Takashi Murakami: Art on the Cutting Edge of Pop Art, Traditional Japanese Landscape and History Painting, Comic Art, and Graphic Design

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Abstract

Takashi Murakami fundamentally influenced contemporary Japanese art, creating a new art movement called Superflat. This paper explores his artworks through art historical methods of formal analysis to highlight how Murakami not only "infiltrate[d] the manga and anime fan communities with his art, he also managed to throw popular culture into the realms of fine art." .This assertion is supported by a visual analysis of three Murakami artworks: *My Lonesome Cowboy* (Sculpture made of oil, acrylic, fiberglass and iron, 100" x 46" x 36", 1998), *Mr. Rainbow Dob* (Offset lithograph, 26.8" x 26.8", 2006) and *Superflat my first love flowers* (Archival pigment print, 29.5" x 29.5", 2020). These artworks showcased the incorporation of traditional Nihonga aesthetics for which Murakami is formally trained into which he blends popular culture elements like manga and anime, creating the SuperFlat art form and new Japanese identity through mass merchandizing. The paper concludes that Murakami was a driving force of Japanese contemporary art and identity while providing suggestions for further research.

Keywords: Takashi Murakami, Superflat, Manga

1. Introduction

This research paper presents the confluence of factors that allowed Takashi Murakami to create a new art form that would inform what many foreigners today consider the Japanese identity. To contextualize many of these factors, one ought to understand the traditional Japanese art of Nihonga to appreciate how Murakami combined this ancestral art form with manga and anime to create Superflat during the aftermath of World War II (1939-45) and subsequent economic downturns that accelerated Japan's adoption of westernized ideals. This research paper argues that Takashi Murakami's exploration of traditional Japanese art, manga, anime, and popular culture (Otaku) influenced the subject matter, medium, and meaning of his artworks, creating a new art movement, Superflat, which brought Japan's uniquely flat and consumer-centric identity to the world's attention. This paper shall examine this influence through three Murakami artworks: *My Lonesome Cowboy* (Figure 1), *Mr. Rainbow Dob* (Figure 2) and *The Future will Be Full of Smile! For Sure!* (Figure 3).

1.1 Traditional Japanese Art of Nihonga

To understand Superflat, one must consider its cultural and stylistic influences, beginning with Nihonga. Around the early 1900s, Nihonga was first used to describe Japanese paintings that adhered to traditional Japanese materials, techniques, and conventions. During the Meiji period, Japan began cross-border trade with foreign lands at the time, resulting in increased modernization and exposure to western artistic styles and culture. As a result, Nihonga and its antithesis, Yoga, were introduced to mark the difference between traditional Japanese artworks and art influenced by

the West. Eventually, Nihonga became an umbrella term for past Japanese art styles like Yamato-e and ukiyo-e, for which traditional Japanese art is most popularly known. In contrast to the comparative depth of western-influenced Yoga which used techniques like modeling and perspective, Nihonga emphasized flatness. Refraining from a realistic representation of its subject matter, Nihonga includes the emphasized use of outlines using Sumi ink and the layering of colors, simplified expressions, and color applied in flat areas. The media used in Nihonga typically included a mixture of natural mineral pigments with water and animal glue (Sumi ink) applied to Japanese paper (Washi) or Japanese silk (Eginu). This style attempted to evoke a greater understanding of the beautiful impermanence of objects and the importance of consciously staying in the moment, like admiring cherry blossom trees that bloom each spring before withering.

2. Murakami's Background

Born on February 1, 1962, in Tokyo, Japan, Takeshi Murakami is a contemporary Japanese artist who pioneered the Superflat art movement in 2000, combining Japanese artistic traditions with popular culture and commercial themes. He is considered the "most successful Japanese contemporary artist to have emerged in the early 1990s" (Favell, 2014, p. 135). In 2008, he was the only visual artist named as one of the top "100 Most Influential People" by Time magazine. In 2010, Murakami became the first Japanese and third contemporary artist to exhibit at the prestigious Palace of Versailles. Murakami also expanded beyond the fine-art world and collaborated with many high-end fashion brands like Louis Vuitton and Marc Jacobs and entertainers like controversial rapper Kayne West, singer-songwriter Billie Eilish, and music producer Pharrell Williams. His artworks have been showcased in over eighty prominent exhibits, and one of his sculptures, My Lonesome Cowboy, sold for over $15 million in 2008. (Naka, 2023, p.130). From 2000 to 2019, Murakami sold the largest number of artworks than any other contemporary artist (Table 1), leading to substantial growth in the Japanese contemporary art market over the last twenty years (Table 2).

Table 1. Top Contemporary Artists by number of lots sold (2000-2019), https://www.artprice.com/artprice- reports/the-contemporary-art-market-report-2020/multiple-choice

#	Artist	Lots Sold	Average Price	Total Price
1	Takashi Murakami (b. 1962)	5,512	$40,618	$223,886,416
2	Keith Haring (1958 - 1990)	4,806	$63,345	$304,436,070
3	Damien Hirst (b. 1965)	4,244	$163,893	$695,561,892
4	Shepard Fairey (b. 1970)	2,989	$2,513	$7,511,357
5	Banksy (b. 1974)	2,815	$35,677	$100,430,755
6	Robert Combas (b. 1957)	2,789	$14,907	$41,575,623
7	Zhu Xinjian (1953 - 2014)	2,755	$22,634	$62,356,670
8	Yoshitomo Nara (b. 1959)	2,727	$120,178	$327,725,406
9	KAWS (b. 1974)	2,104	$78,784	$165,761,536
10	Jeff Koons (b. 1955)	1,902	$493,470	$938,579,940

Table 2. Market Size Comparison of Contemporary Art of United States and Japan, https://www.artprice.com/artprice-reports/the-contemporary-art-market-report-2020/the-contemporary-art-rush/, https://imgpublic.artprice.com/pdf/artprice-contemporary-2013-2014-en.pdf, https://www.artprice.com/artprice- reports/the-contemporary-art-market-report-2016/market-geography, https://www.artprice.com/artprice-reports/the- contemporary-art-market-report-2018/general-synopsis-contemporary-arts-market-performance, https://www.artprice.com/artprice-reports/the-contemporary-art-market-report-2020/the-contemporary-art-rush/, https://www.artprice.com/artprice-reports/the-contemporary-art-market-report-2022/key-figures-for-the- contemporary-art-market

(in $ millions)	2000	2010	2014	2016	2018	2022	8-year growth %
United States	$62.0	$152.6	$583.1	$582.4	$612.8	$1,052.5	80.5%
Japan	$0.0	Under $2	$3.6	$6.5	$14.0	$65.2	1724.6%
Total Contemporary Art Market	$92.0	$1,145.0	$1,584.0	$1,500.0	$1,900.0	$2,700.0	70.5%

2.1 Murakami's Early Years and Influences

During his adolescent years, Murakami was fascinated with manga and anime, both of which grew in popularity as an escapist response to the repercussions of World War II. Popularized in the 1960s by Osamu Tezuka, manga (translated as "whimsical pictures") is a style of Japanese graphic novels and comics. Anime (short for animation) is a style of Japanese computer-animated cartoons based on hand drawings. Murakami stated that "Japan was emasculated by the atomic bombs and the United States and that his generation or younger Japanese have resorted to all things cute in order to escape the realities of life" (Yoshimoto, 2012, p. 119).

Although Murakami aspired to be an animator during his early years, he instead decided to attend Tokyo

University of the Arts, where he received his undergraduate, graduate, and doctoral degrees (1993) in Nihonga, which translates as "Japanese painting." After Japan opened its trading borders during the Meiji period (1868-1912), Japanese painting started to adopt Western influences. In contrast to Western-style paintings, Nihonga represents the return to traditional Japanese painting traditions.

However, Murakami became dissatisfied with the bureaucratic aspects and limited monetary prospects of the Nihonga art world and sought to explore contemporary art styles that would have more commercial appeal. During this exploration, Murakami grew frustrated by the dominant western (namely American) influences of contemporary Japanese art and sought to invent a new art movement based on Japanese tradition and current culture. His background in Nihonga and his fascination with manga and anime would serve as the foundation on which he would explore and eventually represent the emerging popular culture of its fanatical young consumers (Otaku) obsessed with computers, digital media, and pop culture.

After realizing that the Japanese market was not open to new forms of fine art, Murakami strategically moved to New York City to develop an aesthetic that would gain American appeal, after which he could introduce it to Japan with increased leverage. In search for a more Japanese-centric style based on Japanese tradition and his observations of the emerging Otaku generation, Murakami developed the artistic concept of Superflat, which focused on using flat two-dimensional imagery with flat color planes found in traditional Japanese artworks and manga. Superflat, in effect, would break down the traditional distinction between low and fine art, and combine Japanese traditional and contemporary culture. The Superflat imagery resembles the flat silkscreen prints of Andy Warhol, widely considered the founder of popular art. Like Andy Warhol, Murakami brought concepts of low-end Japanese preferences to the high-end market, appealing to all demographics. However, unlike Warhol, he leveraged high-end iconography to produce consumer products at affordable prices for mass consumption domestically and globally.

2.2 Shifts in Japanese Consumerism and The Rise of the Otaku Sub-culture

As a result of Japan's loss in World War II and subsequent concessions like opening its economic and trading borders, Japanese retail consumption increased substantially. "Since the 1960s, the Japanese economy developed with remarkable speed, becoming the world's second-largest economy after the USA, and during the years of the economic boom, in the 1970s and 1980s, the Japanese population moved from being a nation of savers to a nation of spenders" (Borggreen, 2018, p. 175). This mass consumption reflected and accelerated changes to Japanese culture, namely the increased popularity of entertainment, celebrity, and fandom. The changing economic conditions in the latter half of the 20th century drove swift changes in consumer habits and purchases. During the oil crisis in 1973, Japanese consumption shifted from those benefiting the nuclear family, like high-quality television sets, to those of the individual, like luxury clothing.

However, during the recession from 1991 to 2001, the increase in individual consumption resulted in eventual unfulfillment and unhappiness (Borggreen, 2018, p. 176). Consumers began to turn away from luxury goods and toward simple and casual items like manga comics. Examples of widespread changes in purchasing included shifting from western to local, goods to services, and self-interested to altruistic (Borggreen, 2018, p. 178). The art world also changed to reflect and influence these trends. During the 1990s, artworks started to represent consumer iconography, leveraging its recognition as fine art into affordable consumable products. A big driver of this movement was Murakami, who was both a part of and inspired by the emerging Otaku subculture.

Otaku is a descriptive term for people with obsessive interests, typically in computers, video games, manga, and anime. They are "geeks who spend their lives withdrawn from mainstream society, holed up inside their rooms consuming pile upon pile of comic books and watching anime on home monitors… the otaku is most satisfied by solitary and masturbatory imagined relationships with comic book or animation characters" (Cornyetz, 2012, p. 181). Despite being viewed by many as social outcasts in a historically conservative society, the size of the Otaku community continued to expand with the growing popularity of manga, anime, and video games. This trend was fueled further by advancements in broadband, mobile, and internet technology, creating greater adoption and perpetual engagement. As an Otaku himself, Murakami's desire to represent and champion the Otaku culture "comes from the public ignorance of otaku" (Wakasa, 2000).

2.3 Manga and Anime

Manga is known for its cartoonish dominant style, expressive line drawing, use of cute characters with exaggerated facial expressions, and complex storylines. While its roots can be traced back to the Edo period (1603-1867), manga's initial growth in popularity didn't occur until the 1920s, with more widespread adoption starting in the 1950s. Over time, manga separated into gender-age genres like Shonen (for young boys) and Shojo (for young girls) to cater to the specific tastes and grow the readership of these demographic groups.

With a similar artistic style to manga, anime is a Japanese animated cartoon that emerged during the 1960s. Like manga, anime is known for its thick dark outlines, flat drawings and use of colors, limited animation, characters rendered with exaggerated facial features and expressions, and complex narratives. Historically, anime evolved from stories on scrolls narrated by storytellers (Emakimono), and its characters were borrowed from Japanese ukiyo-e prints during the Edo period. Anime changed considerably by adopting Western technological advancements like the limited frame counts invented by the Walt Disney Company, allowing considerably fewer frame-by-frame manual drawings.

As an avid manga and anime enthusiast, Murakami "not only incorporated these styles into his artwork to appeal to the Otaku but in doing so also managed to throw popular culture into the realms of fine art" (Borggreen, 2018, p. 184). In essence, Murakami shepherded the contemporary Japanese art world from pre-war traditional Japanese Nihonga art to a more post-war western style centered on manga, anime, and Otaku and its mass consumerization.

2.4 Superflat Art Movement

A term invented by Murakami in 2001, the Superflat art movement represents a departure from traditional Japanese art to a post-modern version. Fusing popular culture and post-World War II sentiments, Superflat attempts to create a unique Japanese identity. "Many have celebrated the distinctive visual sensibility of Superflat art, which claims to be informed by Japanese visual cultures such as manga and anime, as a unique challenge to Western visual tradition of Renaissance perspective" (Li, 2012, p. 203).

With Superflat as a new art form and cultural philosophy, Murakami introduces a satirical critique of the lack of depth in Japanese culture and consumption through artistic tools like two-dimensional objects, flat colors, thick outlines, and limited depth and perspective. In some sense, Superflat represents Japan's societal homogeneity and flatness, given its simplified ideals of cuteness without an underlying identity.

With Superflat, Murakami attempts to return Japanese contemporary art to traditional Japanese views that historically did not distinguish between fine art and craft, as well as aesthetics and utility. In contrast to Western art, Superflat "posits that there is a legacy of flat, 2-dimensional imagery from Japanese art history in manga and anime… Superflat also served as a commentary on postwar Japanese society in which, Murakami argues, differences in social class and popular taste have 'flattened,' producing a culture with little distinction between 'high' and 'low'" (Rothkopf, 2007, p. 144).

Influenced by Otaku's infatuation with computers and digital media, Murakami goes beyond Warhol's industrial silkscreen-created artworks of commercial and celebrity iconography but instead attempts to represent the aesthetics seen in our present-day technology-driven world like those experienced on flat-screen television and mobile phones. Superflat represents the "soft power of Japanese popular culture as a site of the nation's own infantilization and argues for the soft power of Japanese popular culture to resurrect the nation to new global heights" (Yano, 2009, p. 685). Simplistically, Superflat combines traditional Japanese art of planar forms and humanistic storylines with cutesy characters of manga/anime. An example of using manga, anime and Otaku fascinations can be found in Murakami's infamous sculpture *My Lonesome Cowboy*.

3. My Lonesome Cowboy (1998)

At a relatively large scale of 100 inches tall by 46 inches wide by 36 inches deep, Murakami's sculpture *My Lonesome Cowboy* depicts a nude teenager in the style of a typical Shonen manga comic or anime. The naked teenager has an adult-like muscular, peach-colored body with spiky fluorescent-yellow hair that protrudes mainly to the left

with three pronounced long triangular-shaped extensions pointed to the upper left-hand corner. He stands in an irreverent and proud pose. With his left hand, he is holding his large genitalia, which emanates a jagged sword- like stream of semen, which curls in the air like a cowboy's lasso. His right arm is slightly bent with widespread fingers, softly holding a thick stream of semen as it starts to curve above the teenager.

Figure 1. Takashi Murakami, My Lonesome Cowboy, 1998, oil, acrylic, fiberglass and iron, 100" x 46" x 36", https://www.artnet.com/artists/takashi-murakami/my-lonesome-cowboy-CZ3qc_fWDjp5NquruOGf9w2

His large bright green eyes are webbed-shaped and cover most of his small triangular face. His mouth is slightly ajar and pointed upwards at the ends. His legs are proudly spread wide beyond the width of his shoulders, forming an equilateral triangle. This toy-like figure incorporates an infantile style. Its incorporation of masturbation is similar to pornography found in manga comics and anime cartoons. The artwork also references some characteristics of Ukiyo-e, such as exaggerated genitalia. Given that the figure appears Caucasian, this artwork seems to challenge and satirize Western masculinity's ideals while adhering to Japanese art's roots.

The title of the artwork appears to be a reference to Andy Warhol's 1968 film Lonesome Cowboys, which attempts to represent and satirize American consumer culture, similar to Murakami's goals for his own artworks. Like Warhol, Murakami "set out to challenge the conventions and cultural systems of Otaku communities and dojinshi (fan-driven magazines) environments, for example by modifying the aesthetics of the collectable, small-size figurines and creating life-size figures, thus positioning these characters as disturbingly similar to sex dolls" (Borggreen, 2018, p. 184). In My Lonesome Cowboy, Murakami uses the duality of immaturity and sexual desires, representing characteristics of Japanese identity.

4. Mr. Rainbow Dob (2006)

Whereas My Lonesome Cowboy used sculpture to reference Japanese identity based on manga, anime, and Otaku, Murakami's digitally created artworks Mr. Rainbow Dob represents a pursuit of universal iconography of the Japanese identity. At a relatively small scale of 26.8 inches tall by 26.8 inches wide, this offset lithograph artwork presents the enlarged head of a Mickey Mouse-like animal. Both of the animal's large ears are cropped on the upper right-hand corner and the middle of the left-hand side. The character's head and eyes are looking towards the bottom left-hand side of the artwork. Although the head is angled, there is limited depth.

A thin white outline surrounds the mouse's entire head. The white circular face, in the shape of the letter "O," has two large circular black eyes. The right eye has a pink tapered outline that is thickened towards the top of the black-colored eye. Three thick triangular eyelashes protrude from the upper right side of the eye. The right oval- shaped pupil is towards the eye's upper right corner. The color of the exterior portion of the pupil is a dark pastel blue. The left eyes are similar but with different colors. In contrast, the inner oval-shaped portion is a faint sky-blue color with a minuscule target-like concentric circle with orange and red coloring. Two white circles on both sides of the tiny circle resemble two points of reflection from a bright light source.

The character's nose is rendered horizontally and oval-shaped with a thick black outline, while the large exaggerated smiling mouth has a black color with thin white vertical lines. The remainder of the face and ears have a smooth progression of colors from yellow to orange to purple to blue to green as the viewer progresses from the animal's right ear to the left. Although the blended transitions resemble shading, the flatness of the head still comes through. On the right ear is a large curvy, white-colored letter "B." In contrast, the other ear has a similarly styled large letter "D." In the negative space surrounding the head, Murakami presents expressive, organic psychedelic shapes with varying pastel colors of off-white, pink, purple, red, and orange.

This character, affectionately known as Mr. DOB, is Murakami's alter ego or avatar. Mr. DOB is a shortened

form of the Japanese slang word Dobojite, which translates to "why." Modeled after a manga creature (Doraemon) and a Walt Disney character (Mickey Mouse), Murakami created the Mr. DOB character to test ubiquitous characters' consumer viability. Murakami seems to question why Japanese consumer society needs to be viewed as empty and shallow.

By rendering Mr. DOB with extreme cuteness (Kawaii style), Murakami attempts to create a Japanese version of Mickey Mouse. To Murakami, Mr. DOB is a self-portrait of the Japanese people, highlighting the shallowness of its superficial culture. The character is cute but does not appear to have any meaning or understanding. This Superflat artwork would provide the groundwork for Murakami's famous series of smiling flower artwork like *The Future will Be Full of Smile! For Sure!*

Figure 2. Takashi Murakami, Mr. Rainbow Dob, 2006, offset lithograph, 26.8" x 26.8", https://www.artnet.com/artists/takashi-murakami/mr-rainbow-dob-a-RtoFiHP4yZd53kXtuLLUxA2

5. The Future will Be Full of Smile! For Sure! (2020)

At a scale of 29.5 inches tall by 29.5 inches wide, this colorful print has hundreds of repeated cartoon-like flowers (the subject matter) with overlapping petals. With twelve rounded and symmetric petals, each flower has a circular face. The flowers cover the entire square space, cropping some images on the edges. Most of the space is filled by a large, exaggerated mouth with a slightly concave top and open rounded bottom, resembling an open mouth screaming with joy. Above the smile are two small dots representing their eyes. There are black outlines around all the petals, the circular face, and the mouth.

Although the overlapping petals provide some sense of depth, the flat figures and their flat colors are overwhelmingly two-dimensional. The lightly toned colors range across the spectrum from white, yellow, orange, red, purple, blue, green, brown, and black. The flowers vary in size and coloring of their petals, face, eyes, and mouth. Most petals are colored in the same color, while others have alternating colors. No two flowers use the same colors, creating uniformity of design and form, but uniqueness and individuality with colors.

Figure 3. Takashi Murakami, The Future will Be Full of Smile! For Sure!, 2020, archival pigment print, 29.5" x 29.5", https://www.artnet.com/artists/takashi-murakami/the-future-will-be-full-of-smile-for-sure-a- ternyg3Q2xu_y02NuMxiqQ2

Murakami's subject matter of this painting references familiar iconography found in Nihonga artworks, like the moon, snow, and flower. The medium of pigment print represents digital design and print, alluding to the technology familiar to Otaku. The many smiling flowers with bright colors seem to represent the uniformity of the Otaku in their purchasing characteristics and love of digital media but also reflect their inherent individuality. Although a casual observer may mistakenly interpret this artwork as a cheerful expression synonymous with the "cute" Japanese style, there is a far darker and more serious subtext.

Murakami instead tried to "represent or provide comfort after the trauma and collective dark emotions Japanese locals still are experiencing from the 1945 Hiroshima and Nagasaki bombings" (Rothkopf, 2007, p. 151). Therefore, the perception of happiness is a facade, covering underlying feelings of discomfort and anxiety and representing potential emotions that Otaku feels. "My art is not Pop art. It is a record of the struggle of the discriminated people" (Wakasa, 2000). In many of his artworks, Murakami appears to represent the conflicting duality of identity between interior anxiety and exterior happiness, mixing elements of the past (Nihonga) with the present (manga, anime, Otaku).

6.   Conclusion

The amalgamation of Murakami's formal training in Nihonga, interest in manga and anime, and deep connection with the emerging Otaku culture helped create Superflat. He selects subject matter like cute manga-like characters and choses medium like fiberglass and digital prints. Murakami also uses bright, uplifting colors, and highlights the status and changing viewpoints of those who are traditionally marginalized as outcasts. Reflecting Japanese popular culture, this new artistic style and its mass commercialization into affordable consumer products fundamentally changed Japanese contemporary art, making it more accessible to both Japan's broader population and foreign viewpoints.

Although some refer to Murakami as "The Japanese Andy Warhol," given his blurring of the lines between low-end with fine art, Murakami furthers this concept by offering fine art beyond the elite to the mass population through affordable merchandise extensions. Furthermore, by combining the old with the new in creating Superflat, he elevated the presence of the Otaku as a significant component of the Japanese identity. "For Takashi Murakami, popular culture, cartoons, and Japanimation provide a way of locating a contemporary Japanese identity that is expressed through commodity culture" (Higa, 1996, p. 8). Murakami demonstrated that art magazines and the press carried greater power than art critics and museums in a market-driven art world. He also challenged in what form fine art can be consumed.

Murakami credits his artistic success to what he sees as a widespread cultural mindset of hopelessness in Japan. "It's a closed world with no way out. So, they have to live in a fantasy. I also escape from reality… Therefore, people who have given up resistance find security when they look at art made by a person who is still resisting… This is the role of the artist" (Wakasa, 2000). Whether accurate or not, Murakami questions the identity of nations – away from governmental identity to one of its people and their interests. The necessity of destruction to rebuild an authentic identity is a question which other nations grapple with, including America.

Some may debate whether artists like Murakami were merely shining a spotlight on already emerging cultural trends or the driving force in forging and broadly communicating a new Japanese identity. However, he impacted Japanese contemporary art by tying Japanese pop culture with its global identity. "For Murakami, popular culture, cartoons, and Japanimation provide a way of locating a contemporary Japanese identity that is expressed through commodity culture" (Higa, 1996, p. 6). As an artist, Murakami's most significant impact was representing a more updated, authentic Japanese identity for Japanese citizens and the exotic pleasures of foreign nations. It warrants further investigation whether he also helped redefine the meaning of fine art.

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Parasocial Relationships and Social Media

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Abstract

Since recent years have brought popularity to new media platforms, this paper aimed to explore its impact on Parasocial Relationships. Thus, as the ease with which adolescents can access these platforms today influences their likeliness to form parasocial relationships, the research question was asked: To what extent do parasocial relationships grow due to heightened Twitch, TikTok, and Twitter usage? To answer the question, a qualitative data collection method of surveys was utilized. It was concluded that increased social media usage causes the proliferation of parasocial relationships as adolescents increased social media use establishes a sense of intimacy between themselves and media personalities. These platforms allow celebrities to present a candid, "behind-the-scenes" view of their daily life, which provides viewers with the ultimate intimate details of their existence which reinforces the emotional connections and illusions created and then fostered by a parasocial relationship.

1. Introduction

Social media has been a rapidly growing phenomenon since the early 2000s, and its early beginnings were fraught with technical issues. Tom Anderson, Chris DeWolfe, Mark Zuckerberg, Jawed Karim, Steve Chen, and Chad Hurley were just a few of the main men that are responsible for this. They created the early 2000s' most recognizable platforms: MySpace, Facebook, and Youtube. However, it is now unquestionably true that now MySpace and Facebook have become far too outdated, due to modern-day technological developments, and newly developed and piloted media, fraught with different problems, have become popular. For example, people have recently begun worrying about issues such as the academic development of students in the face of these prevalent platforms (Hashem, 2015). However, the issue discussed in this paper has much more to do with the mental health of students.

Recent years have brought popularity to more media platforms such as Twitter, TikTok, and Twitch. With them, the problems with parasocial relationships and interactions have increased. Parasocial relationships and parasocial interactions are generally defined to be "symbolic, one-sided ties that individuals imagine with media figures and celebrities" (Gleason et al., 2017). Thus, it is possible to conclude that numerous adolescents who use social media platforms, are at risk of or have already formed such relations, especially during quarantine, since parasocial relationships are more likely to form as a consequence of loneliness (Aytulun & Büyükşahin, 2020). The term "Parasocial Relationship" was coined by researchers Donald Horton and Richard Wohl in a 1996 sociology essay. They differentiated between parasocial relationships and parasocial interactions, by explaining that parasocial interaction is initiated and directed by the media person. It is 'triggered if media performers acknowledge the audience's presence [during] their performance". The media performer can do so by arranging an informal face-to-face gathering or verbally addressing the users (Horton and Wohl, 1956). In contrast, parasocial relationships were mainly used to address the specific nature of an interaction between a media person and a user (Rosaen et al., 2015).

So, the "parasocial relationship" term is used to refer to the type of interaction between a media person and users. This includes, for instance, interactions that consist of the influencer speaking directly to the audience and having an informal conversation with users.

Horton and Wohl also used the term "Parasocial Relationship" to characterize the long-term, typically positive, one-sided intimacy that users develop for media performers based mainly on repeated exposure to them. This cemented the difference between parasocial interactions and parasocial relationships as they are used interchangeably in the numerous other research papers on this topic. Dibble and the other authors compared what parasocial interactions and parasocial relationship measures were and argued that the commonly used measures utilized for parasocial interactions are measuring other issues and that parasocial interaction is not interchangeable with parasocial relationships (Rosaen et al., 2015).

Oftentimes, many people question if parasocial relationships are of positive or negative nature. While it is true that parasocial relationships can cause negative effects on the mental health of adolescents because they can lead to increased feelings of loneliness, depression, and anxiety when they take priority over real relationships, they are not all wholly negative. For instance, in a study conducted by Shaaba Lotun and other social and media psychology researchers, it was found that parasocial relationships could potentially be a useful new method that can help reach larger audiences with fewer resources and reduce levels of prejudice and stigma. The method used in Lotun's study was viewers watching personal style videos meant to facilitate a real friendship between two stranger participants alongside a self-disclosure style video. In the videos, participants specifically watched a YouTuber talk about their journey with borderline personality disorder (BPD) and how it was perceived by the public. Then, after watching the stimuli materials participants were given a survey to allow the researchers to determine what type of prejudice they had and what remained after watching the videos. It was concluded that the participants had been able to reduce their explicit prejudice and intergroup anxiety. These lowered prejudice levels were directly related to stronger parasocial relationship bonds since the participants seemed to create a more intimate relationship with the YouTuber after watching her video (Lotun et al., 2022). The study presented an important conclusion for parasocial relationship research since commonly asked questions revolve around their nature and whether they are distinctly beneficial or detrimental. However, parasocial relationships are not distinctly positive or negative. While Lotun's research presents a positive view of parasocial relationships and provides a preliminary introduction to the topic of parasocial relationships overall, it is important to recall that parasocial relationships' effects on people could be either beneficial or harmful as it remains entirely dependent on the person and the context of the situation.

Furthermore, communications researcher Bradley Bond claims that adolescents are more likely to learn from media persons whom they perceive as trusted friends. This relates to parasocial relationships because whenever an influencer posts on social media, they allow their fan bases to gather an intimate 'peek' into their everyday lives. This is then frequently used to create an extremely carefully crafted image that fosters familiarity and intimacy between the influencer and their fans. Bond defines the ability of media personas to painstakingly craft an image and create a sense of closeness and familiarity between themselves and their followers on social media as "performative intimacy". The phenomenon of performative intimacy strengthens parasocial relationships for fans while also allowing celebrities more marketing and brand opportunities. This occurs because as more parasocial relationships occur, an influencer or celebrity's popularity also increases (Bond, 2016). This is important to take note of because it demonstrates where influencers generate their motivations to foster these parasocial relationships and initiate parasocial interactions. Furthermore, Bonds' research also allows for a further positive interpretation of parasocial relationships. Additionally, it also creates an understanding of how deeply social media sites are able to truly affect adolescents' day-to-day life. Also, it is an important revelation to note because the gap in research identified and written about revolved around the effect of social media on adolescents' likelihood of forming parasocial relationships.

Additionally, another study written by anthropologist Zachary Sheldon aimed to determine whether parasocial interactions varied in strength depending on if a character is created fully through computer imagery, enhanced by computer-generated imagery., or when portrayed by a real human actor. To do so, Sheldon and the other researchers had over 100 participants watch a randomly selected movie that fulfilled three predetermined conditions before they measured the participant's strength of parasocial interactions formed. As a result of this study, it was indicated that parasocial interactions formed with enhanced characters were just as strong as the ones formed with non-CGI

characters. However, since viewers were able to form stronger PSIs with human and CGI-enhanced characters than computer-generated ones, it was understood that movie viewers relate to CGI-enhanced characters and human characters just as effectively. However, it is also possible that the types of characters portrayed by fully computer-generated ones are simply far too unrelatable enough to the general public, creating a possible limitation (Sheldon et al., 2021). However, this remained a pertinent study to take note of because, though Twitch streamers, people who play videogames on the streaming platform "*Twitch*", may not be computer generated, their image is not entirely realistic along with the many other influencers who are gaining popularity in the modern world.

As a result of all the information surrounding the effects and perceptions of parasocial relationships, it is crucial to explore how they are furthered due to society's development of technology. With social media platforms' increasing popularity since it provides a means of staying connected with society and individuals' favorite influencers, it becomes essential to explore social media's effects on parasocial relationships. Moreover, since it is understood that the ease with which adolescents are able to access these influences in the modern age influences their likeliness to form parasocial relationships, the question is posed: To what extent do parasocial relationships grow due to heightened Twitch, TikTok, and Twitter usage? According to Pew Research, about 67% of teens use TikTok while 23% use Twitch and Twitter. Overall, 35% of teens say they are on all of these sites and use one of them almost constantly (Pew Research, 2022). Thus, these three sites are the most popular as of now, ensuring that this research provides an updated addition to the many conversations surrounding the topic of Parasocial Relationships. In addition to the popularity of these three sites, since minimal and limited research exists that focuses on TikTok and Twitter in relation to parasocial relationships and the research in relation to Twitch is minimal, this research will be crucial in bridging this gap of knowledge. Few researchers have written about all three sites together which is also important since all three have become much more prevalent after the Covid-19 pandemic. After all, in the past two years the number of American adults who claimed to regularly receive news from TikTok tripled from 3% in 2020 to 10% in 2022 (Pew Research, 2022).

Ergo, since today's adolescents will be the first generation to have grown up amongst rapidly advancing technology, it is important to understand parasocial relationships' impact on their mental health and overall well-being. By researching the relationship between heightened social media use and parasocial relationships, this paper will be able to provide necessary and valuable insight into the effect of social media on adolescents.

2.   Materials and Methods

Two other methods that were considered were a case study and descriptive research. However, since surveys could be used for both methods, it was important to understand the exact definition of each method. Thus, a case study seemed the most feasible since they are used to define the research question and the hypothesis and can be exploratory (Flyvbjerg, 2005). However, since they require intensive analysis of individual groups, it would be difficult to recruit participants who were willing to participate in the study. Also, conducting a case study on this topic without infringing upon ethical guidelines is relatively difficult. On account of this, and since there is no wish to infringe upon the ethics of having human participants in this study, there would have been no way to inspire students to participate in the study. Furthermore, a descriptive research method also seemed feasible since there were many options for data collection. However, the method was quite weak because conclusions of cause and effect could not be drawn. After all, this method is statistics-oriented and statistics do not prove those conclusions.

Overall, surveys are an invaluable tool for researchers since they allow researchers to gain a comprehensive overall understanding of any group's opinions on numerous topics (Ponto, 2015). In the context of this paper, which aims to explore the specific inquiry regarding the extent to which parasocial relationships are exacerbated through social media usage, a survey administered to the general public would allow for the collection of relevant data. Additionally, since the purpose of this paper is to explore a phenomenon and understand its effects on adolescents, a survey allows for the collection of general non-detail-specific data that contain open-ended responses from participants.

Furthermore, the survey simply consists of nine multiple-choice and open-ended questions. Surveys are defined as "the collection of information from a sample of individuals through their responses to questions." (Scott & Schutt,

2012). Thus, the aim of the survey was for it to remain a quick and efficient collection of data since participants do not engage in or provide accurate and reliable data in longer surveys (Kost & Correa de Rosa, 2018). Ergo, the survey was sent to other AP Capstone and general students since there is no limitation regarding gender or class discipline. The questions consisted of what social media (Twitter, Twitch, or Tiktok) participants use more and specifics as to which celebrities they like and why. Also, some deeper questions regarding social media's toxicity, conflict resolution in friendships, and loneliness during the Covid lockdown were asked.

Furthermore, the use of surveys aided in creating the alignment with the research question as surveys allowed the collection qualitative data and investigate relationships between individuals and social media influencers' online personas. Collecting qualitative rather than quantitative data is beneficial as well since quantitative data is used to evaluate a problem on a numeric scale. Primarily, quantitative data is used to quantify the question and convey the answers to the "what" and "how many" parts of a research question. Qualitative data, however, is used to explore and explain ideas since it provides a deeper view into individuals' mindsets in regard to specific events or experiences (Almalki, 2015). Moreover, investigating the specific individual and influencer relationships is important because, while the personas are not real individuals, the participant's perceived relationships with them contain increasingly similar behavior to any typical "person-and-person" relationships (Gleason et al., 2017). Correspondingly, understanding the differing strengths of parasocial relationships and discerning the reasons why they differ allow the research question to be answered better. By having a preliminary and general understanding of how social media affects parasocial relationships, it is possible to determine what qualifies as growth towards a parasocial relationship and its typical effects.

Regarding the analysis of the data used, it was decided to code and analyze the data using thematic analysis. A study from the Ireland Journal of Higher Education aided reaching the conclusion that using open code would be the most suitable for the responses acquired (Maguire and Delahunt, 2017). Open coding is a data analysis process during which the researcher breaks the raw data into smaller parts and creates "codes" to label them. Thematic analysis is a qualitative data analysis that includes reading through a set of data in order to find patterns that evolve into themes.

In conclusion, after all the options were considered, the survey appeared to have the fewest limitations. The only main problematic limitation identified was determining whether participants were lying or not when answering the questions. Regrettably, there was no viable procedure to determine whether participants lie, so the results will likely not be completely accurate. Nonetheless, in spite of this limitation, the data collected will still allow for the drawing of accurate conclusions to answer this paper's research question.

3. Results

Upon completion of the creation of the survey, it was sent out to fellow high school-aged adolescents of any gender since parasocial relationships can occur with anyone. Eight questions were asked and below are the leading eight responses to one question. The social media specifically investigated were Twitter, TikTok, and Twitch. When asked which of the three were used more, 71% of participants claimed to use TikTok the most while 10% used Twitch and 5% used Twitter. Participants were also asked why they enjoyed their favorite celebrities' content (figure 1) and

Figure 1. Why do you enjoy celebrity content?

received answers that specified that 57% enjoyed their relatability and 58% admired them alongside the 25% who felt as though they were friends with the celebrity.
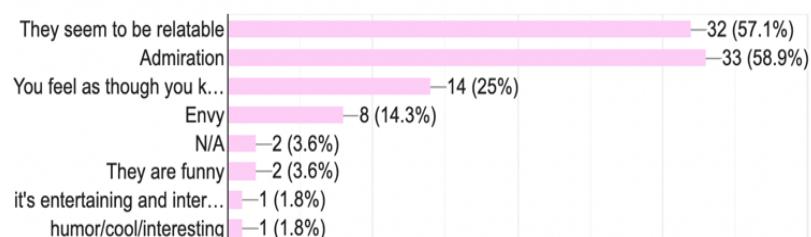
It was also asked if participants had ever begun to distance themselves from friends in favor of checking a celebrity's page (figure 2) since that would mean they were prioritizing relationships with people they do not know
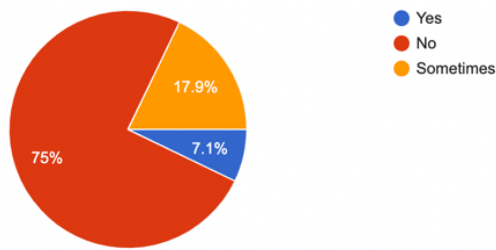
Figure 2. Have you ever distanced yourself from a friend and prioritized checking a celebrity's social media?

research as it was possible to extract specific participant answers to begin coding the data. However, it was also important that the specific influencers that participants tended to like was considered so that it was possible to factor in what platforms they typically used. Figuring out these specifications was important in order to place into consideration what platforms were used most.

Table 1. Specific influencers participants enjoy viewing.

Are there any influencers or streamers or celebrities that you specifically enjoy content from? (say 'no' if this doesn't apply)
Hank Green
Various
KSI, Sidemen, Kai Cenat
Nessa Barrett
WarOwl/n0thing
Anna Sitar
Mr.ArnavPatil
Taylor Swift and Selena Gomez
Lana Del Rey and Mitski (music), Brittnay Broski and Sarah Schauer (youtubers)

over real friends; a key factor of parasocial relationships. The results showed an overwhelming majority of 75% of participants did not do so. However, 18% did so sometimes, and 7% admitted to doing so in general.

The third most important question asked was if participants ever turned to influencers during the conflict with real friends (figure 3) as this would also be a key factor in being considered to have a parasocial relationship. While the majority of participants still said no, a total of 28.6% said yes and that they did so sometimes.
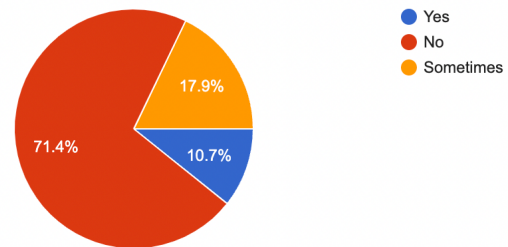
All three answers were quite important to the

Figure 3: Do you ever turn to influencers' content while experiencing conflict with in-person friends?

4. Discussion

Included in the table below are the open codes used, their properties, and specific phrases from participants that aligned with the codes. It was important to identify the specific properties of each participant's responses because they contributed to the development of each of the codes.

Table 2. Coding Table

Open Codes	Properties	Participant Responses
Social media allows for quick updates from celebrities/streamers	Watching of Twitch streams New TikTok uploads New Tweets	Like Lana Del Rey/Mitski for new music Enjoy Alix Earle's TikTok videos Kpop tweets Youtuber tweets
Enjoy content from celebrities	Seem relatable Admire them Envy them Feel known Funny	Feel like they know the celebrity personally Feel like friends Admiration Entertaining Envy
Potentially replace friends	Distance themself from friends in favor of watching celebrities Do not distance themselves from friends	Streamers feel like better friends than reality Streamers cannot replace friends
Distraction during conflict	Better No real conflict	Reach streamers/celebrities at any time No confrontation
Obsession caused by loneliness	Covid lockdown Social media causes isolation	Covid lockdown caused a disconnection from friends Toxic Felt like they were living vicariously through influencers Influencers provided relatability

Next, a thematic analysis of the open codes was conducted. The codes were then synthesized and generated to use their properties to identify the main themes that were supported through the data. Furthermore, the thematic analysis identified two main themes: social media allows for instant gratification and it can lead to distraction and obsession. Below are two theme maps (Figures 4 & 5) that display the themes broken down into the properties that they consist of.
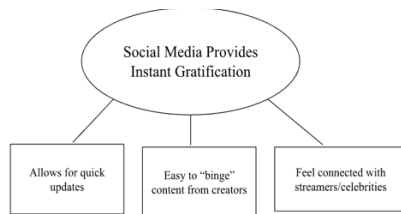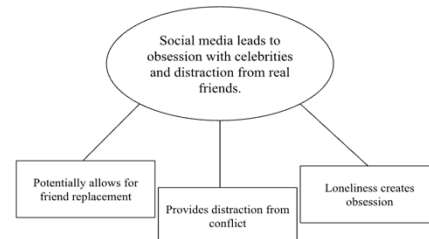
Figure 4. Theme Map 1

Figure 5. Theme Map 2

Since the research question specifically inquired about the growth of parasocial relationships due to increased social media usage, the identified themes connect to that idea. After all, the survey aided the determination of the theme that because social media provides instant gratification, teens are more likely to become addicted to it and spend an increased amount of time watching videos, streams, or checking tweets from their favorite celebrities. This leads to the feeling of connection and kinship with the celebrity that can cause teens to feel closer to these media personas. The second theme about social media causing obsession and distraction also relates well with the research question. Since the usage of social media creates a distraction for teenagers that allows them to escape from conflict and potentially aids them in coping with loneliness, any increased use of these platforms can lead to dependency. In addition to the found themes and coded data, there were several phrases stated by participants in the survey that truly depicted and emphasized the impact of social media on parasocial relationships and their mental health. One participant explained that they believed that social media could potentially create "unachievable expectations and can cause a lot of dysmorphia, especially for teenagers." which demonstrates the clear negative impact of social media on adolescent mental health. However, another participant had believed that they "knew everyone they followed on social media and were friends with them, only because of what they post." Thus, this statement reflects the opposite opinion of the impact of social media on mental health, but it does demonstrate how parasocial relationships begin. Overall, the specific phrases that were given by participants in the survey are able to illustrate the nuanced and complicated relationships between social media, parasocial relationships, and mental health. Though this paper does not specifically investigate adolescents' mental health, it is inferable based on the two main themes found that social media is a leading cause of adolescent mental health issues. As suggested by prior literature, PSRs often occur due mental health problems, typically ones caused by social media, that may lead to dependency, toxic obsession, and further negative effects on an individual's mental health. In this dependency or obsession, individuals are susceptible to begin relying on influencers who create content that feels relatable, causing an individual to depend entirely on an internet persona to form a PSR with.

5. Conclusion

Upon having conducted a careful analysis of the collected data and the results obtained from the thematic analysis, the data showed that increased social media usage causes the proliferation of PSRs. Adolescents increased social media use facilitates these parasocial relationships because adolescents are enabled to establish a sense of intimacy and familiarity between themselves and media personalities. These platforms allow celebrities to present a candid, "behind-the-scenes" view of their daily life, which provides viewers with the ultimate intimate details of their existence. This, in turn, reinforces the emotional connections and illusions created and then fostered by a PSR. In relation to psychology researcher, Tracy Gleason's', conclusion regarding parasocial relationships, these intimate

glimpses that are presented further solidify the PSR. Based on her research, Gleason was able to conclude that since parasocial relationships are relationships without any chance of reciprocity, adolescents use them as a safe space to grow and develop while testing different ways of being (Gleason et al., 2017). This conclusion relates to the research because it aids in the creation of a reasonable inference regarding making the research question since it would aid the body of knowledge to have an answer to the research question. Since parasocial relationships provide safe spots for adolescents, the additional intimate views that any celebrity or influencers provide of their life would entice a viewer much more than previously. These candid glimpses would grant all imagined relationships to become more detailed and thus more specific and engaging for the adolescent.

However, there are a few limitations to the analysis of the raw data collected. Although the data collected supported a relevant and interesting trend, there are some limitations regarding the coding of the raw data. The subjective nature of data coding posed a challenge since there was only one coder. Had there been a team of coders, the data could have been viewed differently, meaning that what was interpreted could be potentially inaccurate. As such, if this study is to be replicated, then it is recommended that a team of coders view the data to ensure a much more objective and realistic interpretation. Furthermore, another issue is that manual coding is known to be prone to errors, so, it is possible that the data coded does not accurately reflect reality. To mitigate this, it is suggested utilizing an online coding software to work alongside the team of coders. Moreover, the survey alone may include some limitations. The questions created may not have been phrased in an easily interpretable way for some readers or they may not be able to capture the nuances of parasocial relationships, causing some important pieces of information to be forgotten.

Furthermore, if there were a replication of this study, it would be advised to supplement the survey with brief interviews of participants to gain a more profound understanding of adolescents' perceptions of the subject. By doing so, it would be possible to gain a deeper understanding of the correlation between social media use and parasocial relationships. Also, it is important to recall that the results of this study are not and will not be conclusive; hence, they should be viewed as a preliminary start for any further research. Therefore, future studies would be able to delve into investigating the influence of parasocial relationships on the psychological health and well-being of adolescents, rather than mainly focusing on how diverse social media platforms can contribute to the formation of parasocial relationships.

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Minowe: Speaking Well through the Ages -
A Journey of Language Suppression and Revitalization

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Abstract

In this essay, we traversed the journey of Native American languages from the boarding school era to the present day. We delved into the strategies employed by the U.S. government to steal indigenous voices, the tragic and on-going impact of these policies, and resilience and creativity that has gone into linguistic revival. Looking at the state of indigenous languages today, we explored the varying ways that indigenous communities have endeavored to revive their languages and found cause for hope. Specifically, we looked to the case of the Ojibwe Nation as a model of exemplary language revitalization and examined that its combinations of institution-based support, innovative use of technology, and grassroots movements can serve as a template for further revitalization efforts.

Keywords: Indigenous, Language, Native American, Boarding School, Ojibwe

1. Introduction

Language is not solely a medium of communication; it is a cornerstone of cultural identity. It is a repository of all the history, wisdom, and traditions of a community. This importance of language holds true for all societies, and perhaps even more so for indigenous communities like Native Americans, where languages have been deeply interwoven into their existence and primarily passed down orally. They defy simple word-for-word translations as they often express concepts wholly unique to the cultures that birthed them. In 1936, American linguist Benjamin Lee Whorf, while studying the Hopi language, concluded that indigenous languages contain perspectives and intuitions that are simultaneously beyond the reach of sufficient English translation and possessed of logic that is every bit as justified pragmatically and experientially as any language he had encountered (Pereley, 2019). Each word, phrase, and expression in these languages encapsulates a unique perspective of life and nature often specific to a population that can number only in the hundreds. Once the last speaker of a given language passes on, so too, do the last vestiges of the wisdom and history that the language bears.

In the late 15th century, as Western colonizers arrived in the Americas, Native American languages numbered in the hundreds (Patrick, 2019). This linguistic diversity reflected the depth of Indigenous culture but also exposed the vulnerability of these languages to systematic efforts of elimination. Geographically proximate tribes spoke distinct languages, making it necessary to learn them separately (Patrick, 2019). These languages, rich with the echoes of countless generations, faced significant threats. American officials promoted assimilation through methods like boarding schools, aiming to replace indigenous cultures with Western Judeo-Christian values. They sought to, in the words of a prominent supporter, "kill the Indian to save the man" (Fear-Segal and Rose, 2016, p. 32).

Central to their strategy, one informed by a centuries-spanning tradition of colonial conquest and cultural chauvinism, was the eradication of indigenous languages and the insistence upon speaking English. These Native American boarding schools were one of the primary instruments of this policy. Native American children were forcibly

removed from their families and communities, prohibited from speaking their native tongues and coerced into using English. The aim was clear: to suppress Native American languages, thereby eradicating an essential part of their identity. For years this war was waged to heartbreaking effect. However, the narrative of Native American languages is not one of erasure and loss alone. Despite systematic suppression, these languages persisted, carried forth in songs, and stories, passed down through generations. Remarkably, tribes kept their languages alive, defying those who sought to extinguish them ruthlessly and efficiently. Today, in a world markedly different from the era of boarding schools, these languages are experiencing a revival. Through a combination of community-driven initiatives, policy measures, and the strategic use of technology, Native American languages are being reclaimed, learned anew, and used with pride.

In this essay, we will traverse the journey of Native American languages from the boarding school era to the present day, revealing the strategies employed by the U.S. government to steal indigenous voices, the on-going impact of these policies, and the inspiring resilience demonstrated by indigenous communities in the face of injustice. We will explore the significant role of legislation in supporting language revitalization efforts and examine how modern technology is facilitating this resurgence. We will also study the case of the Ojibwe Nation as a model of successful language revitalization, before reflecting on the prospects of Native American languages. This is a history that is steeped in tragedy; however, it is lined with optimism due to the courage, ingenuity, and dogged determination of the indigenous communities that outright refused to let their cultures fade into obscurity. This story is, in essence, a tale of repression, resilience, and revival.

2. Historical Background

Native American languages, comprising over 350 distinct languages across 60 language families north of Mexico, reflect the depth and diversity of indigenous cultures (Patrick, 2019). These languages, essential for understanding the world through different tribal perspectives, reflected countless generations thriving in a world vastly different from that of European colonizers. A significant divergence between indigenous tribes and newcomers was the role of oral tradition in education and cultural preservation. Despite the diverse range of Native American cultures, reliance on spoken word over written records was nearly universal (Grande, 2015). Culture, history, religion, and practical skills were transmitted through oral tradition, with each language offering a unique lens to interpret the world, reflecting specific beliefs, customs, and land relationships (Treuer, 2010). Native American education, though less institutionalized and literacy-based than European models, was equally effective in imparting cultural wisdom. It involved a complex network of storytellers, singers, historians, and family members collaborating to pass down knowledge to successive generations. This millennia-old tradition enabled individuals to learn their cultural intricacies and acquire vital survival skills (Stout, 1992). However, European and American colonizers, rooted in Eurocentric perspectives, devalued Native American language and culture (Phillipson, 1992).

The colonization of North America posed a significant question for European settlers and their descendants: how to deal with the indigenous population. Early efforts involved forced removal, dishonest treaties, reservations, and conflict. However, in the late 19th century, a shift towards cultural assimilation emerged. Educator and Pan-Indianist, Fayette Avery McKenzie, encapsulated this shift suggesting that Native Americans were either inherently inferior or products of deficient culture. If they were deemed inferior, assimilation would be cruel, and political rights would be unjust. But if it was a matter of lacking "experience and tradition," there would have been hope through forcibly removing indigenous people from their familiar environments to "civilize" them (Eastman, 1984). McKenzie's view was prevalent at the time, leading the U.S. government to pursue forced cultural assimilation, particularly targeting Native American languages and traditions. The Dawes Act of 1887 marked the beginning of this strategy, dividing reservation lands into private parcels. While reservations allowed some self-governance and cultural identity, the Dawes Act, along with subsequent Curtis and Burke Acts, compelled individuals to abandon their tribal identity and live under the laws and customs of the state or territory in which they lived (*The Dawes Act*, n.d.). Every aspect of the act was aimed at yoking Native Americans with Euro-American customs. It represented a dramatic shift for the tribes economically, agriculturally, socially, religiously, and legally. As tribes spent the latter part of the 19th century adjusting to the new norm, the US government established boarding schools through the Bureau of Indian Affairs to

assimilate Native American children into American customs. By 1900, twenty-five such schools operated across fifteen states, intensifying linguistic and cultural erosion within indigenous communities. Language suppression and replacement played a pivotal role in the government's pursuit to 'civilize' or 'Americanize' Native American populations, making English the essential lingua franca. This started with education, and it started with Native American children.

The Carlisle Indian Industrial School was the pilot school of this new strategy. Richard Henry Pratt, the founder of Carlisle, and coiner of the bone chilling promise to, "Kill the Indian, save the man," already had a long history with Native Americans when he opened the school in 1879. He believed that Native Americans needed to be removed from their own culture's corrosive influences. He expressed his views at the Nineteenth Annual Conference of Charities and Correction in Denver, emphasizing, "They must get into the swim of American citizenship. They must feel the touch of it day after day, until they become saturated with the spirit of it, and thus become equal to it" (Treuer, 2010, p. 133). He requested funds to bring 300 young Native American to Carlisle to teach them English and American skills (Fear-Segal and Rose, 2016, p. 29). Upon arrival, Native American children were systematically stripped of their cultural identity. Their hair, clothes, and names were discarded, and English was enforced as the exclusive language of instruction. Native languages were strictly forbidden, even among peers, often enforced brutally with punishments like beatings, mouth washings with soap or lye, and confinement in jail cells for non-conformists (Treuer and Keenan, 2022). In addition, for students unfamiliar with English, additional hardships pushed them to learn. They were denied books and instead given slates and chalk for rote exercises writing English names for common objects (Stout, 2012). Even those resisting these changes found it challenging to communicate in their native tongues. Boarding schools deliberately mixed students from various tribes, ensuring English was the only means of communication with both teachers and peers. These practices not only distanced the children from their linguistic heritage but also instilled in them a deep-seated fear and shame associated with their native languages (Treuer, 2010).

The deliberate suppression of Native American languages caused a significant break in intergenerational transmission, with many children losing fluency and struggling to communicate with their families. John Rogers, for instance, realized he could no longer speak his native Chippewa to his own parents after years at a Native American school (Child, 1998). This language loss hindered transmission to subsequent generations, leading to rapid decline. The U.S. government's assimilation policies also reshaped Native American societies, further distancing them from traditional practices, including communal living and native languages (Child, 1998). These policies, combined with societal pressures, had a lasting impact, contributing to the decline of Native American languages.

While the focus of this essay is language, it would be a mistake to not note that the long lasting and multigenerational effects of these schools defy reduction. Students at Native American boarding schools were subject to death, disease, physical abuse, sexual abuse, and myriad other forms of torture, both emotional and physical. When the ripple effects are examined today, it is often an impossible task to specify the cause of trauma. What must be noted is that these policies and schools not only robbed countless Native Americans of the ability to take meaningful part in the traditions of their ancestors. They robbed them of the ability to meaningfully communicate their trauma. To heal. To make sense of what had happened to them or share and unburden themselves to their loved ones. Language, their language, was essential in that process. Unfortunately, today, many of these languages are either severely endangered or on the brink of extinction.

3. Indigenous American Languages Today

The United States government's assimilation policies, in the late 19th and early 20th centuries, had a lasting impact on Native American languages, leading to severe endangerment and extinction by the 20th century. These policies disrupted intergenerational language transmission, leading to a decline in fluency. Activist, scholar, and Michipicoten First Nation member, John-Paul Chalykoff, recalls being raised with his grandmother being the last fluent speaker of Ojibwe in his family. "After she passed away, my mother's primary source of Ojibwe ended," notes Chalykoff. His family's story is a common one as fluent speakers of these languages grow older on average. Today Chalykoff devotes his time to revitalizing and preserving his tribe's languages but notes that it is "a puzzle I know I can't fully complete" (Chalykoff, 2023). Native American children in boarding schools lost their native languages,

causing rapid speaker declines, even resulting in some languages becoming 'sleeping' with no fluent speakers. Additionally, English-only enforcement in these schools instilled fear and shame around using Native American languages, which persisted into adulthood, further decreasing language use (Wharton and Shelton, 2013). Native American languages being situated as 'inferior' to Euro-American counterparts eroded their social esteem and discouraged preservation efforts in succeeding generations. The puzzle that Chalykoff worries cannot be completed is not solely a matter of preserving the voices of elders, but finding those that are willing to carry them for successive generations. The sentiment expressed by White Earth elder Joe Auginaush, "We're not losing our language, our language is losing us" (Treuer, 2010, p. 15).

Despite all this, Native voices have been growing louder in recent decades. The latter half of the 20th century and the beginning of the 21st century have seen a resurgent interest in these languages. Sparked by a growing recognition of the value of linguistic diversity and cultural heritage and driven by a desire to reclaim cultural identity and promote community resilience, Native American communities have been leading efforts to revitalize their languages. Robust conversations of when and how to harness and spread heritage languages are being had across multiple tribes. Bolstered by legislative support and the advent of modern technology, these conversations are writing a new chapter in the story of Native American languages.

Since the very beginning of the efforts at suppression, Indigenous communities have creatively employed strategies to preserve their linguistic heritage, initially through subtle and personal resistance. In Indian boarding schools, students found covert ways to communicate in their native tongues despite oppressive conditions. Despite the threat of punishment, many children persisted, driven by pride and the need for connection (Davis, 2001). Storytelling sessions, songs, and other traditional ceremonies often became covert spaces where languages could continue to be used. Historian Kevin Whalen notes that these clandestine meetings led to previously rare occurrences of intertribal friendships and cultural exchanges, laying the foundation for Native American civil rights activism in the twentieth century (Whalen, 2018).

In the early 20th century, organized political action for language revitalization gained momentum as some tribes developed writing systems, teaching languages within their communities, and documenting them. These initiatives countered assimilation policies and paved the way for further organized revitalization efforts. The late 20th and early 21st centuries witnessed a significant policy and legislative shift regarding Native American languages. Federal laws recognized the value of these languages and aimed to support their preservation. The Native American Languages Act of 1990 encouraged the use of indigenous languages in schools, contrasting with the boarding school era, and granted official status for business and governance purposes (S.2167 - 101st Congress, 1990). Another significant legislative measure was the Esther Martinez Native American Languages Preservation Act, enacted in 2006 and reauthorized in 2019. It provided grants to Native American language educational organizations for language immersion and restoration programs. These legislations played a vital role in supporting the resurgence of Native American languages, reflecting a more positive, culturally respectful approach and recognizing Indigenous rights.

Beyond policy and fighting for legislation, grassroots community initiatives have emerged as potent drivers of Native American language revitalization. Tribes have established their own language programs, including immersion schools for children and language classes for adults. Some have adopted "language nests," inspired by New Zealand Māori communities, immersing young children in their native language from an early age (McInnes, 2017). These programs blend traditional and modern teaching methods and often involve elders as keepers of linguistic and cultural knowledge. They provide a full curriculum in indigenous languages, not only teaching the language itself but also using it as the medium of instruction for other subjects. This approach is designed to promote fluency among younger generations and ensure the language's day-to-day usage. In addition to preserving language, they safeguard the transmission of culture (McQuillan-Hofmann, n.d.). Intergenerational learning is a common approach, where elders actively engage with younger generations to pass on their language and culture.

For adult learners, many tribes offer language classes that cater to various proficiency levels. In many of these programs, elders play an integral role. As the primary bearers of linguistic and cultural knowledge, elders often serve as teachers and mentors, working directly with younger learners in an intergenerational exchange of knowledge. This intergenerational approach not only promotes language learning but also strengthens community bonds and ensures the transmission of cultural values and traditions.

Technology plays a crucial role in modern language revitalization efforts as well, offering powerful tools to promote and preserve Native American languages. Language learning apps provide interactive lessons, pronunciation guides, and practice exercises, making language acquisition accessible to a wider audience, regardless of location. Digital archives and databases house audio, video recordings, dictionaries, grammatical guides, and texts, ensuring these resources are readily available for language preservation. Social media platforms serve as hubs for language promotion, fostering a virtual community of speakers, sharing resources, and conducting language challenges. In the digital age, these tech-driven initiatives adapt and thrive, safeguarding Native American languages against future loss.

Language revitalization plans cannot be implemented identically in all situations. While many, if not all, of these tribes face uphill battles after centuries of oppression, their economic, social, and political situations can vary in meaningful ways. There are no cure-alls when it comes to reclaiming their voice. However, grassroots political and community organization, educational initiatives, and inventive use of available technologies seem to be a common thread in the more successful of these efforts.

4.   A Potential Path Forward

When viewing the Herculean task of Indigenous American linguistic revival, it helps to have examples to examine. The Ojibwe Nation offers an illuminating example of a community-driven language revitalization effort. Their efforts at revitalization have utilized political action, grassroots community work, educational reforms, and the innovative use of technology to great success. With fewer than 1,000 fluent speakers left, the Ojibwe language was identified as severely endangered in the 20th century (Maher, 2021). However, the Ojibwe community has not let this discourage their efforts to recover their linguistic heritage. Over the past few decades, the Ojibwe have implemented several initiatives to promote language learning and usage within their community. This has included the establishment of Ojibwe language immersion schools, like the Waadookodaading Ojibwe Language Immersion School in Wisconsin, which teach all academic subjects in the Ojibwe language. Immersion schools have proved invaluable in linguistic revivals because it, in contrast to bilingual education which seeks to supplement language learning that is occurring at home, will help students develop fluency even for children whose homes are losing their grasp on their indigenous language (Hinton and Meek, 2018). These schools not only equip students with linguistic skills, but also immerse them in the cultural context in which the language is embedded.

Moreover, the community has embraced a holistic approach to language revitalization, involving all age groups. Intergenerational programs engage elders as fluent speakers and cultural knowledge bearers, actively educating younger generations. Community language classes empower adults to contribute to language preservation (Katona, 2023). Community language classes provide opportunities for adults to learn and contribute to language preservation. To connect their language directly to the culture that they hope to preserve, the Ojibwe organize cultural events in the Ojibwe language that highlight tribal traditions using the Ojibwe language. This elevates the language from an abstract concept to be studied to a living breathing entity that unites the community intergenerationally (Morgan, 2005).

Embracing technology, the Ojibwe community has created online resources like the Ojibwe People's Dictionary, a talking Ojibwe-English dictionary. They've also launched interactive language-learning apps, offering accessibility for learners of all levels, with over a dozen such apps available. An Indigenous NPO, Grassroots Indigenous Multimedia (GIM), has taken the lead with innovative technological use by creating a video game entitled *Reclaim!* that instructs players in Ojibwe while calling on them to use that language over the course of the game. GIM is also taking the lead in an essential, albeit less glamorous, role that technology plays in language revitalization efforts: archiving and documenting the language. As in all cases of linguistic revitalization, as elder numbers continue to dwindle, the preservation of their voices is vital in both honoring their roles as cultural caretakers and the construction of curricula that will pass on their language (Hinton and Meek, 2018). The digitization of indigenous records and voices, as well as the use of technology in the spread of the language is particularly important as it tends to reach younger speakers more meaningfully as well as lead to intergenerational collaborations by inverting the elder-youth dynamic (Dwyer et al., 2018).

Lastly, the Ojibwe community actively advocates for support at the local, state, and federal levels, successfully securing funding and policy backing for their language programs. Since the middle of the 20th century Ojibwe people

have been advocating for themselves when they saw that their language and culture were not being served or respected by local governments. Ojibwe smartly and frequently engaged in non-violent protest and activism in order to gain the educational reform that laid the foundation for their linguistic revival. By clearly and peacefully voicing their objections underrepresentation and erasure, the Ojibwe were able to form public schools and tribal colleges that catered to their unique cultural heritage (Peacock and Day, 2000).

Throughout all aspects of the Ojibwe revival, and indeed many others like it, there is a common thread that runs counter to the sensibilities of many that earnestly desire to help them. In all these revitalization efforts, a balance must be struck between substantial and meaningful assistance on the part of federal, state, and local governments, and tribal autonomy that allows for tribes to conceive of and implement curricula that is responsive to their urgent and ever-developing project without getting bogged down in bureaucratic quicksand. In several notable linguistic revitalization projects, and specifically in that of the Ojibwe, activist efforts have been frustrated not only by nationalist demands for assimilation, but also liberal ideas of communal decision-making (Lo Bianco, 2018). Heavy-handed and broad-brushing policies designed to encourage equity and raise standards can place unnecessary burdens on Indigenous language schools already struggling to find willing and capable teachers. In the case of the Ojibwe, schools that were given flexibility over areas like curriculum development, staffing, and learning spaces were able to find success even when funding was lacking (Morgan, 2005).

5. Conclusion

Language's role in a culture's identity is so intricately woven into our cultural fabric that it is often difficult to parse exactly how much it touches. It is the way we make sense of ourselves and the world around us. It's how we express emotions, relay histories, teach, and self-reflect. Its importance is simultaneously obvious and ineffable. This much was clear to the men that sought to pry it from the mouths of indigenous peoples in the pursuit of their cultural genocide. If indigenous peoples couldn't speak their language, they ceased to be truly unique and separate from those that sought to assimilate them. It is an astounding feat of resilience that these languages survived at all, and of the utmost importance that they continue to survive. The case of the Ojibwe Nation demonstrates how a community-driven, multi-faceted approach to language revitalization can yield promising results. It underscores the importance of incorporating language learning within cultural contexts, engaging all age groups, leveraging digital tools, and actively advocating for supportive policy measures while fighting for self-determination. Through these means, Ojibwe went from a language on the brink of extinction to one that is the primary mode of instruction in schools from pre-K to university level classes. What was once spoken in whispers in boarding schools is being loudly and proudly communicated intergenerationally across the US and Canada. Similar such efforts need to be supported wherever there are willing indigenous communities to implement them. Furthermore, allowing for self-determination is an essential component of this support. In many ways, it is truly a matter of life and death. Indigenous people are subject to some of the poorest health outcomes across America, and language revitalization could potentially play a positive role. Research has linked language revitalization to positive health outcomes at both an individual and community level in Australia, Canada, and the United States (Walsh, 2018). In addition, the creation of spaces that allow for indigenous peoples to communicate in their language can lessen stigmas and foster relationships between indigenous and non-indigenous peoples (Walsh, 2018). The success of language revitalization projects is far more than the righting of past wrongs. These programs offer a hope for indigenous communities to better make sense of their past as they plan for a future that was almost stolen from them. They offer a lens through which they can begin to restore and rebuild what took them millennia to build, on their own terms, free of oppression.

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The Effects of a High Saturated Fat Diet and a High Protein Diet on the Effects of Left-Ventricular Hypertrophy

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Abstract

Studies indicate that high protein consumption increases risk of cardiovascular disease, while high saturated fat consumption reduces risk. The effects of these diets on left-ventricular hypertrophy remain unknown. This study examined the effects of high protein and high saturated fat diets on left-ventricular hypertrophy in *C. elegans.* Two experimental groups mutated with left-ventricular hypertrophy (JM311 strain) were fed either high protein or high saturated fat diets, while two control groups of JM311 worms and N2 wildtype worms were fed OP50 diets. It was hypothesized that worms fed high fat diets would have less severe left-ventricular hypertrophy than the worms fed high protein diets. Egg viability assay results showed lower egg counts in JM311 control strains (16.33±0.31 eggs) compared to control N2 worms (34.67±0.92 eggs). The high saturated fat diet groups had higher egg counts (32.33±0.28 eggs) than high protein diet groups (26±0.36 eggs). The number of eggs laid by the high saturated fat worms was significantly higher than those of the high protein worms (p=0.03826). The number of eggs laid by both high saturated fats (p=0.65) and the high protein worms (p=0.1642) did not significantly differ from the N2 wildtype group suggesting that high saturated fat and high protein diets can enhance recovery rates in left-ventricular hypertrophy patients, with high saturated fat diets having a more significant effect on recovery rates. These results provide insights on potentially beneficial dietary approaches to clinicians treating patients with left-ventricular hypertrophy.

Keywords: C. elegans, Cardiomyopathy, Left-Ventricular Hypertrophy, Nutrition, Protein, Fats, Diet

1. Introduction

Left-ventricular hypertrophy (LVH), otherwise known as hypertrophic cardiomyopathy, occurs when the walls of the left ventricle, the heart's main pumping chamber, thickens, adding stress to the cardiovascular system. Blood pressure in the heart causes the walls to thicken to the point where the heart is not able to pump with enough force needed to circulate the blood properly. Nearly 1 in 5 people in the United States are affected by LVH (Cleveland Clinic, 2023). If left untreated, this can eventually lead to arrhythmias, heart failures, and other serious complications.

Caenorhabditis elegans are a species of worms used as model organisms for studying many human diseases due to their physiological overlap with humans including the digestive, nervous, and reproductive systems (Yen & Curran, 2016). It has been shown that of the 42 mutated human proteins that are associated with various cardiomyopathies, 35 proteins have orthologs or homologs in *C. elegans*, suggesting that *C. elegans* are a good model organism for left-ventricular hypertrophy (Benueb & Epstein, 2011). In addition, it has also been suggested that because *C. elegans* have a short reproductive cycle, complex multicellular structure, and shared genes with humans, they can be used to replicate dietary and metabolic changes, making *C. elegans* good organisms to evaluate the effects of diet on heart function (Benueb & Epstein, 2011; Yen & Curran, 2016).

Past research has shown evidence to support that high protein diets increase the risks of various arterial diseases (Zhang et al, 2020). After feeding Apolipoprotein E (ApoE) null mice with high-protein diets and measuring the amount of plaque in their body over two months, it was found that there was a significant increase in atherosclerotic plaque at the aortic root. This plaque build-up can cause the arteries to narrow, which leads to multiple cardiovascular diseases (CVD) like atherosclerosis (Zhang et al, 2020). LVH is a cardiovascular disease that is not caused by plaque buildup, suggesting that a high protein diet may not have the same effect on left-ventricular hypertrophy as other CVDs. Another common misconception is that consuming large amounts of fatty acids increases the risk of cardiovascular disease. However, recent data found that the number of unsaturated fats consumed by Swedish men was inversely proportional to that of the cardiovascular disease risk of each participant suggesting that high-fat diets may increase cardiovascular health, in contrast to prior belief (Trieu et al, 2021).

The severity of LVH in *C. elegans* has been measured by counting the eggs laid by gravid adults. In one study, the different properties of two new strains of *C. elegans* (Strain JM311 and VC1317) with mutations that replicate left-ventricular cardiomyopathy were investigated by comparing physiological properties to the wildtype N2 strain (AlKhaleefa, 2020). The JM311 strain was chosen because it contains the *lem-2*(ca19) mutation that results in premature cardiomyopathy, and had a measurable characteristic to track the severity of LVH. The effects of cardiomyopathy in *C. elegans* were compared to the N2 wild-type strain and it was found that the mutated strains' relative brood size was reduced when compared to that of the N2 wild-type strain. These results suggest that *C. elegans* with more severe LVH lay fewer eggs than those with less severe hypertrophy.

Diet has a large impact on the human body, especially for those with cardiovascular disease. Healthy eating not only allows for a longer life span, but also lowers risks of obesity, heart disease, type 2 diabetes, and cancer (Center for Disease Control, 2022). However, with LVH and other cardiovascular diseases, there is conflicting research about what patients should eat or avoid eating, making it hard for them to make healthy eating decisions. This study aimed to determine whether a high saturated fat diet or a high protein diet improved left-ventricular hypertrophy and its progression. These results will help patients navigate controversial information about the benefits or disadvantages of protein and saturated fat diets related to LVH. It was hypothesized that if *C. elegans* mutated with left-ventricular hypertrophy were fed a high protein diet or a high fat diet, the left-ventricular hypertrophy would improve in the group of *C. elegans* that was fed the high fat diet as opposed to the group that was fed the high protein diet because it has been shown that higher consumption of fats leads to an increase in cardiovascular health.

2. Materials and Methods

JM311 and N2 *C. elegans* were obtained from the Caenorhabditis Genetics Center (University of Minnesota). All other reagents were obtained from Millipore Sigma.

In order to evaluate the effect of the macronutrients on left-ventricular hypertrophy, this study uses two experimental groups, JM311 *C. elegans* that are fed either a high saturated fat (HF) diet or a high protein (HP) diet added to the standard diet of *E. coli* OP50. JM311 and N2 wildtype *C. elegans* were fed the standard diet of *E. coli* OP50 and used as a negative control to determine the number of eggs laid by healthy adult worms for each strain. The HF diet includes an addition of 37% palmitic acid and the HP diet includes the addition of 37% valine to the standard *E. coli* OP50 diet.

2.1 Plate Preparation and Stock Culture Maintenance

Nematode Growth Media (NGM) plates were prepared by adding 3 g of NaCl, 17 g agar, and 2.5 g peptone to a 2 L erlenmeyer flask. Distilled water was added until the total contents in the flask was 975 mL and the flask was sealed with aluminum foil and autoclaved for 20 minutes at 121°C at 15 psi. The contents of the flask were left to cool to 50°C and 25 mL of KPO_4 solution pH 6.5, 1 mL of $CaCl_2$, 1 mL $MgSO_4$, and 1 mL of 5 mg/mL cholesterol in ethanol were added to the flask and mixed. Using sterile technique, the NGM was poured into petri dishes until ⅔ full, and the plates were left for 2 days at room temperature to cool and check for contamination.

E. coli OP50 was cultured by inoculating 5 mL of Luria Broth (LB) with a frozen glycerol stock of bacteria. The

newly inoculated tube was placed in a shaking incubator at 20ºC for 24 hours, then stored at 4ºC for later use. For the HF and HP cultures, *E.coli* OP50 was pipetted into a new tube, and valine (protein) or palmitic acid (fat) were added to a final concentration of 37%. The palmitic acid was dissolved in a very small amount of ethanol before addition.

To maintain stock cultures of JM311 and N2 *C. elegans* on the standard diet, *E. coli* OP50 was added to the center of an NGM plate and incubated at room temperature until a bacterial lawn formed. A chunk of agar from a plate of *C. elegans* was moved to a fresh plate using a sterile inoculation loop. Stocks were stored at room temperature and recultured every two weeks. They were disposed of by submerging the contents of the plate in 10% bleach for 10 minutes.

2.2 Egg Viability Assay

To synchronize the *C. elegans*, 50 μls of freshly prepared alkaline hypochlorite solution (1 ml bleach, 250 μl of 10M NaOH, and 3.75 ml sterile deionized H_2O), was pipetted onto an NGM. Gravid *C. elegans* from standard, well-fed culture stocks were chunked onto the plate, and left for 48 hours.

Another NGM plate was prepared with the corresponding high fat diet, high protein diet, or standard diet. A worm pick was gently scraped over the plate with OP50 in a small area and very quickly, the pick was moved to the prepped plate, and pressed onto the media until the worm moved away from the pick and onto the plate. This was repeated 10 times, for a total of 10 synchronized worms on each plate. The worms were left on the plate for 96 hours at room temperature. A dissecting scope was used to observe and count the number of eggs laid on the plate. Three trials of egg viability assays were conducted in order to accurately measure brood size and determine the severity of the condition of each worm group (AlKahleefa, 2020).

2.3 Statistics

Because only three trials were conducted, a non-parametric Mann-Whitney test was the choice of test to conduct. A Mann-Whitney test compares two groups and their medians in order to come up with statistical conclusions. In a Mann-Whitney test, the data values of both groups are combined and ranked from smallest to largest. From there, they are split again, with the ranks separated for each group. The sum of the ranks of each group are found and the U values for each group are found with this formula: U1 = n1n2+0.5n1(n1+1)-R1. The smallest U statistic is that and using a Mann-Whitney table, the U-statistics for the test is found using 5% significance value. This is compared to the minimum U-statistic calculated, and if the U-calculated is smaller than the U-statistic, then there is a statistical difference between the two data values.

However, due to technological advancements, Mann-Whittney tests can be conducted easily with Mann-Whitney calculators. In these calculators, the U-statistic and p-values are given. The p-value is the probability that the null hypothesis is supported by the data. The null hypothesis is always that there is no difference between the two data sets. Using a 95% confidence level, a p-values of 0.05 or lower indicates that the null hypothesis is not supported by the data, and that there is a significant difference between the two data sets.

One Mann-Whitney test was used in order to determine if the HF diet group laid significantly larger amounts of eggs than the HP diet, allowing us to come to a conclusion about which diet was the better diet in improving the worm's LVH conditions. Two more Mann-Whitney tests were conducted, in order to test whether there was a significant difference between the N2 strains and the HF and HP diet groups, in order to determine whether the two diets were able to improve the condition on the worms so significantly that there was no statistical difference between the median eggs laid by the healthy N2 strain and two diet groups.

3. Results

Control N2 *C. elegans* on the standard diet laid 34.67 ± 0.92 eggs per plate while JM311 *C. elegans* on the standard diet laid 16.33 ± 0.31. These data support the previous research which showed a reduction in egg laying in *C. elegans* mutated to exhibit cardiomyopathy (AlKahleefa, 2020). JM311 fed the HF diet group laid an average of 32.33 ± 0.28 eggs per plate while those fed the HP diet laid 26.00 ± 0.36 eggs per plate. The addition of either high fat or
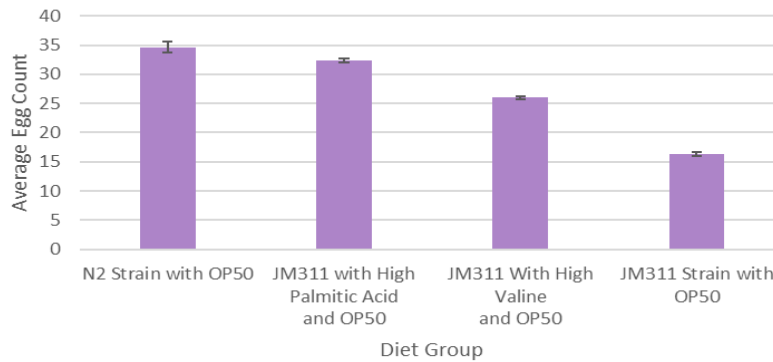
Figure 1. Average egg viability assay egg counts from three trials, for each diet group. Bar graph showing mean eggs laid by each diet group, with standard error bars (n=3). N2 and JM311 were fed the standard control diet of E. coli OP50 and JM311 mutated *C. elegans* were fed the standard diet of *E. coli* OP50 plus either a HF diet or HP diets.

high protein to the diet of JM311 *C. elegans* resulted in more eggs than the JM311 strain fed the standard OP50 diet (Figure 1 and Table 1). These data suggest that both HP and HF diets played a role in improving the LVH conditions.

A Mann-Whitney test was conducted comparing the brood sizes (egg counts) of both experimental groups to each other. Because a small sample size (n=3) was used and there was one outlier present, a non-parametric Mann-Whitney analysis was conducted to determine whether HF diet groups laid

significantly more eggs than the HP diet groups (Table 2). With a significance value less than p= 0.05, the number of eggs laid by worms in the HF diet group was significantly larger than that of the HP diet group. This suggests that the HF diet improved the condition of the worms significantly more than the HP diet group, with its median egg count the closest to the N2 wildtype worm's median egg count (Table 1).

Table 1. Average egg viability assay egg counts of all three trials, for each diet group. Table showing mean ± SD eggs laid by each diet group (n=3). Two groups of JM311 worm strains were fed HF diets or HP diets, and one group of JM311 worms and one group of N2 worms were fed typical OP50 bacteria and grown at room temperature.

Diet Group	Average Egg Count for Three Trial (eggs)
N2 Strain with OP50	34.67 ± 0.92
JM311 Strain with OP50	16.33 ± 0.31
JM311 With High Valine and OP50	26.00 ± 0.36
JM311 with High Palmitic Acid and OP50	32.33 ± 0.28

Table 2. Egg count comparison of the JM311 HP diet group and JM311 HF diet group. Table showing Mann-Whitney statistics values (n=3) of median egg counts of HP and HF worms of the egg viability assay. JM311 worms were fed both HP and HF diets. Mann-Whitney, p = 0.0383

Mann-Whitney statistic values
p-value
0.0383

Table 3. Egg count comparison of the JM311 HP diet group and JM311 HF diet group to N2 wildtype worms. Table showing Mann-Whitney statistics value (n=3) comparing the median egg counts of the N2 worms and the HP and HF worms. JM311 worms were fed either a HP or a HF diet, and N2 wild-type worms were fed the standard *E.coli* OP50 diet.

	Mann-Whitney statistic values
Diet Group	p-value
JM311 HF vs N2 Standard	0.65
JM311 HP vs N2 Standard	0.1642

A Mann-Whitney test was conducted comparing the brood sizes (egg counts) of both JM311 experimental groups to the N2 control group which was fed the standard diet of *E.coli* OP50. Because a small sample size (n=3) was used and there was one outlier present, a non-parametric Mann-Whitney analysis was conducted to determine whether the HF diet group or the HP diet group laid a similar number of eggs as compared to the N2 worms (Table 1 and Table 3). With a significance value of 0.05 (95% likely that there is a difference between data values), the number of eggs laid by worms in the HF or HP diets was not statistically different from the N2 control group (p-value of 0.1642 and 0.65 respectively). These data suggest that the HP or HF diets improved the left-ventricular hypertrophy condition to the point that the animals laid similar numbers of eggs as compared to healthy worms.

3. Discussion

When comparing the effect of a high protein diet to a high fat diet (Table 1 + 2) the results show a statistically significant larger egg count for the JM311 worms fed the high fat diet as compared to worms fed the high protein diet, suggesting that high saturated fat consumption may lead to a less severe cardiomyopathy than that of high protein consumption. This means that the original hypothesis that saturated fat diets would improve LVH rates more than the HP diet is supported by the data of this experiment.

However, there was a lack of a significant difference between egg counts of both the high protein diet worms (p = 0.65) and the high fat diet worms (p = 0.1642), when compared to the N2 wildtype worms (Table 3). This suggests that, in addition to the HF diets, the HP diet also significantly increased egg counts when compared to the N2 wildtype strain. These data suggest that both diets may have the potential to improve LVH conditions.

The results presented in this study partially align with published research. Past studies suggested that high unsaturated fat diets decreased cardiovascular disease risk (Trieu et al., 2021), while high protein diets decrease cardiovascular health (Benian & Epstein, 2011). Though a HF diet improved left-ventricular hypertrophy when compared to the HP diet, both diets improved the LVH as measured by egg laying ability. Thus, it cannot be concluded based on the data presented here that a high protein diet is detrimental to cardiovascular health.

This inconsistency between past research and the research presented here may be attributed to an outlier in the N2 control group. In the future, this study should be conducted again, but with more trials to accommodate for potential outliers. Further, because both nutrients improved the left-ventricular hypertrophy, future research could test whether a combination of both nutrients improves the condition of the worms more than just one nutrient together.

4. Conclusion

C. elegans mutated with left-ventricular hypertrophy were treated with either a high fat diet or a high protein diet and improvement in their egg laying ability was measured as a function of cardiovascular health. The egg viability assay indicated the severity of the condition, where the number of eggs laid correlated with the health of the worms. Using a nonparametric Mann-Withney test and observing the data it was found that HF diets improve conditions of the worms statistically more than the HP diets. In addition, it was found that both HP and HF diets improved LVH conditions in JM311 worms as compared to N2 control worms. This study has identified a potential connection between improvement in left-ventricular hypertrophy with the consumption of both saturated fat and proteins, providing clinicians and patients guidance on what they should be eating.

Acknowledgment

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Electric Vehicle Adoption Deterrents:
A Survey Analysis of High-Income Suburban Individuals
on Key Concerns Impacting Electric Vehicle Purchase Decisions

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Abstract

The general population has many concerns about Electric Vehicles (EVs), but the concerns are significantly different for various income groups. This paper analyzes the concerns of a specific income group about purchasing a battery-powered electric vehicle. While previous studies have investigated people's concerns regardless of income, this study offers novel findings on high-income suburban individuals' sentiment. A 10-question google forms survey was sent out to collect data on EV perception. Based on the results, a T-test was used to see the differences in concern ratings between high-income EV owners and high-income non-owners along with differences in concern ratings in two different suburbs (West Windsor and Plainsboro, NJ, and Frisco, Texas). Interestingly, it suggests that the differences in ratings for apprehensions related to charging and battery efficiency are statistically significant(higher) for EV non-owners compared to owners. In addition, findings also suggest that Initial Cost is a concern for non-owners, but its rating is very similar to that of owners, suggesting that it isn't the primary reason for non-purchase of an EV. The conclusions of this study can facilitate further research in areas focused on educational and awareness building campaigns to address the key concerns regarding EV adoption along with future studies on EV perception.

Keywords: Identity, Gender, Socioeconomic class, Education, Politics

1. Introduction

Electric vehicles (EVs) run on electrical energy stored in their lithium-ion battery pack, unlike most vehicles today, which run on gasoline (a mixture of different fossil fuels). There are common types of electric vehicles, such as a plug-in hybrid, battery electric vehicle (BEV), and hybrid electric. All three involve the use of electricity for power, and they have drastically changed the car market. Their contribution to environmental sustainability is the major reason why the electric vehicle market has grown at a rapid rate during the 21st century and is continuing to do so. From 2011-2021, the percentage of car sales from electric vehicles increased by around 2300%. However, not all consumers are eager to switch to electric. According to a recent survey, less than 4 in 10 Americans say that they are somewhat likely or very likely to buy an electric vehicle (ResearchPew, 2023), suggesting that consumers aren't likely to make the switch anytime soon. While high initial cost continues to remain a significant deterrent, recent research from Statista suggests that only 33% of even high-income individuals considered purchasing an electric vehicle. This could present a significant opportunity since analyzing EV ownership trends within a base where cost may not be the biggest factor might provide insights into the key concerns about purchasing EVs compared to analyzing broader income segments.

This study aims to analyze the sentiment of higher-income (~$150,000-200,000) suburban individuals on deterrents related to EV purchase. While there have been studies on concerns about EV ownership, there have yet to

be studies done on specifically high-income individuals' sentiments. The study also allows for an analysis of differences in concern ratings between current EV owners and non-owners, which can create new insights into EV perception among a homogenous group. Additionally, this study surveyed two suburban geographies within the US because most Americans (52%) live in suburban areas (HUDUSER, 2020). It can be predicted that non-owners will likely display more apprehension to most of the concerns compared to owners considering that the income groups for both owners and non-owners are homogeneous, suggesting that factors other than cost will likely be higher for non-owners, but the degree to which they differ is the primary component of the study because that will help identify the areas that need to be addressed to drive adoption. The paper will discuss the implications of the survey and what this means for future research, particularly in areas related to education and awareness, along with how the design study can be modified to include a larger population.

2.   Materials and Methods

A survey was sent out to middle-aged residents (primary household owner age of 40-65) from the adjacent, suburban townships of West Windsor, NJ and Plainsboro, NJ to investigate further. The median income of individuals that age is $189,006 in West Windsor and $150,526 in Plainsboro (NJMLS, 2023). In addition, the survey also included middle aged individuals from Frisco, Texas to increase the geographical diversity of the responders. Frisco has a median income of $161,547 for residents aged (45-64), which qualified them for inclusion in the survey. Frisco is also a suburban township, but it is larger than West Windsor and Plainsboro and more metropolitan, which further increased the diversity of the study. However, this could be a potential limitation since more suburbs could've been included in the collection of data for more definite conclusions. While it is true that these incomes are much higher than the national average, the cost of living in both these locations is also significantly higher than the national average at 30% and 45% respectively. Also, the purpose of study was to start with the higher deciles of income and see if there is a difference in perception. Further research will need to be done across different income ranges to assess the validity of the conclusions, but this higher-income group would constitute a large market for EVs. In addition, because both locations have significantly higher costs of living, it makes comparing the two regions feasible for the study, especially considering that West Windsor and Plainsboro's averaged median income is more than that of Frisco, but it has a higher cost of living. Furthermore, other demographic indicators suggest a reasonably homogenous population-especially regarding ethnicity (~77% Asian and White population in West Windsor and Plainsboro compared to 75% in Frisco) (Niche, 2023), age (median ages between 35-44 for all 3 locations) (Niche, 2023), and highest education received (80% of West Windsor and Plainsboro Residents have a bachelor's degree or higher compared to 66% in Frisco- both are significantly higher than the national average of 34%) (Niche, 2023).

Next, a specific set of concerns was developed to include in the survey. The survey was primarily designed off past EV sentiment studies, such as the 2023 Global Automotive consumer study by Deloitte, but it was designed to select concerns that are relevant towards the demographics of my sample population along with the goals of the study. For example, one of the focus points of the study was to the attitudes of wealthier individuals toward EV initial costs, so initial car cost was included in the study. Concerns like 'Lack of charger at home' or 'Lack of choice' were not used because they would likely be less problematic for wealthier individuals. Additionally, many concerns were eliminated and combined to decrease the time participants would spend on the study since a shorter survey would likely increase the quality of the responses as people would likely spend more time per question. For example, concerns like 'Lack of alternate power source (e.g., solar) at home' were combined into a category with Electricity Costs because that would shorten the survey. Here is the final list of concerns:

- Initial car cost
- Replacement and maintenance costs (Ex: battery replacement)
- Electricity costs and home infrastructure modifications (Ex: Solar Panel Installation or amp capacity upgrade)
- Battery Efficiency (Miles per KWH)
- Public Charging Accessibility
- Charging Speed

- Resale Value/Capability
- Insurance Premium

Then, the questions and style were developed. Because a statistical analysis was intended to be conducted in the study, a 10-point scale was used, and participants were asked to rate these concerns on how much it would affect their chances of buying an electric vehicle (1 meaning it would not be a factor and 10 meaning it would be a large factor). This was also done because responses like 'very problematic' or 'not problematic at all' would not help, and only knowing whether something is or is not concerning for someone wouldn't help for the type of analysis in this study- only information that would allow for numerical comparisons would work. The 10-point scale was specifically chosen over other numerical scales, such as a 5-point scale for the data to be as precise as possible. In addition, to account for the participants' knowledge and viewpoint on electric vehicles, the survey included a question asking them about their current ownership of electric vehicles ('yes', 'no', 'no-but planning to buy one') and a question asking them about their familiarity with electric vehicles ('very familiar', 'somewhat familiar', 'unfamiliar'). This way further investigation could be done to see if there were correlations between ownership and concern ratings, and knowledge and concern ratings.

Finally, the survey was sent out. It was sent through google forms and mainly through social media, primarily Facebook. No information regarding gender, age, ethnicity, or factors like the number of people in nuclear family was to preserve the anonymity of the responders, but this could be a limitation. However, factors like demographics and average township age were incorporated into the analyses and conclusions, and the survey was sent out to media platforms that have an older population compared to other media platforms. Additionally, because owners were responding to the survey based on their current perception, there could be some hindsight bias in their responses.

The organization of the data and statistical analyses was done through google sheets. The statistics used were averages, coefficient of variation, and p-values from T-tests. A T-test was performed on the ratings between EV owners and non-owners along with the ratings between West Windsor and Plainsboro responses and Frisco responses to test for statistical significance between any of the groups. For the T-Test, the alpha value was the standard 0.05, meaning that the result of the T-Test returning some less than 0.05 means that there is a statistically significant difference between the groups compared. Anything above the 0.05 level does not indicate statistically significant differences, but it can be used to get a general picture of the comparisons between the groups compared.

3. Results

3.1 Survey Results

A total of [N=135] responded to the survey (75 from Plainsboro and 60 from Frisco), where N represents the total number of participants. Only 3.7% of people responded that they were unfamiliar with electric vehicles. I removed those responses to maintain the accuracy of the study, so the data used in the analysis contains [N=130] responses. Out of the 130 responses in the dataset, 72 were from West Windsor or Plainsboro and 58 were from Frisco.

For the results of the study, more than 60% of responders reported being 'very familiar' with electric vehicles and 36.5% reported 'somewhat familiar'. Only 17.7% of
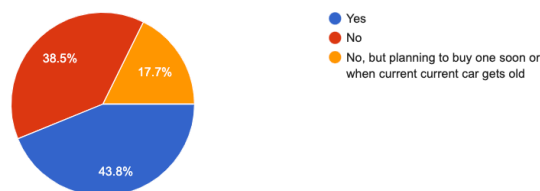

Figure 1: This figure shows a pie chart of the different percentages of responses for each category for the question 'Do you own a Battery Electric Vehicle?'

responders said that they would buy an electric vehicle as their next car, which could mean that the responders who don't own an electric vehicle are less likely to make the switch for now.
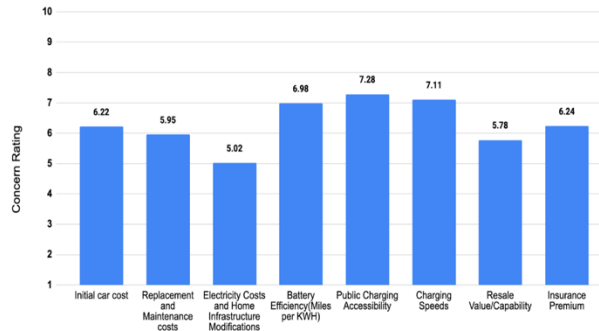
Figure 2: This graph shows the average rating on a scale of 1-10 of [N=130] participants on their concerns about electric vehicle ownership
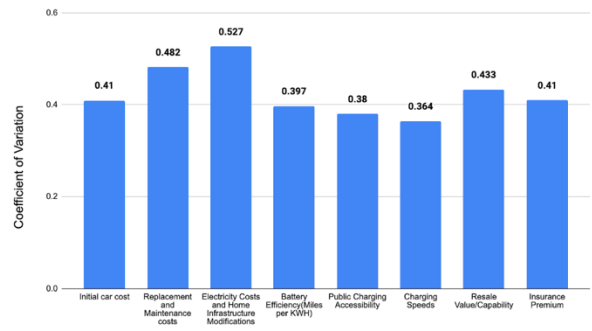

Figure 3: This graph shows the coefficient of variation(cov) of the responses [N=130] for each concern. It was calculated by dividing the standard deviation of each concern by the mean of each concern. Its purpose is to illustrate that certain concern ratings had less variance than others.
*cov<1 for all concerns, which indicates low variance in ratings

Public Charging Accessibility received the highest average concern rating, followed closely by Charging Speeds and Battery Efficiency. After that, there was a substantial drop-off in concern as Insurance Premium and Initial Cost were the next highest rated. Electricity Costs and Home Infrastructure Modifications received the lowest rating by a significant amount. The graph above doesn't factor in ownership or knowledge, but those factors played a major role in the concern ratings; for example, participants who reported being 'very familiar' with electric vehicles had far fewer concerns with any aspects of electric vehicles overall compared to participants who were 'somewhat familiar.

3.2 Ownership T-test

I used this data to specifically focus on certain groups' concern ratings. I aimed to analyze certain trends and find differences between the ratings of owners and non-owners; I combined the categories of 'no' and 'no but planning to buy one' because there were only 23 responses for the latter, which was not enough responses to draw conclusions individually (although the results for this category were even more extreme compared to the 'no' category). To do this, I first performed a T-test on the concerns to see if any differences between owners' ratings and non-owners were statistically significant. I separated the ratings for each concern above into an owner response or non-owner response, and I ended up with 57 responses on the owner side and 73 responses on the non-owner side for each of the 8 concerns analyzed. For the 4 parameters of the T-test, I used the first one for the owners' responses, the second one for the non-owners' responses, the third one for the number of tails, and the fourth one for the type of test. I chose to use 2 tails because I didn't have a specific hypothesis I wanted to test, and I chose to use a type 3 test as it is the two-sample, unequal variance test. The null hypothesis was that there would be no difference in the concern ratings between owners and non-owners. After performing the T-tests, I found that Initial Costs had a P-value of 0.851. However, Battery Efficiency, Public Charging Accessibility, and Charging speeds had P-values of 0.041, 0.031, and 0.004 respectively.

This demonstrates that the results of the T-test are statistically significant for Replacement and Maintenance Cost Responses, Battery Efficiency Responses, Public Charging Accessibility Responses, and Charging Speed Responses because they have P-values less than 0.05, thus rejecting the null hypothesis for these concerns that ownership doesn't affect concern ratings as the comparison was between owners' sentiment on the concerns compared to non-owners' sentiment on the concerns. The results of the T-test show that there is a clear difference in sentiment between owners and non-owners for these four categories. Each of those concerns had a difference of more than one when looking at owners' sentiment compared to non-owners' sentiment. The difference in average sentiment between owners and non-owners for Initial Cost was negligible. Replacement and Maintenance Costs ratings were significantly higher for non-owners compared to owners, making it the only money-related concern to have a statistically significant difference in sentiment between owners and non-owners. Overall, it can be concluded that for the participants in this study, Battery

Efficiency, Public Charging Accessibility, and Charging Speeds are the biggest factors impacting EV ownership; Replacement and Maintenance costs are an important concern for non-owners; and Initial Cost plays a role in EV ownership but is not the reason that non-owners aren't buying them.

Table 1: This table shows the results of the T-test and the different Means, Variances, and P-values for [N=57] owners and [N=73] non-owners for each of the concerns.
*P<0.05 for Replacement and Maintenance Cost Responses, Battery Efficiency Responses, Public Charging Accessibility Responses, and Charging Speed Responses

Concern	Owners (N=57) Mean	Owners (N=57) Variance	Non-Owners (N=73) Mean	Non-Owners (N=73) Variance	P-Value
Initial Car Cost Responses	6.26	6.55	6.18	6.51	0.851
Replacement and Maintenance Cost Responses	5.09	9.19	6.55	6.86	**0.008**
Electricity Costs and Home Infrastructure Modifications Responses	4.60	6.60	5.34	7.12	0.109
Battery Efficiency Responses	6.42	7.89	7.42	7.19	**0.041**
Public Charging Accessibility Responses	6.68	8.43	7.75	6.66	**0.031**
Charging Speed Responses	6.37	6.84	7.68	5.91	**0.004**
Resale Value/Capability Responses	5.85	6.30	5.71	6.29	0.740
Insurance Premium	5.96	7.29	6.45	5.95	0.289

3.3 Geographic Comparison

To analyze the impacts of geography on the ratings, a comparative analysis was conducted on the differences in the ratings between West Windsor/Plainsboro and Frisco.

The data illustrates that there are certain ratings that are higher in Plainsboro compared to Frisco, particularly the three non-financial concerns. Electricity Costs and Home Infrastructure Modifications and Resale Value/Capability did have differences in concern ratings as well, but they weren't analyzed further due to the low ratings they got. Additionally, the difference in Initial Cost ratings between the two locations was very low.
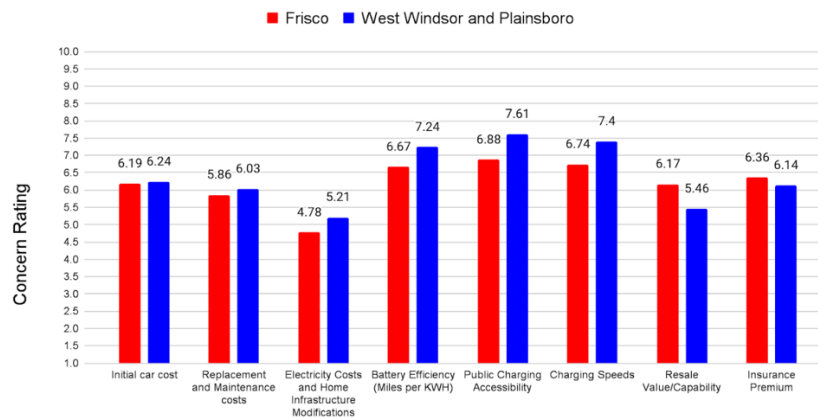

Figure 5: This graph shows the concern ratings for [N=72] participants in West Windsor and Plainsboro compared to [N=58] participants in Frisco

To analyze any differences between the responses in West Windsor and Plainsboro compared to Frisco, another T-test was performed, but this time it was between the participants in both locations. I used the same two-sample, unequal variance test with the same test parameters as earlier: a 2-tailed, type 3 (unpaired) test. However, I used the ratings of Frisco participants as my first parameter and the ratings of West Windsor and Plainsboro EV participants as my second parameter. The ratings for initial cost in both locations were close to identical, so for the test, I only focused on the concerns of Replacement and Maintenance Costs, Battery Efficiency, Public Charging Accessibility, and Charging Speeds because they were the only concerns to have a statistically significant difference in rating between owners and non-owners. This time, my null hypothesis was that location doesn't affect concern ratings. After performing the tests, none of the concerns had a p-value less than 0.05.

Table 2: This figure shows the results of the T-test and the different Means, Variances, and P-Values for West Windsor and Plainsboro (WWP) participants and Frisco participants for each of the four concerns.

Concern	WWP (N=72) Mean	WWP (N=72) Variance	Frisco (N=58) Mean	Frisco (N=58) Variance	P-Value
Replacement and Maintenance Cost Responses	6.03	7.75	5.86	8.96	0.747
Battery Efficiency Responses	7.24	6.46	6.67	9.17	0.260
Public Charging Accessibility Responses	7.61	5.99	6.88	9.58	0.145
Charging Speed Responses	7.40	5.43	6.74	8.16	0.158

The results of this T-test demonstrate that none of the concerns have statistically significant differences based on ratings from the different locations. While West Windsor and Plainsboro participants did report higher concern ratings overall, there isn't enough evidence to suggest that this result is meaningful, especially because there were a higher percentage responses of EV owners from Frisco than those of West Windsor and Plainsboro. Thus, location doesn't undermine the conclusion that non-owners' sentiment of the statistically significant concerns is higher than that of the owners.

4. Discussion

4.1 Results Analysis

The results that high-income suburban individuals are more concerned with the practicality of driving electric vehicles rather than the monetary costs of ownership as the three largest concerns were related to convenience and reported a far higher rating compared to the rest of the concerns. All three of the non-financial concerns received the highest ratings and had statistically significant differences between owners and non-owners, supporting the idea that they are the primary reason that non-owners are hesitant to buy EVs. This is significant because the responders were all from suburban areas, and it was previously demonstrated the results in West Windsor and Plainsboro weren't drastically different from those in Frisco, so it suggests that non-owners potentially overestimate the difficulties related to charging and battery efficiency. Another interesting takeaway is that Replacement and Maintenance costs could play a significant role in EV ownership. It received the second lowest rating for owners but the fourth-highest rating for non-owners, and its results were barely different between the 2 locations. However, it had the highest variation in rating by far for owners and the second highest coefficient of variation overall, suggesting that it is a volatile concern for which the rating is primarily dependent on an individual's circumstances. Moreover, the concern was rated significantly lower than the other three statistically significant concerns, suggesting that it is a factor in ownership but not as important as the other three. It also suggests that non-owners might perceive this concern as more problematic than it is. Unsurprisingly, Initial Cost ratings showed the least difference between owners and non-owners. However, this is still important because it implies that non-owners view prices very similarly to owners, indicating that there are other reasons why non-owners aren't buying them. Moreover, it also supports the notion that non-owners don't find EV prices overrated because of the similar ratings between the two groups.

A key takeaway is that educating the public on EVs is critical to adoption. For example, even though over 80% of electric vehicle owners charge at home (Consumer Reports, 2023), my study and many other studies show that public charging accessibility is still a huge psychological concern for many, especially families that go on long road trips. However, the frequency of people charging electric vehicles at home combined with the results of the study brings up the question of how the government or EV companies can decrease the apprehension amongst non-owners. To decrease this apprehension, the government and EV companies should improve education regarding EVs. Despite the high-income demographics of the population, less than 60% reported being 'Very Familiar' with EV's. Furthermore, 63% of non-owners from my study reported being 'somewhat familiar' compared to only 37% for 'very familiar. This suggests that lack of knowledge of EVs creates hesitancy to buy them considering that non-owners had higher non-financial concern ratings than those of owners but reported being less knowledgeable about EVs. As a

result, it makes sense for the government to invest in programs or advertisements that can help non-owners become more acquainted with EVs, particularly charging and range.

4.2 Education

Another key thing that automakers and the government should do to increase EV adoption is to improve EV education, particularly about range anxiety. Despite my study primarily receiving responses from individuals who earn significantly more than the average person, less than 60% reported being 'Very Familiar' with EV's. Furthermore, 63% of non-owners from my study reported being 'somewhat familiar' compared to only 37% for 'very familiar. Thus, regardless of income, organizations should strive to increase education on EV's across the country. One of the key steps to that is by decreasing range anxiety amongst the population. My study demonstrated how Battery Efficiency (Miles per KWH) was one of the highest-rated factors along with Public Charging Accessibility- both of which contribute to range anxiety. However, my study and others seem to support the idea that people could potentially be far more anxious about range anxiety than they should be.

This suggests that people are more apprehensive about EV range than they should be, so automakers and governments should target to decrease this apprehension. They can do so through mediums such as using technology by making it very clear for current or potential drivers to easily locate the nearest charging station and to give them a sense of perspective of how far their vehicle can travel before they must charge it. Automakers can advertise these features in their ads as these won't require that much time to demonstrate. Furthermore, the government can also advertise these features through things like PSA's, billboards, or collaborations with businesses. Regardless of how automakers and the government choose to decrease apprehension pertaining to range anxiety, they should ensure that they invest time and funding to devise the best education solution possible.

4.3 Future Research

The design and conclusions of this study can be applied to a wide range of scenarios. Firstly, analyzing a broader income and geographic band could yield more definitive conclusions and correlations between EV ownership and sentiment. Moreover, researchers could also analyze responses from groups of people who are considering buying EVs since this study discovered interesting, but statistically insufficient, data regarding populations like that. Additionally, one thing that the study couldn't do, due to not gathering personal information, was examine relationships between certain characteristics and EV concern ratings, so future studies could explore if there are any correlations between EV concern ratings and characteristics such as gender, ethnicity, or size of nuclear family. Regarding location, future research can be conducted on wealthy urban or rural towns to analyze their perspectives and compare those to suburban ones. That kind of research could also look at responses or information from a variety of states since different states have different policies and benefits for getting EVs.

4.4 Limitations

There were a couple of limitations with this study that may have impacted the conclusions. Participants' self-perception of their familiarity with EVs may not be reflective of their actual familiarity. Additionally, this study only analyzed two high-income suburban areas of the country, which may not be reflective of all high-income suburbs. Also, this study drew conclusions from a very narrow subset of high-income earners, so applications of it may not be applicable to some income owners, such as those making more than $250,000. Lastly, this study only focused on BEVs, so the responses of people who own hybrid EVs may have contaminated the responses of the non-owners since their concern ratings would've likely been a lot different than those of owners of gas-powered vehicles.

5. Conclusion

Overall, this study gave new insights into some common concerns about EVs for high-income suburban individuals in the US. Through surveying and analyzing a specific subset of individuals within a specific income range,

this study was able to draw conclusions on the perception of individuals with similar demographics and location. The study was able to find that there were significant differences in concern ratings between EV owners and non-owners for Replacement and Maintenance Costs, Battery Efficiency, Public Charging Accessibility, and Charging Speeds and that the difference between Initial Cost concerns was negligible. The study was able also to demonstrate that there was no statistically significant difference between the two locations analyzed. The results of the study highlight key focus areas and concerns for future studies to analyze and awareness campaigns to help drive EV adoption.

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