0 proposes that the data collected have no statistical significance. However, if the statistical test shows that the data collected have enough evidence against H_0, then we can reject it, and that is when a significant discovery is made.
Due to the test's random nature, there will almost always be a chance of errors. Let α denote the probability of type I error, which is when the test rejects H_0 given it is true, while β is the probability of type II error, which is when H_0 is retained (not rejected) given H_1 is true. If H_0 is rejected when a test has a small type I error, there is a higher chance that the information is part of a general trend and not a fluke. The power of a test is denoted by $1 - \beta$ -- good test would have not only a small type I error but also a high power. A low type I is preferred since scientists are comfortable making a discovery only when they are fairly certain it is true.

A test statistic is needed to reject H_0, which will be compared to a critical value depending on how much error is tolerated.

Since we are working with probabilities, the error tolerated is in sense that chance that we are wrong. Sometimes it is more valuable to know the strength of the evidence against H_0. Towards this end, a p-value could be calculated, and the smaller the p-value (smaller than 0.05 is generally considered strong), the stronger the evidence against H_0.

One type of statistical tests are the goodness-of-fit tests. They are useful in investigating whether the distributions in the statistical model matches the collected data. We will focus on the Chi-square test, with the following test statistic:

$$C_n = \sum_{j=1}^{k} \frac{(Y_j - np_j)^2}{np_j}.$$

The intuition behind this test statistic is to find the size of the difference between the observed, Y_j, and expected, p_j, values in each category that the data is recorded in (divided by np_j to adjust for the size of the category). Hence when C_n is larger, the statistic implies that the observed data deviates from the expected distribution more, making it more likely that H_0 is rejected.

Origin of the MLE; Derivation from the KL Divergence

The purpose of this section is to motivate the derivation of the test-statistics. For our statistical model we will use parametric distributions. This is when the p.d.f (probability distribution function) can be defined by a finite number of parameters. E.g. The parameter for a weighted coin flip is the probability of it coming out heads. To find the parameters would be equivalent to knowing the entire distribution.

The parametric model we will focus on is the multinomial distribution, where there are k categories that the outcome could be, with each outcome having a fixed probability. Taking n samples from such distribution would yield observations $X_1=(X_{11},\ldots,X_{1k})$, …, $X_n=(X_{n1},\ldots,X_{nk})$, where each X_i is a unit vector resulting from a specific category. The multinomial distribution captures the probability distribution for the all the possible outcomes:

$$f(\vec{Y};\vec{p}) = \binom{n}{Y_1 \cdots Y_k} \prod_{j=1}^{k} p_j^{Y_j}$$

where Y_j, equal to the sum of X_{ij} over all i's, is the total number of observations for each of the k categories, and $p=(p_1,p_2,\ldots,p_k)$ is the defining parameter or the probability of getting each of the k different colours in one draw. Note that the distribution itself is governed by each Y_j. The multinomial distributions are a good fit for many models where the outcomes are a fixed number of discrete categories, with the simplest being the binomial distribution.
In order to construct a statistical test, we first need a good estimator of the parameters from our sample. First, we need to develop a notion that can assess the "closeness of two distributions.

Define the Kullback-Leibler divergence as [3]

$$\mathrm{KL}(f(x), g(x)) = \int_x f(x) \log \frac{f(x)}{g(x)} \, \mathrm{dx}$$

where f and g denote two distributions. For convenience we denote $KL(\theta_*, \hat{\theta})$ to mean $KL(f(x;\theta_*), f(x;\hat{\theta}))$. It is useful because of the crucial property that the KL divergence is 0/minimised if and only if the two input distributions are identical. Therefore, finding a good estimator, becomes the problem of minimising the KL divergence. From these properties we can derive the maximum likelihood estimator, the function, which is maximised when good estimates of the parameters are inputted [4,p.122]

$$\mathcal{L}(\theta) = \prod_{i=1}^{n} f(X_i;\theta)$$

Proof is in Section 8.1.

Here f represents the probability distribution of the model, and the X_i's represents a specific set of observations. As the name suggests, the goal is to find the parameters θ that maximises the likelihood function. By maximising the MLE we will have found estimates for the parameters which makes the given observations most probable. Specifically for the multinomial distribution the likelihood function is

$$\mathcal{L}(\vec{p}) = \prod_{j=1}^{k} p_j^{Y_j}$$

So how do we find the parameter which gives the maximum value of L(p)? we can use calculus and differentiate the function with respect to each parameter. This gives us the following estimations:

$$\hat{p}_j = \frac{Y_j}{n}$$

for each category j, hence giving us our MLE estimation, which is simply the sample average

Variance Matrix: Convergent Distribution of the Multinomial Distribution

Even though we have a good estimator for the parameter that converges to the true parameter, we still don't know the rate of convergence. To construct the Chi-square test it is crucial to find the variance, or the spread of the MLE around * to construct the Chi-square test.

Asymptotic Normality with Central Limit Theorem

Here's a key result from statistics that will help us.

Proposition 1 Central Limit Theorem (CLT) [4,p.77] Let $X_1,X_2,\ldots$ be IID (independent and identically distributed random variables) with finite mean and variance and let $\bar{X}$ be the sample average. Then

$$\frac{\bar{X}_n - \mu}{\sqrt{\mathbb{V}(\bar{X}_n)}} = \frac{\sqrt{n}(\bar{X}_n - \mu)}{\sigma} \rightsquigarrow N(0,1) \;\text{ as }\; n \to \infty$$

where $V(\bar{X})$ is the variance of the sample average and μ is the expectation. The squiggly arrow shows convergence in distribution, meaning that the limit of the *cumulative* distribution function of the L.H.S of the expression approaches that of the R.H.S if n is sufficiently large.

The theorem says that the sample average of a random variable will have the recognisable normal distribution with increasing sample size, as well as telling us the rate of convergence. For the multinomial distribution with several parameters, we need another version of the CLT.

Proposition 2 Multinomial CLT [4,p.53]
Let Y and μ be vectors such that

$$\vec{Y} = \begin{bmatrix} Y_1 \\ \vdots \\ Y_k \end{bmatrix}, \vec{\mu} = \begin{bmatrix} \mu_1 \\ \vdots \\ \mu_k \end{bmatrix} = \begin{bmatrix} \mathbb{E}(Y_1) \\ \vdots \\ \mathbb{E}(Y_k) \end{bmatrix}$$

and the variance-covariance matrix is

$$\mathbb{V}(Y) = \begin{bmatrix} \mathbb{V}(Y_1) & Cov(Y_1, Y_2) & \cdots & Cov(Y_1, Y_k) \\ Cov(Y_2, Y_1) & \mathbb{V}(Y_2) & \cdots & Cov(Y_2, Y_k) \\ \vdots & \vdots & \ddots & \vdots \\ Cov(Y_k, Y_1) & Cov(Y_k, Y_2) & \cdots & \mathbb{V}(Y_k) \end{bmatrix}$$

The vectors p̂ and p are the vectors Y and μ divided by n respectively, and the asymptotic normality of vector p̂ is

$$\sqrt{n}(\hat{\vec{p}} - \vec{p}) \rightsquigarrow N(0, \Sigma)$$

where

$$\Sigma = \begin{bmatrix} p_1(1-p_1) & -p_1p_2 & \cdots & -p_1p_k \\ -p_2p_1 & p_2(1-p_2) & \cdots & -p_2p_k \\ \vdots & \vdots & \ddots & \vdots \\ -p_kp_1 & -p_kp_2 & \cdots & p_k(1-p_k) \end{bmatrix}$$

Thus, we have Σ, which tells us the spread of the asymptotically normal distribution. Note that the CLT applies here because the MLE estimation happens to be the sample averages for the multinomial distribution. Otherwise, this would not work, and the variance would need to be computed through the Fisher information matrix. Overall, the limiting distribution of the MLE vector is

$$\sqrt{n}(\hat{\vec{p}} - \vec{p}) \rightsquigarrow N(0, \Sigma)$$

We will need to use the Σ^{-1} in section 5, which is calculated in section 8.2.

$$W - \mu \sim N(0, \sigma^2)$$
$$\frac{W - \mu}{\sigma} \sim N(0, 1) = Z$$

We will use this transformation in section 4 as part of our proof.

Properties of Chi-square test

Convergence of the Chi-Square Statistic

With the consistency and asymptotic normality of the MLE, we will be able to find the distribution of the Chi-square statistic. First, we need to define the Chi-square distribution.

If $Z=(Z_1,\ldots,Z_k)^T$ is a vector of k independent standard normal distributions, then

$$\chi^2_k = \sum_{i=1}^{k} Z_i^2 = \vec{Z}^T\vec{Z}$$

There is only one parameter, k, for the Chi-square distribution, where k is a positive integer.
So far, we concluded that the MLE estimators are $\hat{p}=(\hat{p}_1,\ldots,\hat{p}_{k-1})^T=(Y_1/n,\ldots,Y_{k-1}/n)^T$, and it has the variance matrix . To compute the distribution of the Chi-square statistic, we will rewrite the following expression:

$$\sqrt{n}(\hat{\vec{p}} - \vec{p})^T\Sigma^{-1}\sqrt{n}(\hat{\vec{p}} - \vec{p})$$

in two different ways. The motivation is to change the Chi-square distribution into a form which includes the MLE, and hence can be expanded algebraically.

Firstly, by expanding the expression (see 8.3) using matrix operations,

$$\sqrt{n}(\hat{\vec{p}} - \vec{p})^T\Sigma^{-1}\sqrt{n}(\hat{\vec{p}} - \vec{p}) = \sum_{j=1}^{k} \frac{(Y_j - np_j)^2}{np_j} = C_n$$

gives us the Chi-square statistic. Proof is in 8.4. We recognise Σ^{-1} as $I(p)$.

Secondly, we observe that the expression can be split up into two objects, which is given by (13) and its transpose. Since $\sqrt{n}(\hat{p}-p)$ converges to $N(0, \Sigma)$ by (7), it can be transformed to the standard normal by (8) and (9).

Σ is a positive semi-definite matrix, so it can have 'square roots.' Hence, we have

$$\begin{aligned}&\sqrt{n}(\hat{p}-p)^T\Sigma^{-1}\sqrt{n}(\hat{p}-p)\\&=(\Sigma^{-1/2}\sqrt{n}(\hat{p}-p))^T(\Sigma^{-1/2}\sqrt{n}(\hat{p}-p))\\&\rightsquigarrow \vec{Z}^T\vec{Z}\\&=\chi^2_{k-1}\end{aligned}$$

since p has k-1 rows. The second line is because the positive semidefinite property of Σ implies it is symmetric, so $\Sigma^T=\Sigma$. Hence, we can move one of the $\Sigma^{-1/2}$ into the transpose with the identity $(AB)^T=B^TA^T$.

$$\therefore C_n=\sum_{j=1}^{k}\frac{(Y_j-np_j)^2}{np_j}\sim\chi^2_{k-1}$$

As there is one redundant parameter, the convergence to is expected. Q.E.D

Using the Chi-Square Test

To conduct the Chi-Square test, first we set up our null and alternative hypotheses:

H_0: the multinomial distribution has the parameter p.

H_1: the multinomial distribution does not have the parameter p. and set the significance level α of the test, which is the allowance on type I error.

After finding Y_j for each category, we calculate the Chi-square statistic C_n by (1). We also need to find the critical value of the Chi-square test based on the significance level and the degrees of freedom, k-1.

Simulations

With the Chi-square test's convergence proven theoretically, we shall explore some conditions under which the Chi-square test is applicable; specifically, we will investigate how several variables can affect the power of the test. In the first simulation we will look at a practical scenario involving the colour of camellia flowers and how we can test a basic result in gene theory with the Chi-square test. In the second simulation we will see the idea of overparametrisation (when there is an excess of parameters) and how it can affect the Chi-square test.

Simulation 1: Colours of Camellias

In a simple model of inheritance, genes are lengths of DNA that determine one trait of an organism. Different versions of one gene are called alleles, and they are always in the same location on the same chromosome.

In most animals and plants, the cells are diploid, meaning that each type of gene contains two alleles, which might be different or the same. The nice property about alleles, which makes them fit for the Chi-square test, is that they only give finitely many expressions. The genotypes (specific alleles for an organism's genes) give a discrete set of phenotypes (traits given by the phenotype).

During reproduction, meiosis scrambles the alleles in the resulting cells to create genetic diversity. Hence the occurrence of a phenotype in an offspring is a random variable, and the multinomial distribution is a good model for the phenotypic ratio of the offspring plants that can be tested by the Chi-square test.

The specific example we will look at is the colour of the petals of camellia flowers. They are usually red or white, but when red and white camellias are bred together, they produce a third type with red and white patterns. In total there are three discrete

outcomes.[2] According to gene theory, if a field of only the red-and-white variant of camellias are bred, then the offspring will have a colour ratio of red:red-and-white:white = 1:2:1. The Chi-square test can be used to investigate whether this theory holds, and how effectively the test rejects it.

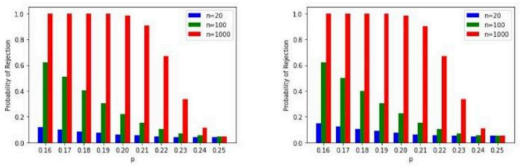
Method

We use Monte Carlo simulations, which entails generating random data that will create converging numerical values. With the multinomial distribution in the code, we will generate random data to arrive at the power of each test. Let p_1,p_2 and p_3 represent the probabilities for red, red-and-white, and white respectively. We will set up the following hypotheses, and carry the test at significance level of 5%: H_0 -- the multinomial distribution for the colours have parameters (p_1,p_2,p_3) = (1/4,1/2,1/4) / H1: the multinomial distribution is not described by H_0.

To carry out the simulation, we will use python to generate multinomial distributions with (p_1,p_2,p_3) = (p,1/2,1/2-p), where p is from (0.16,0.17,…,0.25). We will also test sample sizes of 20, 100, and 1000. Each experiment will be repeated 10,000 times and the probability of rejection is calculated by the number of times the test rejected H0 divided by 10000. For simulation 1, we will also directly compute the theoretical probability of rejection for comparison.

Interpreting results

Both theoretical and experimental powers for varying p are displayed side by side:



(a) Theoretical probability of rejection (b) Simulated probability of rejection

Figure 4: Independent variables p and n are represented by the x-axis and colour of bars respectively. Probability of rejection is the dependent variable and is represented by the y-axis.

The two plots are almost identical upon initial inspection. For small values of n, such as 20, there is a lower probability of rejection in the simulations. This could just be due to the simulation's random nature, as smaller sample sizes have smaller information to converge to theoretical values. The overwhelming similarity suggests that running 10000 Monte Carlo trials is sufficient to generate an accurate representation of power in this simulation.

When p=0.25 (when H_0 is true), all three sample sizes produce a probability of rejection of around 0.05. This is expected since the test is designed to have a significance level of 0.05, so the probability of type I error will

be 0.05. Further comparing the p=0.25 data, the n=20 bar is slightly lower than the n=100 and n=1000 bars, which are closer to 0.05. The difference demonstrates the LLN; as n increases, the convergence to the expected value also strengthens.

From right to left, the models deviate more from H_0. Note that all values of p except for 0.25 are different from H_0 and so should be rejected. It can be seen that from all three sample sizes, the power increases from right to left, suggesting that the Chi-square test is able to reject more of the tests, when p is smaller. We can conclude that the power, the probability of rejecting the H_0 when it is false, of the Chi-square test also increases as the discrepancy between H_0 and the generating distribution increases.

Comparing the trend between all bars of different sample sizes, there is a clear increase in power from n of 20 to 100 to 1000, across all p (except for p=0.24 and 0.25). Whereas the n=20 bars never exceed 0.2, the n=1000 bars already reached 100% rejection by p=0.19. In addition, as discrepancy with H0 increases, the rate at which the power increases is also faster for higher sample sizes. This means that the power of the Chi-square test increases significantly when sample size is increased. An explanation for this is that the variance of the MLE (which is the sample average) is inversely proportional to n. Therefore, with higher sample sizes the variance decreases, so it is easier to tell when the data does not come from H_0.

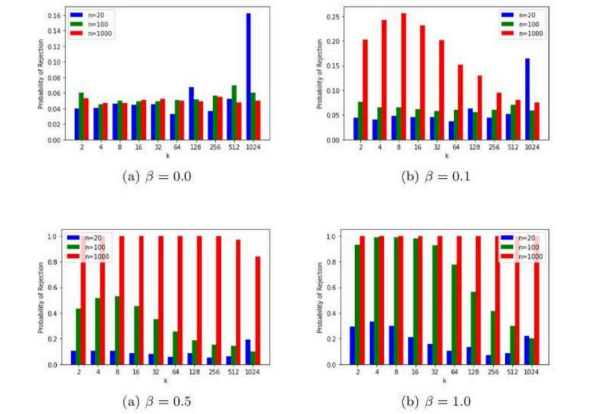
Hence from varying the two parameters n and p, the bar graph shows that the power of the Chi-square test has a positive correlation with both the sample size and the discrepancy between H_0 and the true distribution to H_0.

Overparametrisation

Overparametrisation is an active topic of discussion. As we try to understand the world with models, like in a complex ecosystem, we can often end up with too many parameters and not enough observations. In this simulation we repeat a similar procedure to the previous one, but instead of varying the value of p, we will vary the number of categories in the model then introduce a variable β which will deviate the true distribution based on the category number. For the true distribution we will use $p=(1^{\beta}c,2^{\beta}c,\ldots,k^{\beta}c)$, where c is a constant that will adjust all the probabilities to sum to 1.

The hypotheses are as follows --
H0: the multinomial distribution have k parameters and each parameter is the same
/ H_1: the multinomial distribution is not described by H_0

The bigger the value of β, the more it deviates from H_0. When it is 0, the true distribution will be the same as H_0. Like experiment 1, when the true distribution agrees with H_0, the power of the test fluctuates around 0.05. Large values of n tend to show less fluctuation, but not by a great extent. A bigger number of iterations may yield more converging results.



(a) $\beta = 0.0$ (b) $\beta = 0.1$

(a) $\beta = 0.5$ (b) $\beta = 1.0$

Figure 5: Probability of rejection against number of categories k for four values of β.

The bigger the parameter β, the less uniform the true distribution, hence increasing discrepancy to H_0. The graphs for β=0.1, 0.5, 1 display an eventually decreasing power with increasing k. This is caused by an increase in the parameter to sample ratio as k increases. The more parameters there are compared to sample size, the less accurately the observations will be able to capture the true distribution.

However, there is not a directly negative correlation between k and power. Notably, for bigger values of β, the power is unimodal and peaking at around k=4 or k=8. There are likely two competing effects going on as k is increased; increasing k likely decreases the power but also increases the distance from H_0.

There are also significant anomalies in the trends for k=1024, especially for lower values of n and β. There could be two possible sources of this anomaly. Either there is an error with the random seed generation in drawing the random variables, or the number of categories is too large to generate a converging power. The first explanation is unlikely, since repeats of this experiment in a different Python code yielded similar but not identical results. The latter explanation is more likely as the CLT can converge slower for more parameters.

Conclusion

In the paper we have shown the key parts which are needed to construct the Chi-square test statistic. From the multinomial distribution to estimating the mean and variance through the MLE and CLT. With these two tools it is possible to link the Chi-square test statistic with the Chi-square distribution through its definition.

Although the multinomial distribution may seem limiting, it is versatile as it can model many distributions with discrete categories. This gives the Chi-square test a range of applications in real life scenarios.

Through the computer simulations, we have shown that the Chi-square test is very sensitive to reject the null hypothesis when the tested distribution differs slightly from the null. The sensitivity is further magnified with an increasing number of trials, which confirms the central limit theorem in practice.

Appendix

From KL to MLE

Here we derive an expression for the MLE function from KL divergence. Using the definition of the KL divergence, we can express it as the difference of two expectations.

$$\begin{aligned}\mathrm{KL}(\theta_*, \theta) &= \int_x \log \frac{f_{\theta_*}(x)}{f_\theta(x)} f_{\theta_*}(x) dx \\ &= -\left(\int_x \log(f_\theta(x)) f_{\theta_*}(x) dx - \int_x \log(f_{\theta_*}(x)) f_{\theta_*}(x) dx \right) \\ &= -\mathbb{E}_{f_{\theta_*}}[\log f_\theta(x)] + \mathbb{E}_{f_{\theta_*}}[\log f_{\theta_*}(x)]\end{aligned}$$

which is fit for applying the LLN, allowing us to replace the expectations with averages

$$\hat{\mathrm{KL}}(\theta_*, \theta) = -\frac{1}{n} \sum_{i=1}^{n} f_\theta(X_i) + c(\theta_*)$$

$c(\theta_*)$ simply denotes a constant independent of θ. Using the identification property of KL, we know that when it is at the absolute minimum, then the estimator will converge to the truth. Hence, we want to minimise KL.

$$\begin{aligned}\hat{\theta}^{\mathrm{MLE}} &= \arg\min_{\theta \in \Theta} \hat{\mathrm{KL}}(\theta_*, \theta) \\ &= \arg\min_{\theta \in \Theta} -\frac{1}{n} \sum_{i=1}^{n} f_\theta(X_i) + c(\theta_*) \\ &= \arg\min_{\theta \in \Theta} -\frac{1}{n} \sum_{i=1}^{n} f_\theta(X_i) \\ &= \arg\max_{\theta \in \Theta} \sum_{i=1}^{n} f_\theta(X_i)\end{aligned}$$

Thus, we obtain the likelihood function.

Inverting (through row reduction)

$$\left[\begin{array}{cccc|cccc} p_1(1-p_1) & -p_1p_2 & \cdots & -p_1p_{k-1} & 1 & 0 & \cdots & 0 \\ -p_2p_1 & p_2(1-p_2) & \cdots & \vdots & 0 & 1 & \cdots & 0 \\ \vdots & \vdots & \ddots & -p_{k-2}p_{k-1} & \vdots & \vdots & \ddots & \vdots \\ -p_{k-1}p_1 & \cdots & -p_{k-1}p_{k-2} & p_{k-1}(1-p_{k-1}) & 0 & 0 & \cdots & 1 \end{array}\right]$$

$$r_i \leftarrow r_i - \frac{p_i}{p_1} r_1 \text{ for } i \in \{2, \ldots, k-1\}$$

$$\left[\begin{array}{cccc|cccc} p_1(1-p_1) & -p_1p_2 & \cdots & -p_1p_{k-1} & 1 & 0 & \cdots & 0 \\ -p_2 & p_2 & \cdots & \vdots & -\frac{p_2}{p_1} & 1 & \cdots & 0 \\ \vdots & \vdots & \ddots & 0 & \vdots & \vdots & \ddots & \vdots \\ -p_{k-1} & \cdots & 0 & p_{k-1} & -\frac{p_{k-1}}{p_1} & 0 & \cdots & 1 \end{array}\right]$$

$$r_1 \leftarrow \frac{r_1}{p_1}$$

$$\left[\begin{array}{cccc|cccc} 1-p_1 & -p_2 & \cdots & -p_{k-1} & \frac{1}{p_1} & 0 & \cdots & 0 \\ -p_2 & p_2 & \cdots & \vdots & -\frac{p_2}{p_1} & 1 & \cdots & 0 \\ \vdots & \vdots & \ddots & 0 & \vdots & \vdots & \ddots & \vdots \\ -p_{k-1} & \cdots & 0 & p_{k-1} & -\frac{p_{k-1}}{p_1} & 0 & \cdots & 1 \end{array}\right]$$

$$r_1 \leftarrow r_1 + \sum_{i=2}^{k-1} r_i \left(\sum_{i=2}^{k-1} r_i = \left[\begin{array}{ccc|ccc} p_1+p_k-1 & p_2 & \cdots & p_{k-1} & 1+\frac{p_k}{p_1}-\frac{1}{p_1} & 1 & \cdots & 1 \end{array}\right] \right)$$

$$\left[\begin{array}{cccc|cccc} p_k & 0 & \cdots & 0 & 1+\frac{p_k}{p_1} & 1 & \cdots & 1 \\ -p_2 & p_2 & \cdots & \vdots & -\frac{p_2}{p_1} & 1 & \cdots & 0 \\ \vdots & \vdots & \ddots & 0 & \vdots & \vdots & \ddots & \vdots \\ -p_{k-1} & \cdots & 0 & p_{k-1} & -\frac{p_{k-1}}{p_1} & 0 & \cdots & 1 \end{array}\right]$$

$$r_1 \leftarrow \frac{r_1}{p_k}, r_i \leftarrow \frac{r_i}{p_i} \text{ for } i \in \{2, \ldots, k-1\}$$

$$\left[\begin{array}{cccc|cccc} 1 & 0 & \cdots & 0 & \frac{1}{p_1}+\frac{1}{p_k} & \frac{1}{p_k} & \cdots & \frac{1}{p_k} \\ -1 & 1 & \cdots & \vdots & -\frac{1}{p_1} & \frac{1}{p_2} & \cdots & 0 \\ \vdots & \vdots & \ddots & 0 & \vdots & \vdots & \ddots & \vdots \\ -1 & \cdots & 0 & 1 & -\frac{1}{p_1} & 0 & \cdots & \frac{1}{p_{k-1}} \end{array}\right]$$

$$r_i \leftarrow r_i + r_1 \text{ for } i \in \{2, \ldots, k-1\}$$

$$\left[\begin{array}{cccc|cccc} 1 & 0 & \cdots & 0 & \frac{1}{p_1}+\frac{1}{p_k} & \frac{1}{p_k} & \cdots & \frac{1}{p_k} \\ 0 & 1 & \cdots & \vdots & \frac{1}{p_k} & \frac{1}{p_2}+\frac{1}{p_k} & \cdots & \frac{1}{p_k} \\ \vdots & \vdots & \ddots & 0 & \vdots & \vdots & \ddots & \vdots \\ 0 & \cdots & 0 & 1 & \frac{1}{p_k} & \frac{1}{p_k} & \cdots & \frac{1}{p_{k-1}}+\frac{1}{p_k} \end{array}\right]$$

giving us Σ^{-1} on the right.

Chi-Square Statistic from Matrix Expansions

when it is at the absolute minimum, then the estimator will converge to the truth. Hence, we want to m

$$\sqrt{n}(\hat{p}-p)^T\Sigma^{-1}\sqrt{n}(\hat{p}-p)$$

$$= n\begin{bmatrix} \frac{Y_1}{n}-p_1 \\ \cdots \\ \frac{Y_{k-1}}{n}-p_{k-1} \end{bmatrix}^T \begin{bmatrix} \frac{1}{p_1}+\frac{1}{p_k} & \frac{1}{p_k} & \cdots & \frac{1}{p_k} \\ \frac{1}{p_k} & \frac{1}{p_2}+\frac{1}{p_k} & \cdots & \frac{1}{p_k} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{1}{p_k} & \frac{1}{p_k} & \cdots & \frac{1}{p_{k-1}}+\frac{1}{p_k} \end{bmatrix} \begin{bmatrix} \frac{Y_1}{n}-p_1 \\ \vdots \\ \frac{Y_{k-1}}{n}-p_{k-1} \end{bmatrix}$$

$$= \frac{1}{n}\begin{bmatrix} Y_1-np_1 \\ \vdots \\ Y_{k-1}-np_{k-1} \end{bmatrix}^T \begin{bmatrix} \frac{1}{p_1}+\frac{1}{p_k} & \frac{1}{p_k} & \cdots & \frac{1}{p_k} \\ \frac{1}{p_k} & \frac{1}{p_2}+\frac{1}{p_k} & \cdots & \frac{1}{p_k} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{1}{p_k} & \frac{1}{p_k} & \cdots & \frac{1}{p_{k-1}}+\frac{1}{p_k} \end{bmatrix} \begin{bmatrix} Y_1-np_1 \\ \vdots \\ Y_{k-1}-np_{k-1} \end{bmatrix}$$

$$= \frac{1}{n}\begin{bmatrix} Y_1-np_1 \\ \vdots \\ Y_{k-1}-np_{k-1} \end{bmatrix}^T \begin{bmatrix} \frac{Y_1-np_1}{p_1}+\frac{1}{p_k}(\sum_{j=1}^{k-1}Y_j-n\sum_{j=1}^{k-1}p_j) \\ \vdots \\ \frac{Y_{k-1}-np_{k-1}}{p_{k-1}}+\frac{1}{p_k}(\sum_{j=1}^{k-1}Y_j-n\sum_{j=1}^{k-1}p_j) \end{bmatrix}$$

$$= \frac{1}{n}\begin{bmatrix} Y_1-np_1 \\ \vdots \\ Y_{k-1}-np_{k-1} \end{bmatrix}^T \begin{bmatrix} \frac{Y_1-np_1}{p_1}+\frac{1}{p_k}(n-Y_k-n(1-p_k)) \\ \vdots \\ \frac{Y_{k-1}-np_{k-1}}{p_{k-1}}+\frac{1}{p_k}(n-Y_k-n(1-p_k)) \end{bmatrix}$$

$$= \frac{1}{n}\begin{bmatrix} Y_1-np_1 \\ \vdots \\ Y_{k-1}-np_{k-1} \end{bmatrix}^T \begin{bmatrix} \frac{Y_1-np_1}{p_1}+\frac{np_k-Y_k}{p_k} \\ \vdots \\ \frac{Y_{k-1}-np_{k-1}}{p_{k-1}}+\frac{np_k-Y_k}{p_k} \end{bmatrix}$$

$$= \frac{1}{n}\sum_{j=1}^{k-1}(Y_j-np_j)\left(\frac{Y_j-np_j}{p_j}+\frac{np_k-Y_k}{p_k}\right)$$

$$= \sum_{j=1}^{k-1}\frac{(Y_j-np_j)^2}{np_j}+\left(\frac{np_k-Y_k}{np_k}\right)\sum_{j=1}^{k-1}(Y_j-np_j)$$

$$= \sum_{j=1}^{k-1}\frac{(Y_j-np_j)^2}{np_j}+\frac{np_k-Y_k}{np_k}(n-Y_k-n(1-p_k))$$

$$= \sum_{j=1}^{k-1}\frac{(Y_j-np_j)^2}{np_j}+\frac{(np_k-Y_k)^2}{np_k}$$

$$= \sum_{j=1}^{k}\frac{(Y_j-np_j)^2}{np_j} = C_n$$

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