

AP CAPSTONE

# 2023-2024 AP RESEARCH MODEL PAPER PACKET

All papers presented in this  
packet received a score of a  
5 from CollegeBoard

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## **MODEL PAPER PACKET INSTRUCTIONS:**

Read at least three model papers from the packet prior to the first day of class. In addition, fill out a model paper note sheet for each one you read. To save yourself time, it would be wise to highlight the items listed on the note sheet in the model papers that you read.

Throughout the first quarter of the course, we will discuss and reference each of the papers in this packet.

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# **Cultivation, Resistance, & Beauty:**

## A Case Study on the Defiant Gardens of the Manzanar Internment Camp during World War II

AP Research  
Word Count: 4736

**“The Foundation” by Mitsuye Yamada<sup>1</sup>**

*This could be the land  
where everything grows.  
Bulldozers had sifted up  
large piece of parched woods and  
worthless rocks.  
Bilateral builds to be are not yet.*

*Meanwhile on this dust  
I counted seven shapes  
of sturdy grey and greens  
some small and slender  
vertical parallels.  
No one planted them here with squared T's.  
Some weblike tentacles reaching out  
Toward rounded rotundas.*

*Molded by no one.*

*Here  
starshaped with tiny speckles,  
are these the intruder in my garden  
of new seedlings?  
My garden carefully fed and fettered?  
Of course.  
I pronounced their execution  
with a pinch of my fingers.*

*But here  
among a myriad of friends  
they flourished in weedy wilderness,  
boldly gracing several acres  
of untended land.  
Tomorrow they shall be banished from their home.*

*And watered by many droplets  
of human sweat  
will sprout another college where  
disciplined minds finely honed  
will grow  
in carefully  
planted rows.*

*No room for random weeds.*

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<sup>1</sup> Yamada, Mitsuye. *Camp Notes and Other Poems*. San Lorenzo, California: Shameless Hussy Press, 1976 149.

## Abstract

Following the bombing of Pearl Harbor, US President Franklin D. Roosevelt signed Executive Order 9066, authorizing the incarceration of 110,000 Japanese Americans into internment camps. By 1943, agriculture dominated camp life, especially at the Manzanar Internment Camp in Owens Valley, California. During their internment, the Japanese Americans, unbeknownst to each other, raised a variety of gardens, including traditional Japanese ornamental gardens. The ornamental gardens ranged greatly in size and consisted of raked gravel dry gardens, cactus gardens, showy flower gardens, and ornate rock gardens. In an effort to preserve the history of the near-extinct generation of Japanese Americans, this study seeks to understand the purposes and implications of the ornamental gardens, with a focus on the Manzanar camp. In this qualitative retrospective ethnographic case study, I examine the overarching themes arising from ten interviews with WWII internees who lived at the Manzanar internment camp using the thematic analysis approach. This study found that the Japanese Americans initially raised the ornamental gardens to resist and combat their desolate, harsh environment, but these gardens had unforeseen consequences for the Manzanar community. While the gardens functioned as a pastime, a means to preserve and revive Japanese culture, and, paradoxically, an avenue to strengthen relationships with the War Relocation Authority officials, they also ultimately helped the inmates to conceptualize their highly complex experiences during WWII. This study's findings, with a deep examination of the Manzanar camp, are aligned with broader environmental studies on the Japanese Americans during WWII, specifically with regard to the gardens functioning as acts of resistance. Looking towards the future, I recommend that further research should examine how defiant gardens throughout history compare with one another and drive the narratives of those involved.

## Historical Context

On December 7, 1941, the Japanese bombed Pearl Harbor, catalyzing mass fear and mistrust of Japanese American citizens across the United States.<sup>2</sup> Thus, on February 19th, 1942, President Franklin D. Roosevelt signed Executive Order 9066 which authorized the removal and incarceration of 110,000 Japanese Americans (two-thirds of whom were American citizens) living on the West Coast into temporary internment camps.<sup>3</sup> The executive order also called for the establishment of the War Relocation Authority (WRA), the federal government agency responsible for the relocation of all Japanese people and the creation and regulation of relocation centers (internment camps).<sup>4</sup> Beginning in August 1942, the Japanese Americans were moved into the internment camps and deprived of their civil liberties. On March 20, 1946, nearly six months after the official end of WWII, all internment camps were retired and the Japanese Americans were left to rebuild their American lives.<sup>5</sup>

As Japanese Americans relocated into the internment camps, they were forced to leave their homes and occupations behind. In contrast to their pre-WII lives, the Japanese Americans in the camps were assigned occupations designed to aid the war effort, such as teaching, cooking, and farming.<sup>6</sup> From the perspective of the WRA, the conditions in the internment camps generally provided the “the bare subsistence level”.<sup>7</sup> In camp, the Japanese Americans were relegated to “simple construction barracks,” in the place of homes and provided with a few facilities and

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<sup>2</sup> Oguzhan, Mehmet. “The Relocation and Internment of People of Japanese Descent in the US during WWII”. *Uluslararası Suçlar ve Tarih* 15, (2014): 135-171.

<sup>3</sup> Ibid, 135.

<sup>4</sup> Chiang, Connie. “Imprisoned nature: Toward an environmental history of the world war II Japanese American incarceration.” *Environmental History* 15. No 2 (2010): 236-267.

<sup>5</sup> Ibid, 240

<sup>6</sup> Oguzhan, 150.

<sup>7</sup> “Relocation of Japanese Americans”. War Relocation Authority. Washington D.C., May 1943.

services including food courts, minimal medical care, and education for their children.<sup>8</sup> Despite their job assignments and their access to

meager resources, the Japanese

Americans found themselves with an

abundance of time. After living in the

camps for a few months, the internees

longed to enrich camp life. They began

organizing activities such as painting,

pottery, baseball, fishing, farming, and

gardening.<sup>9</sup> Prior to WWII, Japanese

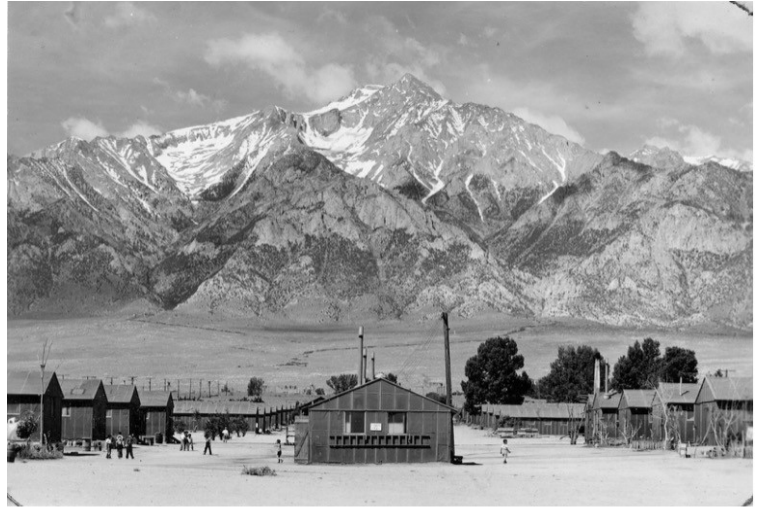
Americans dominated agricultural

businesses in the US. Ten years before the war, one-third of Japanese Americans in Los Angeles

were gardeners. By 1940, on the West Coast more than forty-six percent of Japanese Americans

were employed in agriculture, with an additional twenty-six percent employed in

“agriculture-related activities such as produce businesses.”<sup>10</sup> However, these pursuits had to be suspended at the start of WWII.



Adams, Ansel. *View of barracks with mountains in the background*. 1943. Shinjo Nagatomi Collection, Manzanar National Historic Site Collection. Manzanar Relocation Center.

By 1943, agriculture came to dominate camp life. Camp community groups, led by former

farmers and gardeners, and schools typically maintained the gardens and crops.<sup>11</sup> Most of the

internment camps had victory gardens — gardens initiated by the US government to aid the war

effort. The victory gardens enriched the inmates' government-issued diet with an increased

<sup>8</sup> “Relocation of Japanese Americans”. War Relocation Authority. Washington D.C., May 1943.

<sup>9</sup> Obler, Bibiana. “The Art of Gaman: Arts and Crafts from the Japanese American Internment Camps, 1942–1946” *The Journal of Modern Craft* 4, no. 1 (2011). 93-98.

<sup>10</sup> Tamura, Anna. “Gardens in Camp,” *Densho Encyclopedia*. Last modified July 18, 2016. Accessed September 3, 2017. <http://encyclopedia.densho.org/Gardens%20in%20camp/>

<sup>11</sup> Ibid.



Lange, Dorothea. *Japanese American working in victory garden*. 1942. Dorothea Lange Collection, National Archives. Manzanar Relocation Center.

variety of produce; the internees took this opportunity to plant Japanese vegetables. The Japanese Americans also constructed thousands of ornamental gardens, ranging in size from parks for all inmates to enjoy, block gardens (a set of barracks were called a block), to small personal gardens.<sup>12</sup> Among these ornamental gardens were traditional raked gravel dry gardens, cactus gardens, showy flower gardens, and ornate rock gardens. The Manzanar internment camp in

Owens Valley, CA became famous for the creation of Merritt Park, the most elaborate and sophisticated garden in all in of the camps. The project, featuring ponds, boulders, tea houses, and a waterfall, illustrated the complexity and magnitude of a wartime garden.<sup>13</sup>

## Literature Review

In this literature review, four major works consider the environmental conditions and agriculture across Japanese internment camps during WWII. Bowdoin College Professor Connie Chiang sets the framework for the current literature on the topic. Chiang not only provides an overview of environmental theory and history, but also examines how agriculture influenced the interactions between WRA officials and inmates. Examining specifically environmental injustice theories, Chiang claims that, “WRA officials tried to use nature as an instrument for social

<sup>12</sup>Tamura, Anna. "Gardens in Camp," *Densho Encyclopedia*. Last modified July 18, 2016. Accessed September 3, 2017. <http://encyclopedia.densho.org/Gardens%20in%20camp/>

<sup>13</sup>Ibid.

control by locating the camps in places where they could isolate Japanese Americans and procure their labor in the name of assimilation and patriotism.”<sup>14</sup> As she explores both the perspectives of the WRA and of Japanese Americans, she asserts that in an effort, “to resist and endure their incarceration, Japanese Americans both established intimate connections to nature and sometimes refused to work when demanded.”<sup>15</sup> In short, Chiang argues that, “the natural world” became a platform that upset “power relations” between the WRA and Japanese Americans, “ensuring that WRA control over the detainees was not absolute.”<sup>16</sup>

Kenneth Helphand finds a similar theme in his book on defiant gardens. According to Helphand, defiant gardens are, “gardens created in extreme or difficult environmental, social, political, economic, or cultural conditions”.<sup>17</sup> In his chapter on Japanese internment, Helphand claims that, “At the relocation camps, garden-making was literally the domestication of an inhospitable environment, creating a cultural setting which was a semblance of normalcy.”<sup>18</sup> He further adds that the gardens were mechanisms to maintain “cultural integrity” and “self-respect”; they were “an enterprise of survival, a defense of sanity and a demonstration of psychological, and here political, defiance.”<sup>19</sup> Helphand’s book claims that the gardens served as acts of resistance, a tool to defy the WRA and their living conditions, and a means to emotionally survive the wartime experience. Ultimately, Helphand and Chiang’s analyses demonstrate how the Japanese Americans’ relationship with nature across the camps became a tool for defiance against their incarceration and the WRA.

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<sup>14</sup> Chiang, Connie. “Imprisoned nature: Toward an environmental history of the world war II Japanese American incarceration.” *Environmental History* 15. No 2 (2010): 239.

<sup>15</sup> Ibid, 236.

<sup>16</sup> Ibid, 236.

<sup>17</sup> Helphand, Kenneth I, *Defiant Gardens: Making Gardens in Wartime*. EDRA/Places Awards Research 19, 2007.

<sup>18</sup> Ibid, 117.

<sup>19</sup> Ibid, 117.

Anna Tamura offers a similar perspective as she focuses on agriculture at two internment camps: Manzanar and Minidoka. Similar to Helphand and Chiang, she reports that the gardens functioned as acts of resistance — “political symbols of sedition and non-compliance as well as loyalty and patriotism.”<sup>20</sup> Arguing that the gardens were “restorative agents that fostered communal healing, and [were] the results of cultural cohesion and community competition,” she too highlights how these gardens served as techniques of daily survival.<sup>21</sup> Monica Embrey’s dissertation speaks to Tamura’s claims. In her case study on the environmental justice history of the Manzanar internment camp, Embrey examines the Japanese Americans’ relationship with the Owens Valley land, with a focus on their use and conservation of water. When addressing gardening and farming in the camp, she brings two important Japanese concepts into the literature discussion: “Gaman” and “Shikata ga nai”. In her book *The Art of Gaman*, Delphine Hirasuna defines gaman as, “enduring what seems unbearable with dignity and grace”<sup>22</sup> while Professor Jane Iwamura defines Shikata ga nai as the belief that, “one should not concentrate on the things one cannot change.”<sup>23</sup> With these two concepts in mind, Embrey argues that they are fundamental in understanding the motives of Japanese Americans’ relationships with the land surrounding them. With sources such as Tamura and Embrey, the Japanese Americans’ quest to ease routine adversity shines through; it is apparent that agriculture in the camps fostered emotional survival.

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<sup>20</sup> Tamura, Anna. “Gardens Below the Watchtower: Gardens and Meaning in World War II Japanese American Incarceration Camps,” *Landscape Journal* 23, (2004): 1.

<sup>21</sup> Ibid, 1.

<sup>22</sup> Hirasuna, Delphine, and Kit Hinrichs. *The Art of Gaman: Arts and Crafts from the Japanese American Internment Camps*. Ten Speed Press, 2005.

<sup>23</sup> Iwamura, Jane Naomi. “Critical Faith: Japanese Americans and the Birth of a New Civil Religion.” *Critical Faith The American Studies Association* (1997): 994



While Helphand, Chiang, Tamura, and Embrey’s analyses contextualize the Japanese Americans’ relationships with the environment and agriculture, no study focuses solely on the Japanese ornamental gardens. Furthermore, with the exception of Embrey, this literature lacks comprehensive research on one particular internment camp. While these articles analyze the importance and implications of these gardens, the current gap in research allows for generalizations when understanding the Japanese American experience and their relationship with ornamental gardens. A qualitative ethnographic case study examining the purposes of the gardens in the Manzanar internment camp may shed light on this gap. Furthermore, it will provide deeper insight into the everyday acts of resistance and the grit that enhanced camp life.

## Method

The method of my study addresses the question: *Through a qualitative retrospective ethnographic case study, what purposes did the Japanese ornamental gardens in the Manzanar internment camp serve for the Japanese Americans during World War II?* I hypothesized that the Japanese Americans built the gardens as a pastime, a means to resist the WRA, and a method of healing as a community. It is important to recognize that I made a significant assumption within the research question. Asking, “what purposes did the... gardens... serve” implies that I believe that there is/are purpose(s) behind these gardens. But gardens do not, in general, spring out of deserts without good cause.

## Qualitative Retrospective Ethnographic Case Study

With these questions in mind, it is important to break down and define the different components of the method. Qualitative methods “rely on text and image data, have unique steps

in data analysis, and draw on diverse designs.”<sup>24</sup> In a qualitative retrospective ethnographic case study, “retrospective” implies that outcome of the event has already occurred by the time the study is initiated.<sup>25</sup> Hence, this study analyzed the purposes of the gardens during WWII, rather than the purpose of the gardens today. An ethnographic case study is a sociological method that explores how a select group of people live and make sense of their lives with one another in a particular place.<sup>26</sup> In the context of this study, the selected cohort consists of ten Japanese Americans who lived at the Manzanar internment camp. Each individual in the cohort developed a relationship with the gardens, whether it was through a parent working in the gardens or their own direct contact with and memory of the gardens. This method was chosen to not only fill the current gap in the literature, but also to avoid generalizations when describing the internees’ relationships with the ornamental gardens. I chose to focus on the Manzanar internment camp as it was the largest internment camp in the nation and was home to Merritt Park, and thus has the most primary sources documented.<sup>27</sup>

### **Thematic Analysis**

At the beginning of the study, I thematically analyzed interviews of the ten internees. In thematic analysis, qualitative researchers determine the relationship between overarching themes in a data set; they build their patterns, categories, and themes from the bottom up by organizing the data into increasingly more abstract units of information.<sup>28</sup> This method of

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<sup>24</sup> “Ethnography,” Department of Sociology at Columbia University.edu. Last modified 2009. Accessed October 4th, 2017, <http://sociology.columbia.edu/ethnography>

<sup>25</sup> “Retrospective Study,” NEDARC.org. Last modified August 29, 2016. Accessed September 3, 2017. <http://www.nedarc.org/statisticalHelp/projectDesign/retrospectiveStudy.html>

<sup>26</sup> “Ethnography,” 1.

<sup>27</sup> Tamura, Anna. “Gardens in Camp,” Densho Encyclopedia. Last modified July 18, 2016. Accessed September 3, 2017. <http://encyclopedia.densho.org/Gardens%20in%20camp/>

<sup>28</sup> Creswell, John W. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Thousand Oaks, CA: SAGE Publications, 2014.

analysis was chosen to link the individual experiences of the internees to common themes that can be applied to the Manzanar narrative as a whole. The ten interviews were found on the Densho Encyclopedia Digital Repository by using the search words, “Manzanar camp gardens”, “Manzanar”, “camp gardens”, “parks”, and “camp activities”. The interviews were pre-recorded on the site and range from one to five minutes. Densho Encyclopedia is a nonprofit organization with the “initial goal of documenting oral histories from Japanese Americans who were incarcerated during World War II.”<sup>29</sup> Today it serves as a database of primary sources from Japanese Americans during WWII.<sup>30</sup>

The thematic analysis was conducted in three steps. Firstly, I watched and transcribed each of the ten interviews. I watched the interviews multiple times in effort to familiarize myself with the testimonies of the interviewees. Then, I identified similar experiences among the Japanese Americans in an attempt to understand what types of events contributed to the raising of the gardens. Once I identified similar experiences, the narratives were analyzed to discover the purpose of raising ornamental gardens. Then the overlapping experiences were sorted into groups and further labeled with an overarching theme.

After I conducted a pilot study in December 2017, I realized I lacked a robust and clear argument based solely on using these interviews. Therefore, a second qualitative step was added to my method: a mixed media primary source thematic analysis. I expanded my data set by adding other primary sources such as official documents from the WRA, poems, diary entries, and camp newsletters to flesh out my argument. These sources were found on various platforms

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<sup>29</sup>“About Densho,” *Densho.org*. Accessed September 3, 2017. <https://densho.org/about-densho/>

<sup>30</sup> Ibid.

including Densho Encyclopedia, museum collections, and other literature on the gardens. The primary sources underwent the same process of thematic analysis as the interviews.

### **Limitations**

Before moving on to the findings discussion of the study, it is important to address the limitations in my research process and findings. The first and most significant limitation lies within my cohort. Because most of my desired cohort is over 80+ years old or already deceased, conducting the interviews myself was unfeasible. Owing to the nature of historical retrospective inquiry, I chose instead to use the ten pre-recorded interviews found on Densho. Therefore, I was unable to write the questions myself. Perhaps if I was able to conduct the interviews in person, my findings would have been free of the innate subjectivity of some of the questions asked. Another limitation regarding my cohort was the sample size. Considering the number of interviews and the average length of each segment directly speaking to the ornamental gardens (two minutes), the amount of data I was able to analyze was not lengthy. Given this limitation, I may have missed opportunities for a wider analysis. However, since very few individuals who lived in the Manzanar Camp and were connected to the gardens are still alive today, the perspectives in the interviews still offer crucial insight into the purposes of the Manzanar gardens. Lastly, there was room for human error from both the interviewees and researcher. Because the interviewees were looking back on their experiences, it is possible that they did not accurately depict camp life in the gardens. Similarly, it is possible that I transcribed part of an interview incorrectly or misinterpreted the meaning in these testimonies which could have potentially skewed my data.

## Findings

After I applied the thematic analysis to the interviews and primary sources, seven different themes emerged regarding the purposes of Japanese ornamental gardens in the Manzanar internment camp; however, five themes were repeated consistently. These five themes are: (1) Community Building and Enrichment, (2) Defiance of Environment, (3) Gaman, (4) Shikata ga nai, and (5) Boredom. Below, these five themes are defined.

Table 1: Definitions

Theme	Definition	Number of interviews with this theme
Community Building and Enrichment	The effort to improve or enhance the quality of life through communal activities	5
Defiance of Environment	The attempt to beautify the camp in contrast to the barren environment	4
Gaman	Enduring what seems unbearable with dignity and grace <sup>31</sup>	4
Shikata ga nai	One should not concentrate on the things one cannot change <sup>32</sup>	4
Boredom	The abundance of unstructured time leaving the inmates to feel restless and in need of a pastime	3

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<sup>31</sup> Hirasuna, Delphine, and Kit Hinrichs. *The Art of Gaman: Arts and Crafts from the Japanese American Internment Camps*. Ten Speed Press, 2005.

<sup>32</sup> Iwamura, Jane Naomi. "Critical Faith: Japanese Americans and the Birth of a New Civil Religion." *Critical Faith The American Studies Association* (1997): 994

For the purposes of a robust, clear analysis and line of reasoning, these themes will not be discussed in isolation and will rather be analyzed in the context of the larger narrative of the Manzanar internment camp during WWII.

## Discussion

When the Japanese Americans were relocated to the internment camps, the community immediately faced a problem: the hazardous and poor environmental conditions. Located in the Owens Valley, California, the Manzanar land was notorious for its extreme temperatures, ruthless sun, and strong winds. When the WRA built the camps, they erased any trace of vegetation and leveled the land, “to build roads, prepare building sites, and establish agricultural fields.”<sup>33</sup> This excavation exacerbated the conditions of Manzanar as the newly churned dust coated the lives of the internees, including their skin, food and barracks. Henry Fukuhara remembered, the “wind would come and, and it would be so bad that you could hardly walk outside, and then...



Tamura, Anna. *Block 34 garden*. 2001. Anna Tamura Collection, Anna Tamura Collection. Manzanar Relocation Center.

the sand would come up through the cracks in the floor and would come in through the sills of the window, and it was terrible.”<sup>34</sup> Hikoji Takeuchi added, “let's face it, Manzanar was a barren

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<sup>33</sup> National Park Service. Cultural Landscape Report: Manzanar National Historic Site. Washington DC: U.S. Government Printing Office, 2006.

<sup>34</sup>Fukuhara, Henry, interview by John Allen, Densho Digital Repository, November 6, 2002.

desert.”<sup>35</sup> In fact, four internees used the word “barren” to describe the initial conditions of Manzanar, emphasizing the harsh conditions they endured in their desolate, dust-coated camp.

In effort to resolve the environmental issues of the camp, the WRA launched a camp landscaping program. This advancement set the framework for all future agricultural projects to be developed over the next four years, including victory gardens, cattle ranches, block gardens, and ornamental gardens.<sup>36</sup> While the WRA facilitated many of these landscaping projects, the Japanese Americans initiated the construction of ornamental gardens as a defense against the environment. Sue Kunitomi recalled that internee Henry Uenu raised a little ornamental garden outside of the mess hall, “because everybody lined up for their meals outside the mess hall and there was no shade and no place to sit, so he talked to the mess hall people... and the men in the block ....” including Uenu and his friends, “decided they would build ...this garden.”<sup>37</sup> Uenu’s project ultimately sought to mitigate the hot, uncomfortable conditions near the mess hall. His story, along with others, sparked a grander purpose in raising the gardens: beautifying the camp. Henry Fukuhara recalled that before the Japanese Americans began to build these gardens, “everything was just barren because there



Adams, Adams. *Mrs. Nakamura and family in park, Manzanar Relocation Center, California. Others: George Nakano, Keiko Kamahara, Fuimi Tashim.* 1943. Adam Ansel Collection, Library of Congress Collection. Manzanar Relocation Center.

<sup>35</sup>Takeuchi, Hikoji, interview by John Allen, Densho Digital Repository, November 7, 2002.

<sup>36</sup> National Park Service. Cultural Landscape Report: Manzanar National Historic Site. Washington DC: U.S. Government Printing Office, 2006. 59

<sup>37</sup> Embrey, Sue Kunitomi, interview by John Allen, Densho Digital Repository, November 6, 2002.

were no trees there at all because, with the exception of an apple tree ... [the WRA] bulldozed everything... [the gardens] made the appearance [of the camp] more appealing and more comfortable.”<sup>38</sup> Willie Ito added, “They tried to make it look homey. Rather than seeing nothing but sand, it [was] so nice to see greenery.”<sup>39</sup> Most of the youth, however, had become accustomed to the barren environment. Eiichi Sakauye remembered that, “Because of the gardens [the] bumble bees and butterflies came in.” He further added that he would have to explain to the kids, “*Watch out, there's a bumblebee, it'll sting you.* And then they wondered why I said that to them. And the butterfly comes along, the butterfly comes to suck the sugar from this pollen and so forth. We [told] them how the butterfly lays its egg and it pupates to a worm, and from the worm, it comes to a butterfly. And these kids were quite interested. So the kids come from all parts of the camp and come to see us... I don't think they'd been exposed to



Adams, Adams. *Nurse Aiko Hamaguchi and patient Tom Kano. Others: George Nakano, Keiko Kamahara, Fuimi Tashim.* 1943. Adam Ansel Collection, Library of Congress Collection. Manzanar Relocation Center.

nature.”<sup>40</sup> Essentially, Fukuhara, Ito, and Sakauye’s testimonies describe the stark contrast in environment after the Japanese began building the gardens: with the garden came comfort, beauty and biodiversity. With this juxtaposition, the ornamental gardens defied the barren setup of the Manzanar internment camp. The small but highly significant changes to the landscape altered the Japanese

<sup>38</sup> Fukuhara, Henry, interview by John Allen, Densho Digital Repository, November 6, 2002.

<sup>39</sup> Ito, Willie K. interview by Kristen Luetkemeier, Densho Digital Repository, December 5, 2013.

<sup>40</sup> Sakauye, Eiichi Edward, interview by Wendy Hanamura, Densho Digital Repository, May 14, 2005.



Americans' perceptions toward their internment experience; they came to see beauty can be nurtured even in dust.

Even with this environmental enrichment, Japanese Americans faced an internal struggle. In the camps, the inmates sought to preserve their Japanese culture and identity, yet needed to pledge their allegiance to the WRA and, more broadly, the US. When the Japanese Americans initially settled into the internment camps, their relationships with the WRA were tense and formal. The WRA was responsible for logging the inmates' daily interactions ranging from meal plans to medical examinations. They also regulated the internees' activities and prohibited them from displaying and teaching Japanese culture (including speaking and writing in Japanese and celebrating Japanese cultural events and recreation).<sup>41</sup> Despite these rules, the Japanese Americans silently protested their confinement through the ornamental gardens.

In advancing their agricultural projects, the inmates defied camp regulations but unexpectedly strengthened relationships with the WRA. The nature of these formal interactions with the WRA changed as Pleasure Park, also known as Merritt Park, was built. Brothers Kuichiro and Akira Nishi along with Henry Uenu initiated the project, gathering their fellow inmates to raise the sophisticated, beautiful Japanese ornamental garden. As they embarked on their project however, they faced a problem in the planning of the garden: they did not have the resources



Adams, Adams. *Pool in Pleasure Park*. 1943. Adam Ansel Collection, Library of Congress Collection. Manzanar Relocation Center.

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<sup>41</sup>Mizuno, Takeya. "Government Suppression of the Japanese Language in World War II Assembly Camps." *Journalism and Mass Communication Quarterly*. (2003).

needed to grow the garden, including machinery, plants, and shrubs. And so the debates and deliberation with the WRA began. Eventually, the Nishi brothers convinced the WRA to not only move forward with the project, but also fund supplies and further loosen camp rules. Henry Nishi, son of Kuichiro, recalled that when his father needed locust trees for Pleasure Park, “[the WRA] must have been given permission to go out of camp... to get locust trees because there [were] no locusts... on the property.”<sup>42</sup> Similarly, Arthur Ogami remembered his father, “...had a crew and [the WRA] provided [a] truck for him. And he'd go out to the foothills of the mountain to pick up rocks and trees, shrubs to use in the garden”.<sup>43</sup> As the Japanese Americans pushed the limits of their incarceration to build gardens, they found themselves rewarded with opportunities to venture out of the camp, allowing them short reprieves from their highly regulated lives. Eventually, the brothers renamed Pleasure Park to Merritt Park after WRA project director Ralph Merritt in gratitude for his help. Though the WRA still recorded and charted every aspect of the inmates lives (including the gardens), the innate nature of the interactions between the two groups changed course. As the two parties worked together, the WRA learned to trust the Japanese Americans and came to empathize with the Japanese American perspective. Though the gardens initially symbolized defiance, they ultimately functioned as an agent to soften the interactions between the WRA and internees.

While the gardens became a pathway for communication between the WRA and internees, they also forged closer relationships among the Japanese Americans. In Manzanar, sixty-percent of the Issei generation (the first generation of Japanese Americans) had worked in agriculture and landscaping businesses prior to WWII.<sup>44</sup> By raising the gardens, the Japanese Americans were

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<sup>42</sup> Nishi, Henry, interview by Richard Potashin, Densho Digital Repository, January 8, 2009 .

<sup>43</sup> Ogami, Arthur, interview by Richard Potashin, Densho Digital Repository, March 10, 2004.

<sup>44</sup> National Park Service. Cultural Landscape Report: Manzanar National Historic Site. Washington DC: U.S. Government Printing Office, 2006. 46

able to reconnect with their lives before WWII as a community. Madelon Arai Yamamoto remembered that as her father dug a large ornamental pond in 1943, “he had many friends that helped, that were interested in building the pond... before I knew it they were in front of the house digging it out. And then before I knew it they arrived with the concrete, and then before I knew it there was boulders all around there.”<sup>45</sup> Yamamoto’s testimony demonstrates how the initiative of one person had a multiplier effect on the participation of those around him. George Izumi further described how the gardens were a mechanism for Japanese Americans to collectively reunite with their heritage. He recalled, “there was a fellow named... Mr. Kato, who was a rock garden specialist. He built that garden. He brought all the stone, big rocks down there, and they built a beautiful rock garden up near the hospital.”<sup>46</sup> Similarly, Henry Fukuhara added that, “there were gardeners that knew how to make the real Japanese gardens,” and taught the younger generations the practices of the Issei.<sup>47</sup> Henry Nishi added, “none of us had too much experience [with ornamental gardens]. We were pretty.... young. But most of our... dads were not around either because they were interned elsewhere... [we were] exposed to a lot of agriculture, ornamental agriculture.”<sup>48</sup> Perhaps the gardens acted as a liaison between the generations so the Issei were able to pass down their expertise in traditional Japanese gardening. Yamamoto



Lange, Dorothea. *Japanese American working in garden*. 1942. Dorothea Lange Collection, National Archives. Manzanar Relocation Center.

<sup>45</sup> Yamamoto, Madelon Arai, interview by Richard Potashin, Densho Digital Repository, May 6, 2011.

<sup>46</sup> Izumi, George, interview by John Allen, Densho Digital Repository, November 6, 2002.

<sup>47</sup> Fukuhara, Henry, interview by John Allen, Densho Digital Repository, November 6, 2002.

<sup>48</sup> Nishi, Henry, interview by Richard Potashin, Densho Digital Repository, January 8, 2009 .

added, “it was a way to develop a little community.”<sup>49</sup>

The efforts to beautify the Manzanar environment, build community, and pass down Japanese gardening techniques, however, would not have been possible without the abundance of unstructured time. In the majority of the interviews, the Japanese Americans recalled how bored they were in the camps. Madeline Yamamoto also remembered, “...even though all adults had some sort of responsibility or, quote, job, in camp, they had lots of time. No one had cars, no one could go to the movies... We had a lot of time on our hands.”<sup>50</sup> Perhaps this is to say that without the free time in the camps, the gardens would never have been raised. Jun Ogimachi added, “Well... the people within the block were just doing them. They just... need[ed] something to do.”

<sup>51</sup> Yamamoto and Ogimachi’s testimonies bring to light two important Japanese beliefs: *gaman* (enduring what seems unbearable with dignity and grace)<sup>52</sup> and *shikata ga nai* (not concentrating on the things one cannot change)<sup>53</sup>. Perhaps the gardens allowed the internees to focus on an aspect of their life which they could change, rather than dwelling on the ways their lives were regulated. George Izumi added, “So, you know, it goes to show you that if... any individual... set[s] their mind to do what they want to do, they can do it. It doesn't matter ... what it is in life.”<sup>54</sup> Looking back on his father’s garden next to the camp hospital, Arthur Ogami added, “I think the gardens expressed that just because we’re here, we have to do something to refresh our feelings. I think that the gardens... express[ed] that there is hope for peace and

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<sup>49</sup> Madelon Arai Yamamoto, Densho Digital Repository, 2011.

<sup>50</sup> Yamamoto, Madelon Arai, interview by Richard Potashin, Densho Digital Repository, May 6, 2011.

<sup>51</sup> Ogimachi, Jun, interview by Richard Potashin, Densho Digital Repository, June 3, 2010.

<sup>52</sup> Hirasuna, Delphine, and Kit Hinrichs. *The Art of Gaman: Arts and Crafts from the Japanese American Internment Camps*. Ten Speed Press, 2005.

<sup>53</sup> Iwamura, Jane Naomi. “Critical Faith: Japanese Americans and the Birth of a New Civil Religion.” *Critical Faith The American Studies Association* (1997): 944

<sup>54</sup> Izumi, George, interview by John Allen, Densho Digital Repository, November 6, 2002.

freedom. And you can go to these gardens and feel it.”<sup>55</sup> Izumi’s and Ogami’s reflections on their experiences suggest these gardens functioned as a mechanism of endurance for the people of the Manzanar internment camp. As the Japanese Americans crafted intricate yet bold gardens, they reflected their heritage and peacefully channeled their feelings. Through organizing and nurturing these gardens, the Japanese Americans found their strength, voice, and hope in a time seeded with alienation and adversity.

## Conclusion

These interviews summarize the purposes of the ornamental gardens for the Japanese Americans in the Manzanar internment camp. The cohorts’ reflections on their WWII experiences make apparent that the gardens served to defy environmental



Toyo Miyatake. *Block 34 mess hall garden*. 1943. Archie Miyatake Personal Collection. Manzanar Relocation Center.

conditions, improve relationships with the WRA, reconnect generations, and offer creative expression of their feelings. When comparing the results of this study to the body of literature, certain key differences emerge. The first difference is that while this study does recognise that the gardens were defiant against the environmental conditions, the results did not find that they were used to resist the WRA as Chiang claimed in her study.<sup>56</sup> Rather, I found that the gardens eased the tense relationships between the two. This proves my earlier claim that the gap in

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<sup>55</sup> Ogami, Arthur, interview by Anna Tamura, Unpublished oral history, 2002.

<sup>56</sup> Chiang, Connie. “Imprisoned nature: Toward an environmental history of the world war II Japanese American incarceration.” *Environmental History* 15. No 2 (2010): 236-267.

literature must be addressed to avoid generalizations when describing the internees' relationships with the ornamental gardens. Furthermore, while the literature focuses on the gardens acting as political statements, my findings suggested that rather than resistance, the significance in the gardens lay in their emotional grounding for the internees of Manzanar.

In contrast to many reactions to unjust historical turning points, the Japanese American response to alienation and incarceration is stunning. While this study is significant in that it preserves the history of this near-extinct generation of Japanese Americans, the narrative of the Manzanar ornamental gardens, arguably more significantly, is a exemplar template for peaceful protest and communal healing. Looking towards the future, I recommend that further research should examine how defiant gardens throughout history compare with one another and drive the narratives of those involved — for example, Guantanamo Bay prisoners scavenged seeds from their meals which flourished as secret gardens, an endeavor later known as “Seeds of Hope”.<sup>57</sup> Or, ironically, the British serving in Afghanistan built their own oasis, the Helmand Peace Garden, surrounding their military headquarters. Today, an English Rose grows there in defiance of its barren environment.<sup>58</sup> These stories and many others bring to light the complexity at the intersection of cultivation, resistance, and beauty. Ultimately, the ornamental gardens and their implications serve as the perfect symbol of graceful endurance. Like the gardens, the Japanese Americans were assimilated, organized, and parented. However, despite the obstacles of their barren and toxic environment, they too found a way to thrive.

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<sup>57</sup> Helphand, Kenneth I, “Defiant Gardens: Making Gardens in Wartime,” *EDRA/Places Awards Research* 19, (2007): 33.

<sup>58</sup> *Ibid*, 117.

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**Oversexualization of Marvel Heroines:**

**A Content Analysis of the MCU**

AP Research

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### Abstract

Over the past ten years, the Marvel Cinematic Universe (MCU) has grown exponentially in popularity all over the world, becoming the highest grossing film franchise of all time. With this global viewer base, and the power of how characters are displayed in media, the portrayal of MCU superheroines merits an investigation. My study aimed to analyze the trends in these portrayals, specifically focusing on female heroes in the MCU. It also sought to answer the question, “What is the extent of oversexualization of key female heroes, such as Black Widow, Scarlet Witch, and Captain Marvel, in Marvel Cinematic Universe movies from 2010-2020?” To measure this, I conducted a content analysis of all Marvel films from 2010-2020 which had a notable presence of superheroines. I then divided the aspects of these heroines’ portrayal on film into three main categories. After completing this analysis for each film, I concluded that the oversexualization of heroines such as Black Widow, Scarlet Witch, and Captain Marvel, among others, decreases over time. However, it does not necessarily decrease in female-centric films. Also, physical traits, such as costumes, and camera angles appeared to contribute most to overall oversexualization. The results of my research shed light on the areas in which Marvel can improve in order to portray women more fairly and nonsexually, as well as those in which they depict superheroines well.

## Introduction

My research seeks to answer the question, “What is the extent of oversexualization of key female heroes, such as Black Widow, Scarlet Witch, and Captain Marvel, in Marvel Cinematic Universe movies from 2010-2020?” These films vary greatly over time in their treatment and visualization of female heroine characters, and these sometimes harmful decisions by the filmmakers have real-world effects on viewers of all ages and genders. To further examine these trends of oversexualization, and how Marvel can improve on its depiction of influential heroines, I will conduct a qualitative content analysis which identifies key instances of oversexualization in each film, and combines them into an overall oversexualization score (O.S.) for each film. Within my research, and online dictionaries, “oversexualization” means to make something excessively sexual in character or quality, or also to become excessively aware of someone or something’s sexuality, or to diminish an object or person to only its sexual qualities.<sup>1</sup> Here, this will refer to any instance of these events involving a character, specifically with regards to physical traits, communication style, or role in a narrative. These characters will be Marvel heroines like Black Widow, Scarlet Witch, and Captain Marvel along with others, all chosen for analysis by the parameters of my codebook. Further, I specifically selected the Marvel Cinematic Universe (MCU) only, as it has the most global influence and is thus most pertinent to my investigation.

I aim to explore how specific components of the way MCU heroines are portrayed on film contribute to their oversexualization. I hypothesize that oversexualization will be relatively high in most movies, but that it will decrease as films become more recent, and with films that focus centrally on women, such as *Captain Marvel*. I also hypothesize that the characteristics which influence a film’s O.S. most will relate to a heroine’s physical features and how she is filmed.

## Literature Review

### **The Marvel Cinematic Universe**

The 2010s and early 2020s have seen the overwhelming success of the relatively new franchise assembled by the Marvel Cinematic Universe. As Norwegian University writer Fauske explains, the Marvel film *Avengers: Endgame* alone has “a lifetime gross of \$2,797,800,564,” making it the “most successful movie of all time,” and catering to those of all ages except small children and the very elderly.<sup>2</sup> In addition, Bean’s examination in *Forbes Magazine* of the highest-grossing movies ever shows the “MCU” (Marvel Cinematic Universe) to be the “most lucrative movie franchise of all time,” more than doubling the worldwide gross of its closest competitor, *Star Wars*.<sup>3</sup> As such, many of the authors discussed below, as well as Fauske, agree that the MCU has an audience spanning genders, generations, and ethnicities, and thus should merit an investigation about how different groups in its primary viewership, such as women, are

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<sup>1</sup> “Oversexualize.” *Wiktionary*, Wikipedia, 16 Dec. 2020, [en.wiktionary.org/wiki/oversexualize#:~:text=\(transitive\)%20To%20sexualize%20excessively](https://en.wiktionary.org/wiki/oversexualize#:~:text=(transitive)%20To%20sexualize%20excessively).

<sup>2</sup> Fauske, Gard Ruben. “How the Marvel Fandom Made *Avengers: Endgame* the Most Financially Successful Movie of All Time.” *Norwegian University of Science and Technology Bachelor’s Project*, May 2020, pp. 2.

<sup>3</sup> Bean, Travis. “All 24 Marvel Cinematic Universe Films Ranked At The Box Office-Including ‘Black Widow’.” *Forbes*, *Forbes Magazine*, 11 May 2020, [www.forbes.com/sites/travisbean/2020/04/24/all-23-marvel-cinematic-universe-films-ranked-at-the-box-office-including-black-widow/](https://www.forbes.com/sites/travisbean/2020/04/24/all-23-marvel-cinematic-universe-films-ranked-at-the-box-office-including-black-widow/)

represented. While said authors have conducted studies on specific female characters in the MCU, such as Loreck with Black Widow, none yet have done an analysis this up-to-date and focused on oversexualization.<sup>4</sup> My research will center on content analysis in order to glean the widely influential messages about women, and specifically female heroes, that these movies broadcast to their global audiences.

### **Oversexualization and Postfeminism**

The MCU's longest-standing fan favorite heroes are mostly male, such as Iron Man, Captain America, and Black Panther, but in more recent years women have begun to take up much more of center stage, starring in projects such as *Captain Marvel*, *Ant-Man and the Wasp*, and the upcoming unreleased projects *Black Widow*, *WandaVision*, and *Captain Marvel 2* (2020, 2021). As a result, even before heroines had their own films, film analysts in the scholarly community, cited below, sought to characterize the portrayal of women through postfeminism, which is the primary lens of the MCU regarding women. Postfeminism is a word "used to describe a societal perception that many or all of the goals of feminism have already been achieved, thereby making further iterations and expansions of the movement obsolete."<sup>5</sup> It is considered by DeMarchi to be a "false...ideology" which creates "female representations that appear to empower but actually disempower women."<sup>6</sup> Stringer, Radner, and Sherman hold similar opinions, citing with other films that "in postfeminist culture, being able to proudly show off one's body is understood as a position of empowerment — provided that one's body is suitably close to the ideal..." This ideology seems to defeat itself even though it is shown as successful in films, which according to the authors is "providing a fantasy solution to one of the deepest contradictions of society."<sup>7</sup> These postfeminist ideals leave the door open for female characters to be oversexualized, and while it could be said that sexually portrayed women display female sexual empowerment, this is not actually the case. According to Ameter, "Many Marvel supporters will claim that these women have the right to wear sexual uniforms... just as modern women have the right to do so," however, "These characters are created and designed, therefore their personality traits and uniforms are not their personal choice but forced upon them by their creators."<sup>8</sup>

As such, the overly sexualized depiction of female heroes can be much more harmful than positive, as supported by Pennell and Behm-Morawitz's study: viewing clips of a "sexualized-victim character" in superhero films "resulted in less egalitarian beliefs about women's roles in society," and viewing "superheroines in superhero films may, at least

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<sup>4</sup> Loreck, Janice, et al., editors. "Screening Scarlett Johansson." *Palgrave Macmillan*, 2019, pp. 1–221., doi:10.1007/978-3-030-33196-2,

<sup>5</sup> Butler, Judith. *Postfeminism*. 19 Aug. 2016, canlitguides.ca/canlit-guides-editorial-team/postfeminism-and-conservative-feminism/postfeminism/

<sup>6</sup> DeMarchi, Mary Louise, "Avenging women: an analysis of postfeminist female representation in the cinematic Marvel's Avengers series" (2014). College of Liberal Arts & Social Sciences Theses and Dissertations, pp. 1-100. <https://via.library.depaul.edu/etd/167>

<sup>7</sup> Sherman, Yael D. "Neoliberal Femininity in Miss Congeniality (2000)." *Feminism at the Movies: Understanding Gender in Contemporary Popular Cinema*, by Rebecca Stringer and Hillary Radner, Routledge, 2011, pp. 80–90.

<sup>8</sup> Ameter, Jess. "Gender Portrayal in the Marvel Cinematic Universe." *UCCS Undergraduate Research Journal*, 2019.

temporarily, lower body esteem for female viewers.”<sup>9</sup> Similarly, Wright and Tokunaga highlighted a second, more alarming problem in their research, presenting that men more frequently exposed to this oversexualization “were more likely to perceive women as sex objects” and displayed attitudes that predicted “sexually aggressive inclinations and behaviors in both cross-sectional and longitudinal studies (Hald et al., 2010).”<sup>10</sup> This demonstrates the concerning effects of objectification in media, and why I studied the MCU’s globally viewed films more extensively for these negative trends.

### **Female Heroines**

As Ray discusses, Bandura’s social cognitive theory “assumes that behavior can be learned ‘through direct experience or indirectly through the observation of models’ (Smith et al., 2002, p. 87).” It follows that media, such as the MCU movies I will be examining, is a clear example of one of these models.<sup>11</sup> Additionally, Bussey and Bandura state that gender is fundamentally important because “some of the most important aspects of people’s lives, such as...talents they cultivate...conceptions they hold of themselves and others, the...opportunities and constraints they encounter, and the social life and occupational paths they pursue are heavily prescribed by societal gender-typing.”<sup>12</sup> With these psychological assertions in mind, the way that women are portrayed in films becomes essential to how they view themselves and develop gender schema. Yet, as Temuzion concludes in his exploration of the Bechdel test, which asks for the “ground level demands” that two named women discuss something other than men, a globally lucrative franchise like Marvel has “nearly half of its movies” failing to meet those demands, and thus ignores “the interests of women.”<sup>13</sup> Ameter concurs: “If every female Superhero has a copy and paste personality,” like the striking similarities between Black Widow and Captain Marvel, “they are not an accurate representation of women.”<sup>14</sup> Thus, Marvel heroines are not currently well-represented, and cannot yet be upheld as examples for women seeking true self-representation in popular films.

However, as Ferguson determines, while “women were most anxious following a sexually violent show with negative female portrayals... Strong, independent female characters in

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<sup>9</sup> Pennell, Hillary, and Elizabeth Behm-Morawitz. “The Empowering (Super) Heroine? The Effects of Sexualized Female Characters in Superhero Films on Women.” *Sex Roles*, vol. 72, no. 5-6, 11 Mar. 2015, pp. 218., doi:10.1007/s11199-015-0455-3

<sup>10</sup> Wright, Paul J., and Robert S. Tokunaga. “Men’s Objectifying Media Consumption, Objectification of Women, and Attitudes Supportive of Violence Against Women.” *Archives of Sexual Behavior*, vol. 45, no. 4, 2015, pp. 955–964., doi:10.1007/s10508-015-0644-8

<sup>11</sup> Ray, Kristen, “Gender Portrayal in Marvel Cinematic Universe Films: Gender Representation, Moral Alignment, and Rewards for Violence” (2020). Theses and Dissertations. 8528. <https://scholarsarchive.byu.edu/etd/8528>.

<sup>12</sup> Bandura, Albert, and Bussey, Kay, “Social Cognitive Theory of Gender Development and Differentiation,” *Psychological Review* 106(4), pp. 676, November 1999, PubMed, doi:10.1037/0033-295X.106.4.676.

<sup>13</sup> Temuzion, K. V. “Sex Equality in Marvel Movies.” *International Journal of English Literature and Social Sciences*, vol. 4, no. 6, 2019, pp. 1738–1739., doi:10.22161/ijels.46.17.

<sup>14</sup> Ameter, Jess. “Gender Portrayal in the Marvel Cinematic Universe.” *UCCS Undergraduate Research Journal*, 2019.



television shows appear to negate the influence of sexual and violent content.”<sup>15</sup> Though other researchers have determined that positive female portrayals have positive effects, and that Marvel has significant shortcomings in these areas, I seek to further these two ideas. I intend to close this gap in the research by discovering how the MCU can improve their depictions of female heroes, as well as promote the more beneficial and strong female characters they have already developed.

## Method

### **Overview**

My method consists of five main steps: 1) select Marvel movies from 2010-2020 to analyze, 2) analyze these films for oversexualization based on my codebook, 3) grade them based on the amount of oversexualization criteria they contain, 4) compare all the films in order to determine common themes across the board, and 5) suggest ways that Marvel can improve their representation of women.

### **Selection**

I conducted an analysis for the films *Iron Man 2*, *The Avengers*, *Captain America: The Winter Soldier*, *Avengers: Age of Ultron*, *Captain America: Civil War*, *Thor: Ragnarok*, *Ant-Man and the Wasp*, *Captain Marvel*, *Avengers: Infinity War*, and *Avengers: Endgame*. I have selected these films based on several components: presence and prevalence of female heroes in the plot, popularity at the box office, and significance of female heroes in each film, whether it be to the plot as a whole or the heroine's overall character arc (e.g. Black Widow was introduced as the first female hero in *Iron Man 2*). For the purposes of my study, a female hero or heroine will be defined as a female character with an alternate ego or name, special suit, and physically extraordinary, combative, and/or supernatural skill set. So, for example, Agent Maria Hill and Gamora wouldn't pass this test because they have no alter egos, Nakia would not pass because she has no suit, and Jane Foster would not pass because she has no skill set meeting my criteria. This allows me to narrow my set of films only to those which have a significant focus on women who fulfill my definition of a heroine, and thus to focus on the films with the most impactful and influential portrayals of women.

I have chosen these measures for selection specifically because a film is neither useful nor valuable to analyze for my study if women are neither present nor prevalent, since this implies that they will not provide significant data and will not affect female audiences as greatly. Simply put, if there are no heroines present in the film, or a heroine is present but has no bearing on the plot and/or her arc is not affected--in other words, is not prevalent--then that film adds no value to my research. Also, if one film with women is not as popular at the box office as another, its audience will be lessened, and thus the effects of the trends I am studying will not be as widespread as with a more popular film. In terms of my measures for who a heroine is, I have utilized contrasting studies of non-hero female characters in Marvel films to determine what a heroine is not: an ordinary civilian woman who has no powers or special skill set, and possesses only one identity for the audience (Pennell and Behm-Morawitz, 2015; Ray 2020). Therefore my definition of a heroine can be judged as a fair assessment of what traits to seek within the Marvel

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<sup>15</sup> Ferguson, C. J. “Positive Female Role-Models Eliminate Negative Effects of Sexually Violent Media,” *Journal of Communication*, 62(5), 2012, pp. 888–899.  
doi:10.1111/j.1460-2466.2012.01666.

Cinematic Universe and other similar superhero films, though it does not apply to outside genres or films that are not comparable to the movies in the MCU.

### Categories for Oversexualization

My discussion of oversexualization is mainly grouped into three categories, under which other metrics will fall: physical oversexualization, communicative oversexualization, and narrative oversexualization. Under physical oversexualization fall metrics such as how revealing a female heroine's costume is, how form-fitting it is, how practical it is, how sexually she is portrayed by the camera (e.g. close shots of her breasts, curves, or other "sexual" attributes), and other similar items. Below I have included two collages of screencaptures to more fully define examples of costumes and camera angles. The leftmost collage shows more sexualized costumes in the left column (i.e. more cleavage showing, less practical cut, cumbersome hairstyle, etc.) and less sexualized costumes in the right column (i.e. more coverage, tactical attire, shorter hair). The rightmost collage depicts more sexualized camera angles in the left column (i.e. bra/excessive cleavage showing, unnecessary highlighting of butt or breasts) and their less sexualized counterparts (i.e. better ways to do the same scene, such as showing shoulders instead of butt during walking, focusing more on the face, and refraining from focus on cleavage in fight scenes) in the right column. All image credits go to Disney and Marvel.

#### Costumes

#### Camera Angles



**Oversexualized**

**Less Sexualized**

**Oversexualized**

**Less Sexualized**

Under communicative oversexualization fall metrics such as how sexual or husky a female heroine's tone is, how often and how intensely she flirts verbally, how she conveys sexuality to others through expressions like hooded eyes and emphasized lips, as well as other similar items. Under narrative oversexualization fall metrics such as how important a female heroine is to the plot, if she passes the "sexy lamp" test (i.e. could she be replaced with a sexy lamp with no change to the plot?), if she is involved in a scene which passes the Bechdel test (i.e. two named women discussing something unrelated to men), if she has a role other than or more important than a "love interest," if her percentage of screen time is low, and other similar items. All these three provided a fairly comprehensive examination of how oversexualized the heroines are in a given MCU film.

I then weighed these items as my analysis progressed in order to determine which category carried the most significance in a film's overall O.S., through examining which category's higher amounts of oversexualization tended to predict a higher overall amount of oversexualization. This assisted my analysis later on so I could pinpoint specific areas in which Marvel, alongside other superhero film franchises, should seek improvement. In light of these methods, I hypothesized that O.S. would be relatively high in most movies, but that it would decrease as films originate from more recent years, and with films that focus centrally on women, such as *Captain Marvel*.

### **Gathering Oversexualization Data**

In order to gather my data, I utilized a qualitative content analysis with a codebook including all of the aforementioned categories. I noted every instance of the previously listed phenomena as well as other events, visuals, or plot points that arose with specific descriptions. I also determined the screen time of each heroine in each film to be later compared with their male co-stars. I tested this on a non-Marvel, similar-content film, *Wonder Woman*, in order to gauge the validity of my codebook and any changes which needed to be made. I then completed the same process of analysis for every film listed above, and scored each film accordingly on its oversexualization. This was achieved through two measures: a combined score including physical oversexualization plus communicative oversexualization, and a third score including narrative oversexualization. For the costumes under physical oversexualization, I calculated a full score for each costume, and then averaged the scores of all costumes to obtain an overall costume score.

After using these categories to calculate a final oversexualization score, I compared the scores of each film with the others in order to determine which film contained the most oversexualized female heroine(s), if my hypotheses were correct, and how Marvel can improve their portrayals of women in the future according to my findings. I also created a quantitative representation of the prevalence of certain events, visuals, or narrative roles in order to compare and contrast them between categories and overall, and to see how each metric and category contributed to overall scores for each film. I measured whether or not oversexualization has decreased with time, as well as if this holds true for each heroine. The graphical representations of this data are depicted in the following section.

## Results

### **Weighing Variables**

After conducting my analysis, I observed the pattern that each category held a different weight among the others in determining a film's final O.S. Physical oversexualization had the highest weight of the three categories, or "mega-variables," simply because it is the most pervasive in the visual component of watching a film, and is often the most variable, so its effect on a film's overall score is frequently large. Moviemakers communicate primarily through a visual medium, and thus much of the oversexualized tone in a certain film, if it is present, can often be found in the way people are presented visually, whether it be through costumes, camera angles, or facial expressions, the last of which is discussed later.<sup>16</sup> For the purposes of this

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<sup>16</sup> Van Leeuwen, Theo. "Moving Language: The Visual Language of Film." *Redesigning English: New Texts, New Identities*, by Sharon Goodman et al., Routledge, Abingdon, NY, 2007, pp. 81–85.

analysis, “physical” refers to anything pertaining to the body that does not include communication, and instead centers around actions and appearances.

The second mega-variable had a medium weight among the three because it typically did not yield a lot of data with MCU movies. When it did yield data, it contributed some to a film’s overall score, though not as much as the physical category. Dialogue and facial expressions can be considered as a more secondary language of filmmakers, and so the expressions and statements of characters are given secondary importance here, while they may take more precedence depending on the film. For this analysis, “communicative” refers to any word, facial expression, or body language that seeks to convey a message and has been purposefully placed in the film.

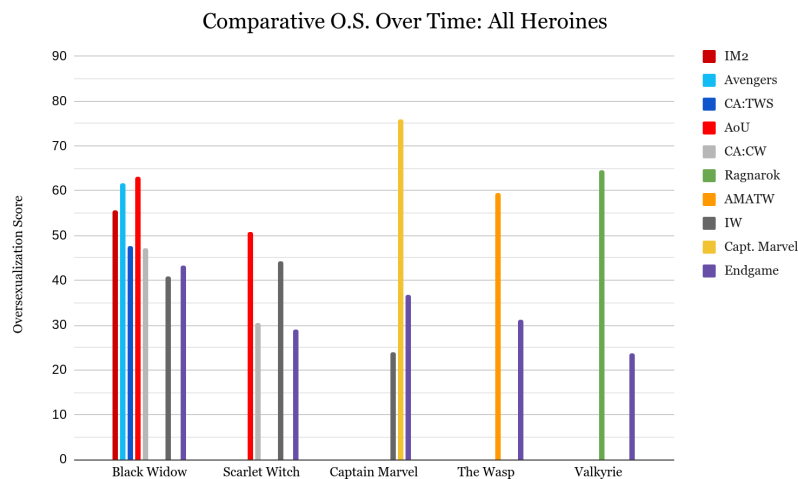
The narrative category had the lowest weight of the three mega variables, since it could increase or decrease quite variably without any correlation to the overall score of the film. That is to say, a female heroine could be sexualized whether she is on screen for five minutes or 105 minutes, and my data displays this quite clearly. The only smaller variables of relative weight in this category were the passing of various narrative tests, although depending on the test, the results could be quite consistent, and thus not hold much sway over a film’s final score. Here, “narrative” means anything pertaining to a character’s role in the plot, their presence and frequency on screen, their place in the cast as a main or side character, and their character development in relation to others. This category’s score was included separately given its nature, which would have skewed the data.

### Charts and Related Quantities

For the purposes of this analysis, I visually represented my findings through column charts, since this clearly and simply depicts various trends in my data. In most of these charts, each film corresponds on the graph to its O.S. I decided to break this down for each heroine, because their presence and prevalence varies in each film, and thus only some films will produce a score pertaining to them. Below, however, I have included the aggregated graph of all the scores of all the heroines in this study, which are grouped by heroine, and wherein each column color corresponds to a different film. I completed this in order to represent my findings as a whole, and to show the trends that remain consistent throughout all the films studied herein. Films are ordered chronologically by release date for narrative clarity, as well as to match the order in which they were coded and analyzed. Some columns may include spaces between them as a result. In some graphs, for visual purposes, I have abbreviated the film titles—for example, *Infinity War* may be shortened to “IW,” *Captain America: Civil War* may be shortened to “CA:CW,” etc.

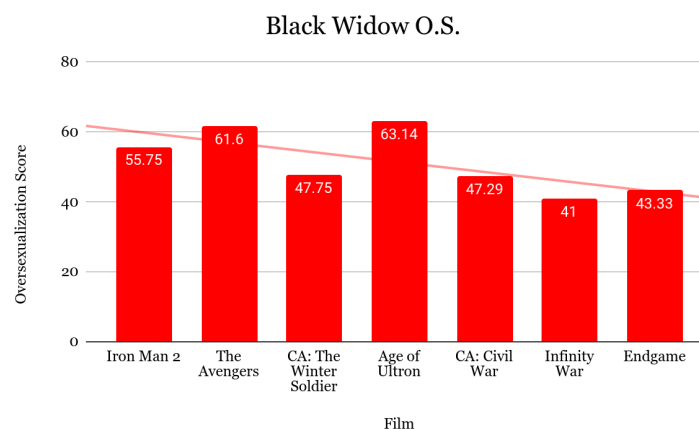
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Fig. 1, “Comparative O.S. Over Time: All Heroines”



As depicted in Fig. 1 above, there is an overall downward trend in O.S., across all films and heroines. This supports my initial hypothesis that O.S. would decrease over time as films originated more recently, with the exception of Captain Marvel. It is likely that this discrepancy is due to her comparatively large amount of screen time, since she is the only MCU heroine to date with a solo, feature-length film. Because the movie is about her, the camera is on her more than anyone else, and this may also lead to more sexualized camera angles purely because of frequency on screen rather than purposeful shots. This disproved my hypothesis that O.S. would decrease in female-led films. For a more extensive, focused look at the data, I also grouped additional charts by heroine, which allowed a more simplified examination of overall trends. Fig. 2 below demonstrates data for Black Widow, the most prevalent and pivotal MCU heroine so far. She is focused on centrally here because she is in the most films and gives the most comprehensive view of the trends.

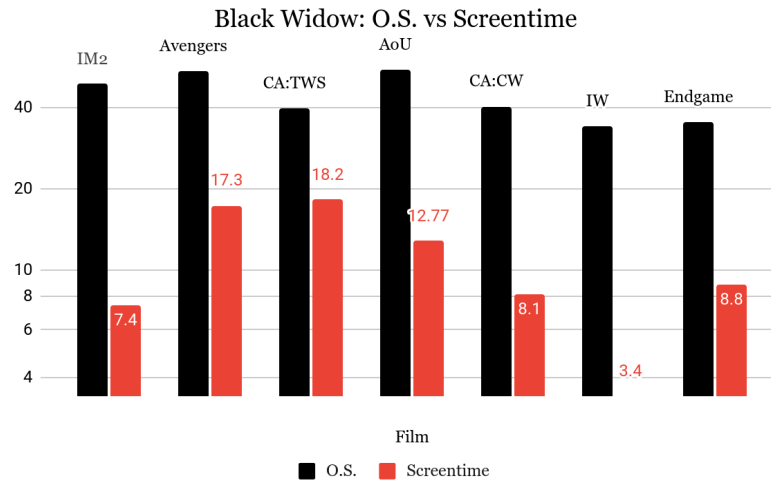
Fig. 2, “Black Widow: O.S.”



Though some fluctuation is present, notably in the early *Avengers* movies more so than others, the overall trend is that Black Widow’s O.S. decreases over time, and is lowest in her

final non-solo films. I have included a trendline in the graph to display this, since it is not as clearly shown from the bars alone. This pattern remains similar with the second most prevalent heroine, Scarlet Witch, whose graphs I have attached in the appendix. I also compared Black Widow's O.S. to her screen time in each film, as depicted through the bar chart in Fig. 3 below.

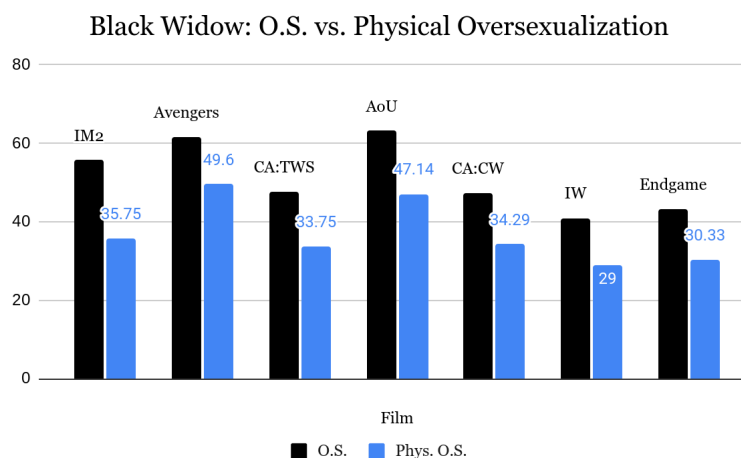
Fig. 3, "Black Widow: O.S. vs. Screentime"



While it can be expected that Black Widow's screen time would be much lower in mass ensemble films such as *Infinity War* and *Endgame*, there does not appear to be a significant relationship between O.S. and screen time. This also holds true visually in the graph of Scarlet Witch, whose chart is attached in the appendix.

Finally, I constructed a representation of the variable which most heavily contributes to the overall O.S. of a heroine in any film: physical oversexualization, and more specifically, how many times a heroine is shot at a sexualized and unnecessary camera angle. See Fig. 4 below for details.

Fig. 4, "Black Widow: O.S. vs. Physical Oversexualization"



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As is clearly illustrated by Fig. 4, physical oversexualization, mainly through camera angles, is strongly connected to the overall O.S. for any given film. This trend also remains constant in the results of other heroines (see appendix). I can assert that camera angles are the central cause of the importance of physical O.S., not costumes, because in any given film the camera angles on average make up more than half of its physical O.S., and thus have the most bearing on the final O.S. Unfortunately, this high amount of camera angles was in part due to the tightness and cleavage level of some of the costumes, which made many regular upper or lower body shots turn into same-level shots with breasts or butt. If some of these costumes had not been as revealing or tight, the number of sexualized camera angles could have been lower, but this holds true mainly for earlier movies versus more recent films. Consequently, I consider camera angles to be the most central predictor of a high O.S. under the umbrella of physical oversexualization.

### Conclusion

After analysis, a few central patterns emerged from the collected data. First, the O.S. of the films on the whole for every heroine had a net downward trend as films became more recent. This confirms my earlier hypothesis that this trend would occur, even despite some outliers, such as *Captain Marvel*, due to total screen time rather than purposeful oversexualization. Second, for heroines such as Black Widow and Scarlet Witch with a more significant role in large ensemble films, like *Avengers* and *Age of Ultron*, their O.S.s followed the overall downward trend yet had unusual spikes in these early ensemble films. This may be due to closer adherence in these films to their early costumes, which were more sexualized, but may also be due to the fact that both films were directed by Joss Whedon. He did not go on to direct any other MCU movies, and may therefore have a unique influence over these films specifically, though this cannot be conclusively proven here. Third, there did not appear to be any significant correlation between a heroine's screen time and her O.S. for any film. As seen above in Fig. 3, screen time fluctuates greatly without O.S. following the same pattern, and this holds true not only for Black Widow but most other heroines as well. This does demonstrate the important principle that a female character is not bound to be sexualized if she is on screen for long enough, but that any amount of screen time, if used wisely and purposefully, can portray a female character fairly. Also, while I initially hypothesized that sexualization would be comparatively lower in solo films, the O.S. in *Captain Marvel*, the only heroine solo film in the MCU as of 2020, was quite high, even with positive low scores for most of her costumes. However, as stated above, this seems to be a result of frequency on screen rather than intentional oversexualization. Finally, the category which was most influential over a film's final O.S. was physical oversexualization by far, and more specifically camera angles on certain body parts from different levels. As discussed above, this was in part due to the sheer overuse of tight and cleavage-heavy outfits, but since this trend remained in later films with less sexual costumes, camera angles remain the largest contributor to a high O.S. for any film.

My research expands on the broader scholarly conversation by taking a different approach to many of the ideas explained in existing studies. For example, my process of a content analysis over MCU heroines from 2010-2020 brings DeMarchi's process of analyzing Marvel women up to date with the much wider range of heroines introduced since her study. I also add more weight to the principles outlined in Ameter's research by backing it up with a more concrete analysis of the trends she noted. Consequently, what I have studied supplements

the findings of Galdi et al., as well as Pennell and Behm-Morawitz, Ferguson, and Wright and Tokunaga, since it provides key, globally viewed instances of media which affect both women's body image and self-esteem and potentially men's views toward women.

There are few concerns in terms of ethical considerations for this research. The material I am coding, and all the characters therein, are the copyright property of the Disney corporation and Marvel. However, I still have the freedom to use this material under the "fair use" doctrine, since I am utilizing them purely for educational purposes and not for profit.<sup>17</sup> A second consideration to note is that I am defining oversexualization from the perspective of current American cultural norms and expectations. What "oversexualized" is will definitely vary across regions, cultures, and time periods, and will affect these differing groups in different ways, hence why this definition and how I interpret it is limited only to this paper and other works coming from a similar context.

### **Errors and Future Research**

Some potential sources of error I noted during this process were regarding the consistency of my coding across each movie. In order to remedy this, I made sure to return to earlier coding sheets and check specific measures for consistent scoring, even at times rewatching specific scenes to fill gaps in costume or camera angle scores. Also, while I initially sought to measure approximate screen time on my own, I realized that this would become a large source of error if I completed coding simultaneously, so I instead used existing sources to find each heroine's screen time in their films. Finally, as discussed briefly above, I decided to split oversexualization into separate categories based on scores to minimize error and outliers.

For a later rework of my project, in order to decrease error and promote thoroughness, I would return to each film a second time and recomplete my coding, so as to ensure that every O.S. was fully correct according to my codebook. However, due to a limited time frame and lack of extra coding assistants, I was not able to undergo this process myself. I could also add statistical tests to strengthen the relationships between variables, and could view these films at a slower speed in order to log every shot, angle, and piece of dialogue more fully.

For future research, similar studies can expand on my findings by moving into examinations of Marvel women who did not fit my definition of a superheroine, as well as analyses of women in Marvel's up and coming television shows. In addition, while I mainly focused on female heroes, a study regarding the oversexualization of male heroes could also illuminate areas for Marvel to improve.

### **Significance and Suggestions for Change**

As prefaced above in my literature review, my research has significance in two major areas: how the filmmakers of the MCU should progress in light of my data, and how the recorded trends affect those who watch these films. Because of the results of my research, my most key suggestion for positive change is in the department of physical oversexualization. In order to portray heroines in a more genuine and fair manner, directors and costume designers should continue the positive trend of costumes with more coverage and less tightness, practical footwear and hairstyles, and lower amounts of makeup. Even more importantly, I suggest that cinematographers should quite literally focus on what shows a heroine's personality and

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<sup>17</sup> Office, U.S. Copyright. "More Information on Fair Use." *More Information on Fair Use* | U.S. Copyright Office, Oct. 2020,

[www.copyright.gov/fair-use/more-info.html#:~:text=Fair%20use%20is%20a%20legal,protected%20works%20in%20certain%20circumstances.&text=Nature%20of%20the%20copyrighted%20work,purpose%20of%20encouraging%20creative%20expression](http://www.copyright.gov/fair-use/more-info.html#:~:text=Fair%20use%20is%20a%20legal,protected%20works%20in%20certain%20circumstances.&text=Nature%20of%20the%20copyrighted%20work,purpose%20of%20encouraging%20creative%20expression).



character development, rather than her physical features from sexualizing angles. On a more secondary note, longstanding characters have received much of their due screen time, but newer players deserve just as much of a role as older ones, specifically in ensemble movies. It is rather concerning that though screen time fluctuated, no heroine other than Captain Marvel in her solo feature received more than 30% of a film's available screen time.<sup>18</sup> In order for Marvel to create genuine change in a genre that is both so new and so widely enjoyed, I suggest that they must not only portray their heroines non-sexually, but also give them a big enough space to make an impact.

In addition, my research has expanded on the scholarly discussion by providing examples of the sexualizing trends which women view in popular media. While Marvel has made significant strides in promoting more positive portrayals of women in the superhero genre, there still seems to be a long way to go, as evidenced in part by my findings. A continuation of improvement on Marvel's part may benefit how both younger and older female viewers are able to accept their bodies and conceptualize their strengths through accurate models, as discussed by Ray, Pennell, and Behm-Morawitz. More importantly, it may also set a powerful precedent for the treatment of women in movies of all other genres, many of which have only a fraction of Marvel's globally influential viewership.<sup>19</sup>

Finally, increased beneficial representation of heroines in the MCU may have the added effect of providing egalitarian models of gender for men as well. If male viewers, with ages ranging from childhood to later life, observe not only powerful, non-sexualized heroines, but also strong heroes who respect their female colleagues, this could improve their attitudes toward women and may even decrease propensities for sexual aggression, building off Wright and Tokunaga.

In summary, though Marvel still needs progress, the overall decrease in oversexualization of its heroines is heartening, and should be continued into its newest endeavors for Phase 4. My research is only an early step in the necessary practice of constant improvement. Through this, real change for women in media can--and hopefully will--be achieved.

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<sup>18</sup> "MCU Complete Screen Time Breakdown." *IMDb*, IMDb.com, 5 Mar. 2021, <https://www.imdb.com/list/ls027954311/>.

<sup>19</sup> Stoll, Julia. "Viewership of Marvel Superhero Movies by Age Group in the U.S. 2018." *Statista*, 13 Jan. 2021, <https://www.statista.com/statistics/807367/marvel-movie-viewership-age/>.

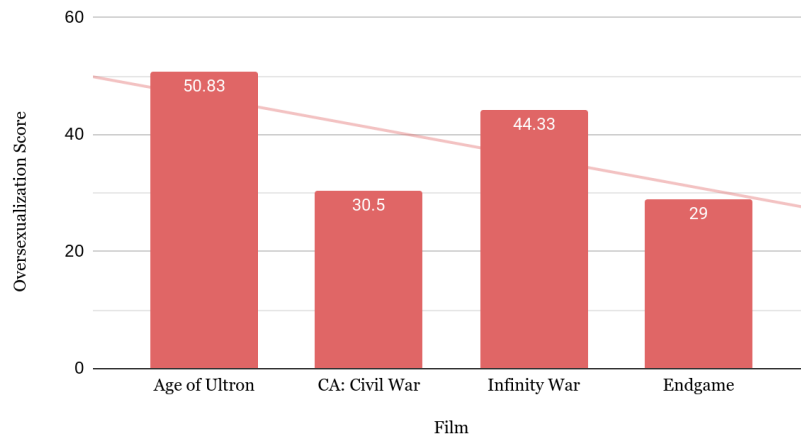
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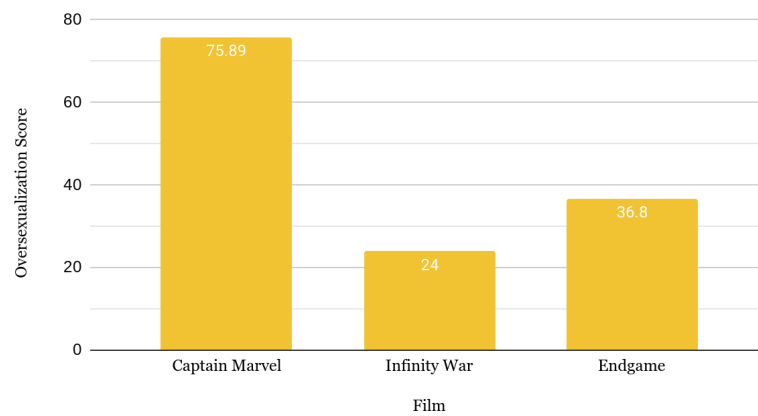
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## Appendix

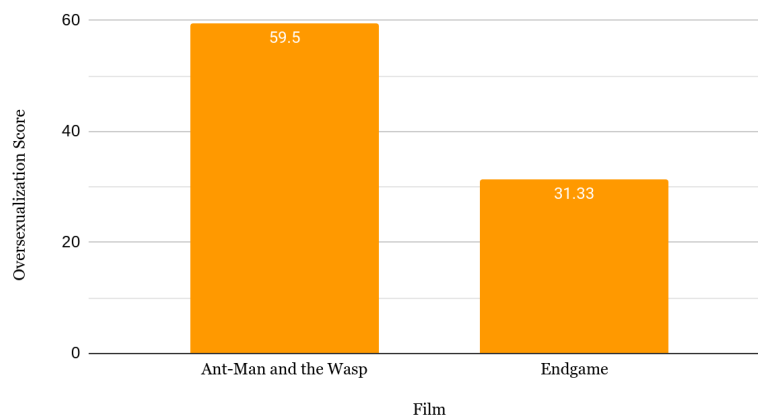
### Scarlet Witch O.S.



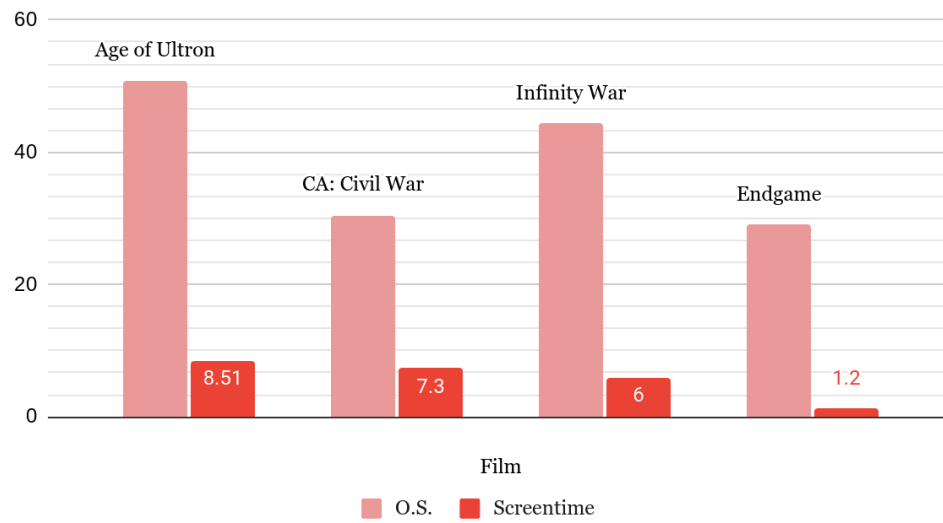
### Captain Marvel O.S.



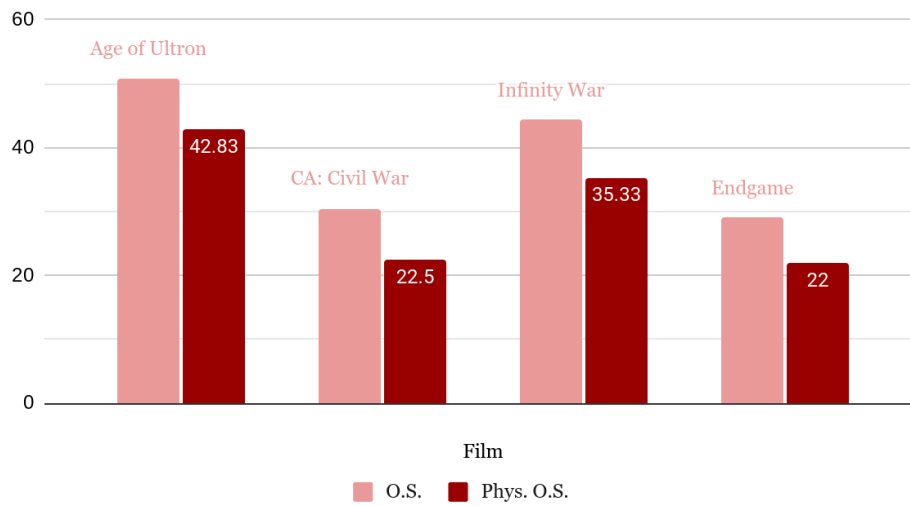
### The Wasp O.S.



### Scarlet Witch: O.S. vs. Screen time



### Scarlet Witch: O.S. vs. Physical Oversexualization



### Appendix: Marvel Oversexualization Codebook

**Unit of Data Collection:** The actions, dialogue, facial expressions, physical appearance, costumes, and narrative roles of female heroines in the Marvel Cinematic Universe, or MCU. A female heroine is defined as a female character with an alternate ego or name, special suit, and physically extraordinary, combative, and/or supernatural skill set. For the purposes of my analysis, this will include heroines such as Black Widow (Natasha Romanoff), Captain Marvel (Carol Danvers), and Scarlet Witch (Wanda Maximoff), among others. When justifying what counts as an “extraordinary, combative, or supernatural skill set,” the coder must be able to cite significant plot instances or mentions of either, both, or all of those three types of skill sets with the other two conditions also having been fulfilled. If dealing with an origin-story film in which the heroine gains her known alter ego, or its significance or origin becomes clear, after the beginning of the movie, the scenes before that moment are considered codable.

#### **Other Coding Instructions:**

DO NOT code the opening or closing credits. This does not include any post-credits or mid-credits scenes, which can be coded if they contain codable content such as that which is listed above.

For all coding, only utilize the information available to you as a viewer of the films, not as a Marvel fan or fan of a certain actor, and excluding any trivia or outside knowledge you may have gained from external media including but not limited to cast interviews, special features, or articles.

In addition, DO NOT code the scenes in which a female heroine is discussed if she has not previously been introduced on screen (i.e., she has been visually depicted and introduced by name, whether it be false identity, alter ego, or real name).

Please include images with each film as examples of physical oversexualization. Communicative oversexualization images may be included at coder’s discretion but are not essential.

Finally, please code each film with the English closed captioning subtitles ON, for ease of coding.

**Film ID:** Please indicate the film analyzed with one of the corresponding numbers from the table below. Also refer to this table when listing the film's year, and the primary heroines in each film.

Film ID	Film Title	Year of Film	Female Heroine(s) in Film, by Alter Ego
1	<i>Iron Man 2</i>	2010	Black Widow
2	<i>The Avengers</i>	2012	Black Widow
3	<i>Captain America: The Winter Soldier</i>	2014	Black Widow
4	<i>Avengers: Age of Ultron</i>	2015	Black Widow, Scarlet Witch
5	<i>Captain America: Civil War</i>	2016	Black Widow, Scarlet Witch
6	<i>Thor: Ragnarok</i>	2017	Valkyrie
7	<i>Ant-Man and The Wasp</i>	2018	The Wasp
8	<i>Avengers: Infinity War</i>	2018	Black Widow, Scarlet Witch
9	<i>Captain Marvel</i>	2019	Captain Marvel
10	<i>Avengers: Endgame</i>	2019	Black Widow, Scarlet Witch, Captain Marvel, The Wasp, Valkyrie

**Coder ID:** 1, for primary coder, add more numbers corresponding to different coders if necessary

**Date:** Fill in the date the coding for one of the above films was completed, in the format Month/Day/Year (ex. 12/01/2020).

**Heroine ID:**

Heroine ID	Heroine Alter Ego and Name
1	"Black Widow," Natasha Romanoff
2	"Scarlet Witch," Wanda Maximoff

3	“The Wasp,” Hope Van Dyne
4	“Captain Marvel,” Carol Danvers
5	“Valkyrie,” Brunnhilde

### Physical Oversexualization

**Costume:** Code each of the heroine’s costumes in each film with short descriptions to denote which costume is being coded, even if she appears in only slightly modified versions in other films.

- *Tightness:* 1-overly loose, 2-loose, 3-functionally tight, 4-overly tight
- *Revealingness:* 1-overly covered, 2-mostly covered, 3-moderately uncovered, 4-mostly uncovered
- *Hem Length:* 1-floor length/full trousers, 2-ankle length, 3-calf length, 4-knee length, 5-mid-thigh length, 6- above mid-thigh, 7-high-low, mixed hem
- *Features Mostly Uncovered:* 1-breasts, 2-butt, 3-legs, 4-stomach (if none of these, write 0, include multiple numbers for multiple areas)
- *Accentuated Features* (e.g. bright color, see-through material, tightness on these specifically): 1-breasts, 2-butt, 3-legs, 4-stomach (if none of these, write 0, include multiple numbers for multiple areas)
- *Heels on Shoes:* 1-zero to three inches, 2-three to six inches, 3-seven to nine inches (roughly estimate based on how much is visible from codable scenes)
- *Shoe Practicality:* 1-feet fully covered, 2-top of foot/toes uncovered, 3-unnecessary laces, strings, or other impractical features (include multiple numbers for multiple areas)
- *Accessibility of Weapons Based on Costume* (do not include those with powers requiring no weapons): 1-highly accessible (ex. on belt, in pockets, strapped to back), 2-mildly accessible (ex. not many places to keep weapons, only one-two areas), 3-not accessible (costume leaves no room for weapons/weapon storage)
- *Makeup* (exclude makeup that is part of a “mask” or to hide identity): 1-light and natural, 2-mild makeup (lipstick, mascara), 3-moderate makeup (light coverage with more eyeshadow and darker lips, maybe liner), 4-intense makeup
- *Hairstyle* (include genuine hair in any hairstyle and/or any wig that heroine is forced to wear): 1-highly practical (ex. pulled back, out of face, not likely to be caught/pulled, hairstyle not so delicate/complex that it wouldn’t hold), 2-moderately practical (ex. out of face but still liable to be pulled/caught or has low hold), 3-mildly practical (ex. some out of face and/or liable to be caught/pulled and/or has low hold), 4- impractical (in face, fully down, low hold, potentially heavy or burdensome hairstyle or wig)

**Camera Angles:** Code the notable camera angles that include/focus specifically on the heroine and how they portray her. Mainly code scenes which portray one heroine alone, instead of the



heroine with another woman or male character. Exceptions may be made for two heroines in one shot.

- *Focus on Features* (code each number multiple times for multiple instances): 1-breasts, 2-butt, 3-legs, 4-stomach, 5-lips, 6-full body overview (up to down or vice versa)
- *Angles*: 1-lower to focus on cleavage, 2-lower to focus on butt, 3-from above to focus on cleavage, 4-from above to focus on butt, 5-same level shot with breasts, 6-same level shot with butt

### Communicative Oversexualization

**Flirting:** Code how intensely, often, and/or sexually a heroine flirts with other characters, male or female, hero or non-hero, in her codable scenes from each film. This will include mostly verbal, but more physical as it increases in intensity, and motive is not considered here.

- *Frequency*: 1-no flirting, 2-one to three instances of flirting, 3-three to five instances of flirting, 4-six or more instances of flirting
- *Intensity* (only code if the heroine has more than zero frequency): 1-low intensity (ex. casual banter, playful, mostly nonsexual comments), 2-medium intensity (ex. mild to moderate sexual comments, mild to moderate physical advances), 3-high intensity (ex. intense sexual comments, heavy physical advances, “throwing oneself” at someone)
- *Tone*: 1-normal, measured speaking voice, 2- husky, breathy voice, 3-very husky, breathy voice and whispering

**Overall Tone:** Code for the general tenor of a heroine’s voice over the course of the film, not just in flirting instances, and with any character.

- 1-normal, measured speaking voice, 2- husky, breathy voice, 3-very husky, breathy voice and whispering
- *Frequency*: note number of instances of each of above speaking patterns in heroine’s scenes, from 0-total number of dialogue segments in film

### **Facial Expressions:**

- *Emphasized Features* (if none of these, write 0, include multiple numbers for multiple areas in a scene): 1-lips pushed out, 2-eyes hooded, 3-any use of tongue
- *Direction of Gaze* (if heroine glances pointedly at any “sexual” body part of another character, or maintains suggestive eye contact): 1 if yes, 0 if none, 2+ for how many instances in film

### Narrative Oversexualization

**Plot Importance:** Code how major or minor a heroine is in moving the story forward in each film, whether she is the main character or not.

- *Status*: 1-protagonist, 2-in main cast but not protagonist, 3-side character, 4-mostly insignificant character in large main cast (ex. *Infinity War*, *Endgame*)
- *Frequency*: 1-one to three speaking scenes, 2-four to six speaking scenes, 3-seven or more
- *Bechdel Test* (how many scenes the heroine is in which pass the bechdel test): from 0-total number of dialogue segments in film
- *“Sexy Lamp” Test* (does heroine pass test?): 1-yes, 2-no
- *Love Interest Test* (does heroine function as something else?): 1-yes, 2-no
- *Total Screen Time*: note total screen time for each heroine in each film, percentage of film

The Modification of Buildings Based on the Mounds of Macrotermes for the Purposes of Thermoregulation  
and the Elimination of the Need for Modern Air Conditioning

Word Count: 4069

## Abstract

The current way that the air conditioning of buildings is conducted is both overly expensive and harmful to the environment. Alternatives to modern air conditioning are not common, but one potential solution lies in the deserts of Zimbabwe. *Macrotermes*, a genus of termites found in this region, produce mounds that thermoregulate independently. The Eastgate Centre, a building in Zimbabwe, was designed to imitate this process and function without modern AC. The goal of this research is to find a way apply the same techniques to buildings that already exist. To test the potential of this, a scale model building with an added chimney and fans (similar to the Eastgate Centre) was compared to a similar model without modifications when exposed to a heat lamp that was representative of the sun. The temperatures at each level of each building were recorded over a number of trials with the light facing eight different sides of the building for five minutes. The differences in temperature between room temperature and the temperature after the light exposure were calculated and showed that, on average, the modified building resulted in a smaller difference than the control building. The mean for the modified building was 4.2583°C, while the mean for the modified building was 5.075°C. An ANOVA was run on the data that verified the design's promise and, therefore, suggested that it deserves further investigation, perhaps on a larger scale.

## Introduction

There is a genus of the family Termitidae native to Africa and Southeast Asia called *Macrotermes*. Within this genus are numerous different species. For the purposes of this study, the focus will be on *Macrotermes natalensis*, *Macrotermes subhyalinus*, *Macrotermes vintrialatus*, and *Macrotermes michaelseni*. These four species are found throughout northern Namibia which is in southern Africa. The leading researcher in these termites is Dr. J. Scott Turner, a professor of biology at the University of New York College of Environmental Science and Forestry. In his study "Architecture and morphogenesis in the mound of *Macrotermes michaelseni* (Sjöstedt) (Isoptera: Termitidae, Macrotermitinae) in northern Namibia", Turner details his research in Namibia relating to the four termite species previously mentioned (Turner, 2000). He discovered that the mounds of these Macrotermitinae are found at a density of one to four per hectare throughout southern Africa.

Within the genus of *Macrotermes*, Turner found particular interest in the mounds of the *Macrotermes michaelseni*. These mounds have unique features, distinguishing them from those of the other species. The features worth noting include the spherical space below the mound, reserved for the queen, workers, and fungus garden, and the tunnel network in the mound, responsible for promoting the circular flow of air. As a whole, these mounds behave as if they were constructed for the regulation of the colony environment, conditions such as temperature, humidity, and concentration of gases, rather than for the habitation of the termite colonies themselves. Differing from *Macrotermes michaelseni*, the mounds of the species *Macrotermes natalensis*, *Macrotermes subhyalinus*, and *Macrotermes vintrialatus* contain large circular openings at the top connected to vertical chimneys. These chimneys are the basis of the induced flow model.

In a separate study, "On the Mound of *Macrotermes michaelseni* as an Organ of Respiratory Gas Exchange", Turner further develops the idea of this species' mounds being designed to regulate the internal environment. The research conducted for this article focused primarily on the interaction between the termite mounds and the internal and external gases rather than the physical characteristics and internal structural mappings. He claims that the mound is "simply the most visible component of a structure that extends well below the ground" (Turner, 2001). Prior to this study, there was an incorrect understanding of the means of gas exchange within the mounds of the *Macrotermes michaelseni*. It was believed that the mound could be classified by the thermosiphon model. Within this model, buoyant forces are deemed responsible for the circulation of air through the nest and surface tunnels. The colonies supposedly have a high metabolic rate, capable of producing hundreds of watts, and, therefore, heat. Resultingly, air would be heated and humidified, causing it to lose density and rise to the surface.

This thermosiphon style ventilation is actually found to be completely unsubstantial, based on the data Turner collected using tracer gases to analyze the rates and patterns of gas movement within the mounds. In reality, the gas exchange of the mounds is induced by the complex interaction between the kinetic energy in the wind, the metabolic convection in the nest, and the overall architecture of the mound, tunnels, and nest within. The ventilation movements of the mound are more tidal than they are circulatory, meaning they are driven by wind speeds and directions.

According to Jeremy Smith, an editor of *The Ecologist* with a Ph.D. in geography, these termites require "a constant temperature of 30.5°C" in order to survive (2007). But the temperatures of the region in which they inhabit can vary from 1.7°C to 40°C, so the mounds the termites construct are capable of both diffusing and restoring significant quantities of heat (2007). This need for precise temperature has been studied by Judith Korb, a professor of evolutionary biology & ecology at the University of Freiburg. She determined that the need is derived from many species of *Macrotermes*' "ectosymbiotic relationship with basidiomycete fungi of the genus *Termitomyces*" (Korb, 2003). This symbiosis is maintained through the termites' capabilities to thermoregulate their mounds and produce the optimal temperature for fungus growth. Korb's research also revealed that the mounds only fluctuate less 2°C on average, despite any outside temperature fluctuations (2003).

It is the regulatory complexities within the termite mounds that inspired architect Mick Pearce while designing the Eastgate Centre, a shopping center in Harare, Zimbabwe. Pearce found particular interest in the "termites' use of the thermal capacity of the ground and the mound, and their labyrinths of ventilation tunnels", according to Environmental Health Perspectives and Massachusetts Institute of Technology writer, Richard Dahl, in his article "Cooling Concepts: Alternatives to Air Conditioning for a Warm World" (Dahl, 2013). Using the model of the termite mound as a guide, Pearce was able to design the Eastgate Centre in such a way that it operates without the usage of traditional air conditioning.

This building relies on the concept of night flushing. At night, cool air is driven through tunnels in the concrete structure, so that it can cool the concrete ceiling that absorbs heat all throughout the day. The heat absorbed during the day travels through the same tunnels by

means of fans and convection forces in the numerous chimneys found in the center of the building.

Dr. Turner, along with fellow researcher Rupert C. Soar, the Director of Freeform Construction Ltd and the Termes Trust in Namibia, and a lecturer at the University of Greenwich School of architecture and construction, argue that the Eastgate Centre is not as much like a termite mound as Pearce had perhaps thought. In their article “Beyond biomimicry: What termites can tell us about realizing the living building”, the two claim that Pearce based his building on a dated conception of the inner workings of *Macrotermes* mounds (Soar and Turner, 2008). The only comparable feature between that the Eastgate Centre contains is the large stacks, resembling the large vents atop termite mounds of *Macrotermes natalensis*, *Macrotermes subhyalinus*, and *Macrotermes vintrialatus*. This portion of the building is based on the induced flow model. According to Turner and Soar, Pearce failed in his attempt to recreate the thermosiphon model, which is now rejected by most scientists in the field. In his attempt, Pearce had to turn to low capacity fans during the day and high capacity fans at night for ventilation.

But despite the difference from the original structure of termite mounds, Pearce’s method proved to be ultimately successful. He was able to design the Eastgate Centre in a way that allows it to now function using merely “10% of the energy of comparably sized air-conditioned buildings in Harare” (Dahl, 2013). However, the process of dialing in on the exact thermoregulation requirements for the building took three years to reach their most optimized and efficient point. This had to do with the conditions and preferences of the occupants and the machinery within. And all that time spent and information gathered is only applicable to this specific building. Turner and Dahl speculate that some sort of living building will become the future for sustainable architecture, but, ultimately, this will also have to be something that is specific to singular buildings, and must be designed into them.

The purpose of this research is to find a simpler means to transform buildings that already exist into something that functions in a way similar to the Eastgate Centre and be capable of thermoregulation at a small fraction of the energy that it used prior. The complex elements of design worked into the Eastgate Centre make it nearly impossible to replicate the termite mound thermoregulation system in the same way for preexisting buildings. That is why an easily adaptable methodology is required in order to create an effective, yet inexpensive modification that can be applied to essentially any standing skyscraper. The new design will be evaluated on the following categories: effectivity compared to Eastgate Centre and complexity of application.

Note. The extent of research conducted on termites of this genus and their mounds, while extremely thorough, is limited by a small number of researchers. This has resulted in a relatively minimal sampling of perspectives on the inner functioning of such mounds. This paper has attempted to maximize available information and include all seemingly substantiated viewpoints to construct a synthesized conception of these termites and their mounds.

## Method

For the purposes of this research, it is necessary to construct a scaled down model of the proposed modified building to run sufficient tests to determine its effectivity. Although preferable, the utilization of a full sized building is completely impractical given the scope of this project. So instead, a small scale model will suffice as a basis to conclude upon whether or not the design is deserving of further testing or if it requires modifications.

The tests being conducted are comprised of temperature recording and analysis of the scaled modified building. This is one of the methods used by Turner in his study of termite mounds in the article “On the Mound of *Macrotermes michaelseni* as an Organ of Respiratory Gas Exchange”. By utilizing similar methods to those conducted in mound research, the successful application of the techniques of termites can be better measured, as they have been proven to be the most successful. The temperature data from the experimental building model must be compared to that of a similarly constructed control building without any modifications. In order to accurately predict the effects of the modifications in a full sized building, the models must be exposed to directed heat, simulating the sun.

It was believed that by imitating the induced flow technique of termite mounds, a similar cooling effect could be established in preexisting buildings without any majorly intrusive renovations. The induced flow model makes use of a chimney that runs through the center of the mound, connecting to the inner tunnels, to channel hot air out. The Eastgate Centre relies on similar chimneys, serving the same purpose. This leads to the conclusion that the role of a chimney is crucial to the operation of a termite-styled thermoregulation system. Since the creation of a central chimney in buildings that have already been constructed would require a great amount of demolition and remove a major portion of the space in the building, having the chimney attached to the side of the building is a more productive alternative. Another seemingly essential component of the induced flow model in termite mounds is the ability to harness wind to force hot air to be vented out of the chimney. On a larger scale, wind becomes relatively insignificant compared to the massive size of a building. That is why the Eastgate Centre made use of fans to simulate wind and drive air through the chimney, to be expelled out the top. Fans must also be utilized for the modification of a preexisting building for the same reason. These two elements together, should be able to produce a lower internal temperature for a scaled building when compared to an equally scaled building without the modifications.

Acrylic glass, one-eighth of an inch in thickness, has been used to fabricate the models. This plastic, made out of polymethyl methacrylate acid, is beneficial as it has “exceptional weatherability, strength, clarity and versatility” (Plaskolite, 2017). This material was most fitting for this project because it allows for easy viewing of the thermometers and is relatively easy to cut. Both the experimental and control are 30cm in height and 15cm in width (with the exception of the chimney on the experimental model which adds an additional 5cm to one side) and comprised of three stories. Having three stories will provide a sufficient base of understanding of how the temperature differ from an upper to a middle to a lower level. The individual pieces of cut acrylic glass have been sealed together using

a hot adhesive to ensure that the system is airtight in the manner outlined in a computer drafted model made prior to construction (Fig. 1). The dimensions and specifications for the cut pieces are as follows: Seven 30cm x 15cm rectangles, eight 15cm x 15cm rectangles, three 5cm x 5cm rectangles, one 15cm x 5cm rectangle, three 10cm x 1cm rectangles, one 35cm x 15cm rectangle with two 30cm x 5cm rectangles cut from inside (forming the largest wall of the chimney), one 30cm x 15cm rectangle with three 1cm x 5cm rectangles cut from inside (forming the wall flush to the chimney).

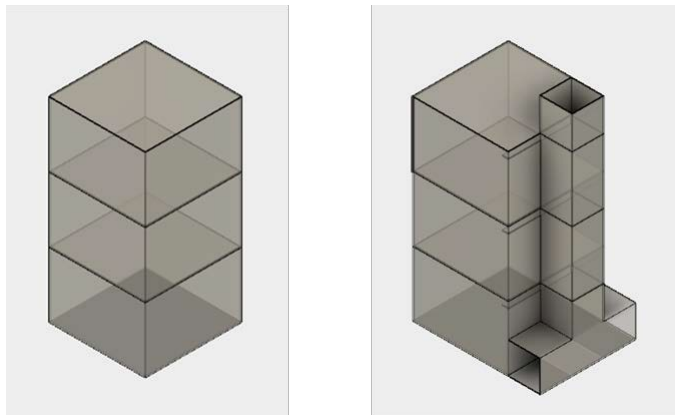


Figure 1. Computer-aided drawing developed using Autodesk Fusion 360 software

Glass thermometers were placed on the inside of each level. The building models were subject to a heat lamp 35cm away, angled down at 45° below horizontal, and with the bottom of the bulb at the same height as and facing the model. After five minutes of constant exposure, the temperature was recorded from each thermometer. This was then repeated twice for a total of three trials. Then the

## Results

Table 1. Temperature per thermometer at varying positions for control building, after five minutes of light exposure

Position	Trial 1			Trial 2			Trial 3		
	Thermometer A (°C)	Thermometer B (°C)	Thermometer C (°C)	Thermometer A (°C)	Thermometer B (°C)	Thermometer C (°C)	Thermometer A (°C)	Thermometer B (°C)	Thermometer C (°C)
1	25.8	23.9	26.1	26.2	25.4	25.7	26.1	25.8	27.8
2	26	24.2	25.9	24.7	23.8	26	25.2	23.7	23.3
3	25	24.1	26.1	23.9	23.1	24.5	26	24.9	27.5
4	23.4	22.2	24.2	23.1	22	23.9	24.7	23.1	25.4
5	23.9	22.7	24	23.6	22.4	23.8	24.1	23.5	24.9
6	23.1	22.3	24.2	24	23.3	24.7	24.1	23.6	25.7
7	24	24	25.5	24.1	24.2	26.4	24.2	23.8	26.5
8	24.4	23.8	26.4	25.3	24.9	25	25	24.6	26.7

building was rotated 45° clockwise (Fig. 2) and the temperature was recorded three times. This was repeated for a total of eight distinct positions and an overall total of 24 trials for each building.

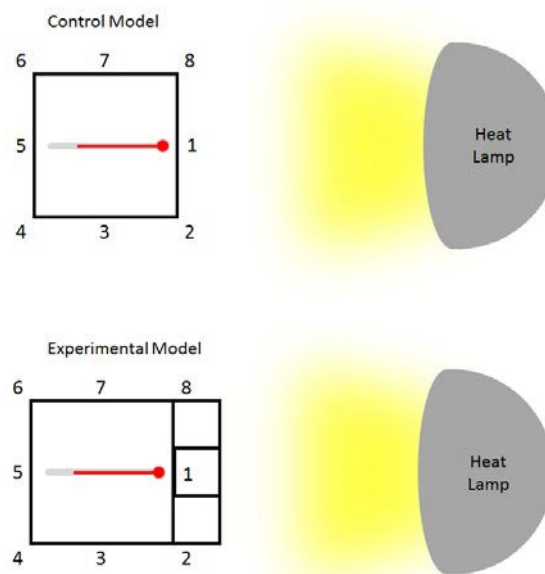


Figure 2. Diagram showing numbering used throughout tests to identify which side is facing the heat lamp for a specific trial.

Table 2. Temperature per thermometer at varying positions for modified building, after five minutes of light exposure

Position	Trial 1			Trial 2			Trial 3		
	Thermometer A (°C)	Thermometer B (°C)	Thermometer C (°C)	Thermometer A (°C)	Thermometer B (°C)	Thermometer C (°C)	Thermometer A (°C)	Thermometer B (°C)	Thermometer C (°C)
1	26.1	24.5	25.8	26.5	26	26.1	24.9	25.2	26.2
2	26	24.5	24.3	26	25.5	25.5	25.5	25.6	25.7
3	25.5	25.2	25.6	26.2	26.3	26.5	25	25.7	26.6
4	24.8	23.9	24.1	23.9	23.1	24	24.4	23.7	25.1
5	23.9	23.7	23.5	24.2	24	25.3	23.5	22.8	22
6	23.8	23.8	24	24.3	24.2	25.1	23.6	23.5	25.1
7	24.1	24.1	24.2	25	25.5	26.1	23	23.1	24.9
8	25.5	24.3	24.1	24.3	25	24.7	24.1	23.9	24.5

Note. Thermometer lettering corresponds to the level of the building the thermometer is on with A being on the top floor, B being on the middle floor, and C being on the bottom floor.

The raw data collected from the thermometers showed no clear trends or correlations. The temperature seemed to vary relatively significantly but randomly based on the two variables shown here. During testing however, it was noticed some of the thermometers were displaying different temperatures than the 20°C when they

were supposed to be at room temperature. To fix this calibration error, the actual temperatures displayed at room temperature for each thermometer were subtracted from the temperatures after the exposure, resulting in the adjusted data set.

Table 3. Adjusted change in temperature per thermometer at varying positions for control building, after five minutes of light exposure

Position	Trial 1			Trial 2			Trial 3		
	Thermometer A (°C)	Thermometer B (°C)	Thermometer C (°C)	Thermometer A (°C)	Thermometer B (°C)	Thermometer C (°C)	Thermometer A (°C)	Thermometer B (°C)	Thermometer C (°C)
1	5.966666667	6.466666667	5.466666667	6.366666667	7.966666667	5.766666667	4.766666667	7.166666667	5.866666667
2	5.866666667	6.466666667	3.966666667	5.866666667	7.466666667	5.166666667	5.366666667	7.566666667	5.366666667
3	5.366666667	7.166666667	5.266666667	6.066666667	8.266666667	6.166666667	4.866666667	7.666666667	6.266666667
4	4.666666667	5.866666667	3.766666667	3.766666667	5.066666667	3.666666667	4.266666667	5.666666667	4.766666667
5	3.766666667	5.666666667	3.166666667	4.066666667	5.966666667	4.966666667	3.366666667	4.766666667	1.666666667
6	3.666666667	5.766666667	3.666666667	4.166666667	6.166666667	4.766666667	3.466666667	5.466666667	4.766666667
7	3.966666667	6.066666667	3.866666667	4.866666667	7.466666667	5.766666667	2.866666667	5.066666667	4.566666667
8	5.366666667	6.266666667	3.766666667	4.166666667	6.966666667	4.366666667	3.966666667	5.866666667	4.166666667

Table 4. Adjusted change in temperature per thermometer at varying positions for modified building, after five minutes of light exposure

Position	Trial 1			Trial 2			Trial 3		
	Thermometer A (°C)	Thermometer B (°C)	Thermometer C (°C)	Thermometer A (°C)	Thermometer B (°C)	Thermometer C (°C)	Thermometer A (°C)	Thermometer B (°C)	Thermometer C (°C)
1	5.066666667	4.766666667	4.866666667	5.466666667	6.266666667	5.166666667	3.866666667	5.466666667	5.266666667
2	4.966666667	4.766666667	3.366666667	4.966666667	5.766666667	4.566666667	4.466666667	5.866666667	4.766666667
3	4.466666667	5.466666667	4.666666667	5.166666667	6.566666667	5.566666667	3.966666667	5.966666667	5.666666667
4	3.766666667	4.166666667	3.166666667	2.866666667	3.366666667	3.066666667	3.366666667	3.966666667	4.166666667
5	2.866666667	3.966666667	2.566666667	3.166666667	4.266666667	4.366666667	2.466666667	3.066666667	1.066666667
6	2.766666667	4.066666667	3.066666667	3.266666667	4.466666667	4.166666667	2.566666667	3.766666667	4.166666667
7	3.066666667	4.366666667	3.266666667	3.966666667	5.766666667	5.166666667	1.966666667	3.366666667	3.966666667
8	4.466666667	4.566666667	3.166666667	3.266666667	5.266666667	3.766666667	3.066666667	4.166666667	3.566666667

Note. When the measurement bias caused by the thermometers is factored out, the true effect of the modifications to the building can be determined. The data can then be categorized based on the variables of the experiment: position and thermometer location.

Table 5. Mean change in temperature for control and modified buildings, after five minutes of light exposure, based on building position

Position	Control Mean (°C)	Modified Mean (°C)
1	5.659259259	5.133333333
2	5.525925926	4.833333333
3	5.981481481	5.277777778
4	4.525925926	3.544444444
5	4.525925926	3.088888889
6	4.792592593	3.588888889
7	5.214814815	3.877777778
8	5.414814815	3.922222222

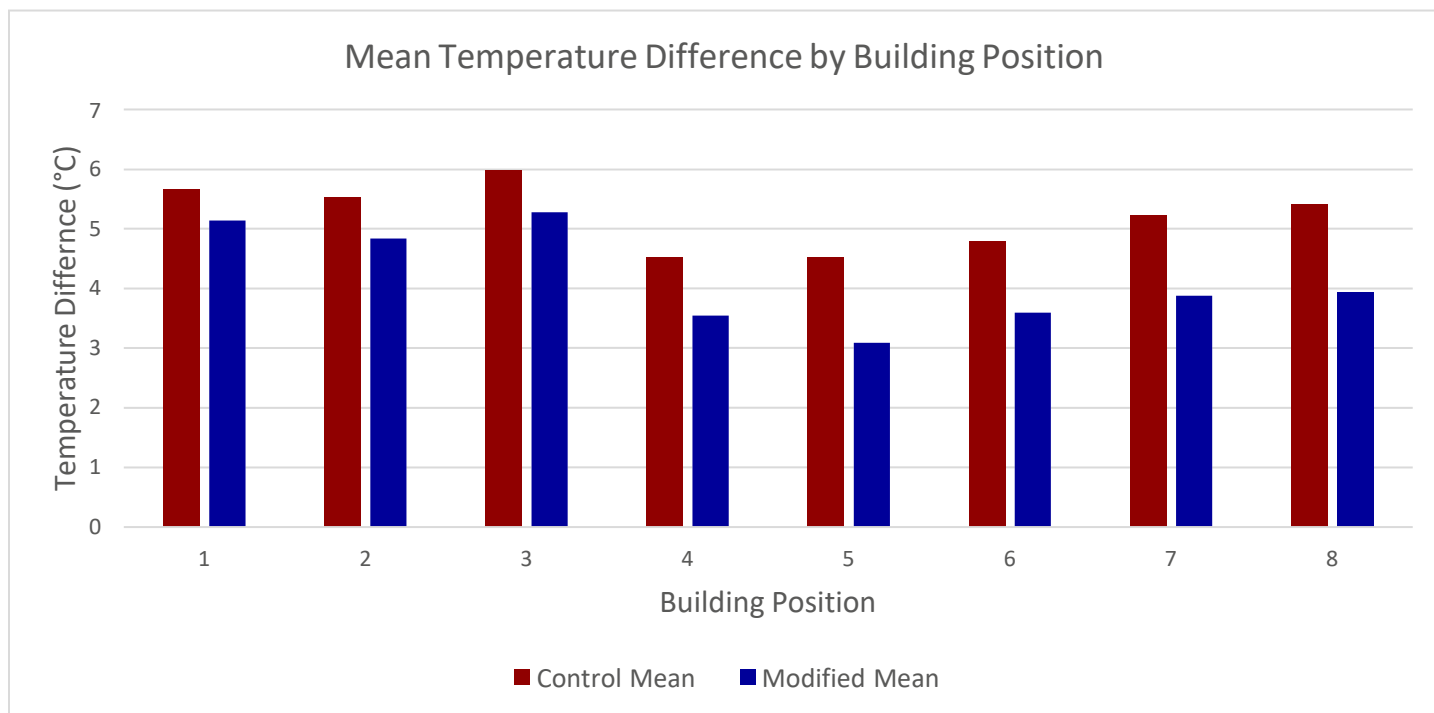


Figure 3. Mean change in temperature for control and modified buildings, after five minutes of light exposure, based on building position

With the exception of the statistics from position 3, the graph shows a decrease in the value of the mean temperature difference for both the control and experimental buildings from position 1 to position 5, and then an increase from position 5 to position 8. This observation is expected based on the nature of the thermometers being used to test. The relative distance between the light and the bulb of the thermometer has a noticeable effect on the temperature after light exposure. The mean temperatures at position 5 were the lowest, as the bulb was furthest away from the heat lamp at this position. The

mean temperatures at position 1 were the highest (again excluding position 3), as the bulb was closest to the heat lamp at this position. The means at position 3, while not qualifying as statistical outliers, are most likely due to testing variability. It does seem out of the ordinary that both the control mean and modified mean would both be higher than expected on the same position, but there were no observable outside factors that could have led to this abnormality, so it must be due to uncontrollable variation within the testing.



Table 6. Mean change in temperature for control and modified buildings, after five minutes of light exposure, based on thermometer location

Thermometer	Control Mean (°C)	Modified Mean (°C)
A	4.62083333	3.72083333
B	6.42916667	4.7292
C	4.56527778	4.025

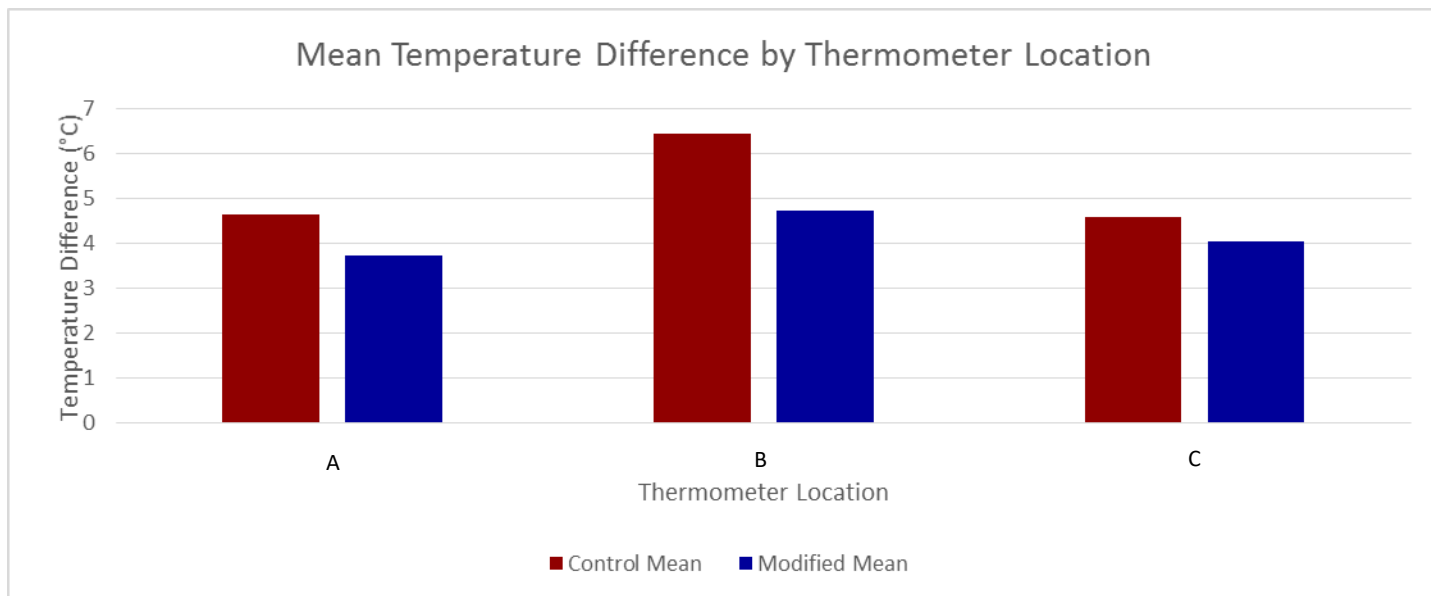


Figure 4. Mean change in temperature for control and modified buildings, after five minutes of light exposure, based on building position

It is clear, based on the graph of mean temperature difference and thermometer location (Fig. 4), that the thermometers in the middle of the model buildings experienced higher temperatures on average. The control building had a mean of roughly 6.429°C for temperatures recorded at thermometer B, while having significantly lower means of roughly 4.621°C and 4.565°C for thermometers A and C respectively. The modified building displayed a similar trend, just with a smaller discrepancy between the means. For thermometer B, the mean was roughly 4.729°C, while for thermometers A and C, the means were only roughly 3.721°C and 4.025°C respectively. This trend is most likely due to the height and angle of the heat lamp relative to the models. The lamp was angled such that the center of the bulb is pointing directly at the center of the middle floor of the building. This caused the thermometers in location B to receive be most affected by the lamp, explaining the previously stated trend. It would seem logical that the data from thermometer A would be consistently higher than that of thermometer C, as thermometer A, although not directly aligned with the center of the bulb like thermometer B, is the closest thermometer to the heat lamp. But this is only the case for the control mean. The modified mean for thermometer C proved to be unexpectedly higher than that of thermometer A. This result is speculatively due to the nearly undetectable heat produced by the

fans. Although quantity of heat is miniscule, the close proximity between the fans and the wall of the lowest floor might have resulted in the discontinuity between the control and the modified model's trends.



Figure 5. Photograph of control model testing apparatus with indication of light bulb direction

Table 7. Mean and standard deviation change in temperature for unadjusted and adjusted data of control and modified building models, after five minutes of light exposure

Data Set	Mean (°C)		Standard Deviation (°C)	
	Control	Modified	Control	Modified
Unadjusted Data	24.575	24.725	1.249873233	1.020321684
Adjusted Data	5.075	4.258333333	1.175518319	0.987805836

The unadjusted data set means for the entirety of the data collected showed a very slight difference between the control and modified building models, with the modified being higher. This means that the thermometers in the modified building recorded higher temperatures on average than those of the control building after being exposed to the heat lamp. The difference between these values was only 0.15°C. However, with the improper calibration of the thermometers factored out in the adjusted data set, there is a seemingly more

significant difference between the means of the two models. The control model had a mean temperature difference of 5.075°C, while the modified had a mean temperature difference of 4.2583°C. The difference between these two means is much larger and more significant than that of the unadjusted data set, at 0.8167°C. The modified model also had a lower standard deviation of 1.0862°C than that of the control model, which was 1.1541°C.

Table 8. Results of 8x2x3 factorial ANOVA to determine statistical significance

Tests of Between-Subjects Effects					
Dependent Variable:	Result				
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	154.420a	47	3.286	5.822	0.000
Intercept	3069.164	1	3069.164	5438.165	0.000
Condition	30.250	1	30.250	53.599	0.000
Position	74.693	7	10.670	18.907	0.000
Thermometer	30.620	2	15.310	27.127	0.000
Condition * Position	8.228	7	1.175	2.083	0.053
Condition * Thermometer	0.732	2	0.366	0.648	0.525
Position * Thermometer	8.860	14	0.633	1.121	0.350
Condition * Position * Thermometer	1.037	14	0.074	0.131	1.000
Error	54.180	96	0.564		
Total	3277.764	144			
Corrected Total	208.600	143			
a. R Squared = .740 (Adjusted R Squared = .613)					

An 8x2x3 factorial analysis of variance was run on the adjusted data set to determine if the modified building showed statistically significant differentiation from the control building. The ANOVA results showed statistically significant main effects of condition, position, and thermometer as  $p \leq .0005$  for all of these variables. However, there were no significant interaction effects.

## Conclusion

Based on the results of the ANOVA, it can be stated that the modified building's temperature was lower than the control building's

temperature and this difference was statistically significant. This means that the attempt to design a model that reduced the need for modern air conditioning in a building was successful and the original design criteria were met. The design was also relatively simple, as only minimal construction would be required to remove small portions of the outer walls and to add a chimney and fans. So based on the scope of this research, the design was successful. The extent to which the design is successful in a real-world scenario is uncertain however, as a less than one degree Celsius difference was obtained, which is not enough from a practical perspective. Modern air conditionings allow for major temperature reduction from outside conditions, so the

modifications being developed must be able to produce similar results if they are to be implemented. There is also the issue of the scale model's translation to an actual building. There is a certain amount of unpredictability that comes with this translation, as there is no way to account for numerous factors, including wind, building insulation, humidity, heat convection, etc.

In order to broaden the relative reduction in temperature with the modification, in an attempt to provide a safeguard against these incalculable effects, future testing is required. By no means has the optimally simple yet effective solution been developed, but there are several ways to achieve results closer to such a goal. It would first be beneficial to make improvements to the testing method, to make the small-scale simulations more realistic.

Only a total of eight unique positions were tested in this experiment. A real building would have to be effective against the sun in every possible location. While it would be both inefficient and nearly impossible to test this fully, a broader range of positions should be used to create a more comprehensive idea of how the building will function at any given location relative to the sun.

If more floors were added to the scale model, it would become possible to assess the strength of the loss of cooling as height increased. This unavoidable phenomena cannot be fully measure based on just three floors, but is necessary, as the end goal is to devise a design effective on buildings ranging in size from one story buildings to skyscrapers. Most buildings also contain more than one room per floor. So the scale model should also be divided into rooms to see how wall partitions effect the distribution of temperature.

Given the difficulties encountered due to the improper calibration of the thermometers, a more precise measuring instrument should be used to obtain more exact results. Digital thermometers would be an ideal substitute, as they are not only more precise, but also make data collection easier for the researcher. In addition to that, digital thermometers can be made smaller than glass thermometers so more could be placed throughout each floor. This would allow for a more inclusive vision of how the temperature differs based on the location within the floor. This data would allow for the determination of weak spots within the floors, where temperature is significantly higher. Then a means could be developed by which the location could be cooled.

Logically, based on the design created, the greater the distance is from the chimney, the warmer the temperature should be. The Eastgate Centre utilizes a technique to eliminate this issue that was omitted from the design in this research so that it would more sufficiently meet the simplicity criteria set forth at the start. Underneath each floor of the shopping center is a channel system that draws the cool air from the chimney into the floor so that the hot air may leave through the openings in the top of the floors. The chimney is also divided into two sections, a cool sector that the air

flows out of and a warm sector that the air flows in to. This division allows for more efficient management of heat through the separation of the air by temperature to prevent excess heat diffusion. The complexity of this design must be weighed in comparison to the reduction of the temperature that follows. The tradeoff between complexity and effectivity is crucial and a balance must be maintained when attempting to implement these more technical design elements.

While the design was effective from a cooling perspective, the heating capabilities of the design must also be eventually taken into account. Obviously, most buildings utilize air conditioning to both cool and heat the rooms, based on the season. This is not as much of an issue for the Eastgate Centre, as it is located in the tropical climate of Zimbabwe, where temperatures remain relatively hot year-round. But in order for the design to be considered effective in all parts of the world, heating techniques must be first explored and developed.

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# AP<sup>®</sup> RESEARCH 2017 SCORING COMMENTARY

## Academic Paper

**Sample: C**

- 1 Understand and Analyze Context Score: 6**
- 2 Understand and Analyze Argument Score: 6**
- 3 Evaluate Sources and Evidence Score: 6**
- 4 Research Design Score: 7**
- 5 Establish Argument Score: 7**
- 6 Select and Use Evidence Score: 6**
- 7 Engage Audience Score: 3**
- 8 Apply Conventions Score: 6**
- 9 Apply Conventions Score: 3**

### HIGH SAMPLE RESPONSE

The Modification of Buildings Based on the Mounds of Macrotermes for the Purposes of  
Thermoregulation and the Elimination of the Need for Modern Air Conditioning

#### **Content Area: Understand and Analyze Context — Row 1**

The response earned 6 points for this row because the paper has a clear focus (comparing a new model to that of the Eastgate center in Zimbabwe) and purpose (see page 3, paragraph 4: "The purpose of this research is to find a simpler means to transform buildings that already exist into something that functions in a way similar to the Eastgate Centre and be capable of thermoregulation at a small fraction of the energy that it used prior"). The paper uses sources to demonstrate the feasibility of using termite mounds as an inspiration for more energy-efficient building design, thus situating the student's inquiry within a broader context.

#### **Content Area: Understand and Analyze Argument — Row 2**

The response earned 6 points for this row because the paper puts various sources in conversation with each other (see pages 2 and 3: Pearce, Turner & Soar, and Smith sources). For example, on page 3, first column, the student notes that: "According to Turner and Soar, Pearce failed in his attempt to recreate the thermosiphon model..."; this demonstrates the lack of an effective model of architecture, which the student's inquiry then attempts to provide.

#### **Content Area: Evaluate Sources and Evidence — Row 3**

The response earned 6 points for this row because the paper clearly demonstrates a sophisticated awareness of the existing literature in the field, including an understanding of why this literature is necessarily limited at this time (see page 3, column 1, bottom: "Note. The extent of research conducted on termites of this genus and their mounds, while extremely thorough, is limited by a small number of researchers"). The sources cited within the literature review are highly credible and subject to the student's own evaluation.

# AP<sup>®</sup> RESEARCH 2017 SCORING COMMENTARY

## Academic Paper

### Content Area: Research Design — Row 4

The response earned 7 points for this row because the paper carefully elaborates its complex method in a manner which makes it clearly comprehensible and replicable. The student provides a rationale for developing a scale model and a control model, and suggests the model could be used to justify larger scale projects. See page 3, top of second column: "For the purposes of this research, it is necessary to construct a scaled down model... Although preferable, the utilization of a full sized building is completely impractical... So instead, a small scale model will suffice as a basis to conclude upon whether or not the design is deserving of further testing or if it requires modifications".

### Content Area: Establish Argument — Row 5

The response earned 7 points for this row because the paper includes a complex and reflective argument, using evidence effectively to modify steps in the method (thermometer calibration) and to reach a valid conclusion after an interpreted analysis (see page 8, column 1: "Based on the results of the ANOVA, it can be stated that the modified building's temperature was lower than the control building's temperature and this difference was statistically significant"). The paper also acknowledges limitations and implications on page 9, column 1: "By no means has the optimally simple yet effective solution been developed, but there are several ways to achieve results closer to such a goal. It would first be beneficial to make improvements to the testing method, to make the small-scale simulations more realistic".

### Content Area: Select and Use Evidence — Row 6

The response earned 6 points for this row because the paper not only uses relevant evidence to make its claims, but also evaluates its evidence during the research process in order to ensure its continued relevance and reliability (see page 5, both columns). The creation of the models demonstrates creativity without sacrificing academic rigor. This in turn exemplifies the recursive nature of research emphasized in the Capstone courses.

### Content Area: Engage Audience — Row 7

The response earned 3 points for this row because the paper includes and interprets several images and figures that help to clarify the student's models (see page 4); it also includes tables that are clearly interpreted to justify the student's final conclusion. See page 8, column 2 for Table 7: "The control model had a mean temperature difference of 5.075°C, while the modified had a mean temperature difference of 4.2583°C. The difference between these two means is much larger and more significant than that of the unadjusted data set, at 0.8167°C". In general, the extensive use of diagrams and tables greatly enhances the communication of the paper's claims and the delivery of its argument.

### Content Area: Apply Conventions — Row 8

The response earned 6 points for this row because the paper provides accurate, credible, and consistent citation throughout almost the entire paper. The missing bibliographic entry for Plaskolite, 2017, on page 3, column 2 is one minor error. The paper also deftly integrates the knowledge of others while distinguishing between the student's voice and those of sources.

Running Head: ANALYZING THE PREVALENCE OF THE MEDITERRANEAN DIET  
WITHIN CONNECTICUT FACILITIES THAT CARE FOR RESIDENTS WITH  
ALZHEIMER'S DISEASE

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Analyzing the Prevalence of the Mediterranean Diet Within Connecticut Facilities that Care for  
Residents with Alzheimer's Disease

May 26, 2020

Word Count: 5406

# ANALYZING THE PREVALENCE OF THE MEDITERRANEAN DIET WITHIN CONNECTICUT FACILITIES THAT CARE FOR RESIDENTS WITH ALZHEIMER'S DISEASE

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## ABSTRACT

The neurodegenerative Alzheimer's Disease is the most common form of dementia. Previous researchers have found a link between the Mediterranean Diet and curbed symptoms and effects of Alzheimer's Disease. This finding from the pre-existing research sparked the goal of this research study: to examine the extent to which Connecticut facilities that care for residents with Alzheimer's Disease are incorporating aspects of the Mediterranean Diet into meal plans.

To assess the prevalence of the Mediterranean Diet amongst 12 Connecticut facilities, 3 methodology tools were used: a pre-validated quantitative questionnaire, qualitative interviews, and both qualitative and quantitative content analyses were conducted on dining menus.

It was concluded that 100% of the participating facilities incorporate aspects of the MedDi into their meal plans. It was additionally concluded that the incorporation of the Mediterranean Diet is both intentional and unintentional and to varying extents.

# ANALYZING THE PREVALENCE OF THE MEDITERRANEAN DIET WITHIN CONNECTICUT FACILITIES THAT CARE FOR RESIDENTS WITH ALZHEIMER'S DISEASE

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## INTRODUCTION

The rate of Alzheimer's Disease (AD) is increasing annually and claims the unfortunate title of the most common form of dementia (Omar, 2019). In fact, AD accounts for 50%-80% of all dementia cases which affects 40-50 million people currently (Gupta, Lee, Choi, Lee, Kim, Kwon, 2019). "Alzheimer's disease is an irreversible, progressive brain disorder that slowly deteriorates memory, thinking skills and eventually the ability to carry out life's simplest tasks" (National Institute on Aging, 2017, p.1). AD does not lack research and attention; researchers and professionals strive each day to uncover ways to circumvent the neurodegenerative condition—an illness that involves deterioration in parts of the brain.

The pre-existing research regarding AD indicates that dietary choices can lessen symptoms or deter the risk of contracting the cognitive disease (Yusufov, Weyandt, Piryatinsky, 2017). The numerous diets and dietary patterns that researchers have examined include the Ketogenic Diet, Mediterranean Diet, MIND Diet, high iron-related patterns, and high oil related patterns (Rusek, Pluta, Ułamek-Kozioł, & Czuczwar, 2019; Omar, 2019; Shi, El-Obeid, Li, Xu, & Liu, 2019; Woodside, Gallagher, Neville & McKinley, 2014). After reviewing numerous studies pertaining to dietary choices that curb effects and symptoms of AD, it is clear that the Mediterranean Diet (MedDi) garners the most attention in this field and prevails overall in curbing further cognitive decline. The MedDi replicates the eating patterns of individuals from Greece and Italy in the early 1960s (Woodside, Gallagher, Neville, McKinley, 2014). The "building block" for the MedDi is olives, which can be in oil form. The olives provide prominent biophenols, a chemical that can help fight chronic illnesses, including AD (Omar, 2019). The



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general guidelines of the MedDi (Figure 1) include high intake of foods rich in fiber, protein, and

docosahexaenoic

acid (DHA). Foods

rich in DHA help

prevent or improve

several chronic

conditions,

including AD.

Some examples of

foods consumed

**Figure 1:** *Mediterranean Diet Guidelines/Food Pyramid* (Dodge, 2017)



while abiding to the diet include fish, nuts, legumes, and eggs (Shi, El-Obeid, Li, Xu, Liu, 2019).

According to the pre-existing research, the richness in natural foods plays a role in increasing

cognitive function—"any mental process that involves symbolic operations...perception,

memory, creation of imagery or thinking" (Segen's Medical Dictionary, 2011, p.1).

## Gap in the Research

The pre-existing research links the MedDi to positive outcomes concerning cognitive function (e.g., Hernandez-Galiot & Goni, 2017; Scarmeas, Stern, Tang, Mayeux, & Luchsinger, 2006). However, the pre-existing research does not indicate if facilities that care for residents with AD incorporate the MedDi into meal plans. The purpose of this study is to address this gap. This is salient to determine because the prevalence of AD is increasing and it is vital that AD facilities are cognizant of the MedDi due to the link between diet and cognitive function (Nicolson & Ngwenya, 2001). Therefore, this study can assist with facilities choosing to

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implement aspects of the MedDi to curb and deter AD symptoms (Omar, 2019). To analyze the prevalence of the MedDi at AD facilities, the guiding research question is: To what extent are aspects of the Mediterranean Diet being incorporated into the meal plans in Connecticut facilities that care for residents with Alzheimer's Disease?

## LITERATURE REVIEW

### Search Strategies

Sources were located via scrutinizing various databases with the limiter of peer-reviewed to ensure credibility. Keywords used while researching were: diet, Mediterranean Diet, cognitive function and Alzheimer's Disease.

### Increased Cognitive Function Via the Mediterranean Diet

Researchers, using diverse methods, similarly conclude: there is a correlation between the MedDi and the prevention of or the curbing of AD symptoms. This is attributed to the proportions of foods comprising the diet. For example, when following typical adherence to the diet, red meat is consumed only on a monthly basis and fruits and vegetables are heavily incorporated into the diet on a daily basis (Yusufov, Weyandt, Piryatinsky, 2017).

In a study conducted by researchers in Madrid, 79 subjects  $\geq 75$  years old were fed the MedDi and later assessed on their cognitive status and potential symptoms of depression. The subjects were surveyed and interviewed daily to test their adherence to the diet, their cognitive function, and potential signs of depression. The study concluded that adherence to the MedDi positively correlates to increased cognitive function, but the correlation to depression symptoms remains unclear. The researchers found that many elders lack essential nutrients such as fish and

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other fatty vitamins, which are abundant ingredients in the MedDi (Hernandez-Galiot & Goni, 2017).

Evidence of improved cognitive function regarding the MedDi was also assessed by means of surveying. In alignment with Hernandez-Galiot & Goni's (2017) method of utilizing surveys, researchers from Spain assessed the linkage of adherence to the MedDi to chronic mental illness. This cohort study had 11,015 subjects who each filled out a 136-item food frequency questionnaire, that established the participants' general adherence to the MedDi. After data collection for four years, the study "revealed a significant direct association between adherence to Mediterranean diet and all the physical and most mental health domains ...." (Henriquez Sanchez, Ruano, de Irala, Ruiz-Canela, Martinez-Gonzalez, Sanchez-Villegas, 2012, p.360).

Additionally, researchers from the Taub Institute in New York inspected the link between the MedDi and risks of AD. A total of 2,258 subjects were examined over 1.5 years. All subjects participated in an interview which assessed cognitive function. The cognitive assessments included "tests of memory (short- and long-term verbal and nonverbal), orientation, abstract reasoning (verbal and non-verbal); language (naming, verbal fluency, comprehension, and repetition), and construction (copying and matching)." The subject's food intake was recorded daily and assessed for MedDi adherence by interpreting their results on a zero to nine scale (higher score meaning higher adherence). The result of the study determined: "Higher adherence to the MeDi was associated with lower risk for AD" (Scarmeas, Stern, Tang, Mayeux, & Luchsinger, 2006, p.1). The pre-existing research highlights the alignment between AD and the

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MedDi; it is of importance to conduct research on this finding to determine if facilities caring for residents with AD are utilizing this diet.

### **Foods in the Mediterranean Diet Contributing to Increased Cognitive Function**

Researchers have discovered foods, nutrients, and vitamins that increase cognitive function, however, the minimum consumption of the diet to achieve curbed symptoms of AD remains unknown (Omar, 2019). According to Omar, olives and olive oil are considered the foundation of the MedDi. The olive, in any form, is a main source of monounsaturated fat. The general format of the diet is as follows: “high consumption of fruit, vegetables, legumes, and complex carbohydrates, with a moderate consumption of fish...and a low-to-moderate amount of red wine during meals” (Sofi et al., 2010, p.798). According to Sofi et al., when an individual has neurological damage, there is an increase in reactive oxygen species. This leads to an imbalance in the brain known as oxidative stress. This stress can diminish the brain's way of repairing damage. As the amount of reactive oxygen species increases, the amount of oxidative stress in the brain also increases. The oxidative stress that is produced can be affected by dietary choices. There are foods rich in antioxidants that can decrease oxidative stress; for example, vitamin C and vitamin E are rich in antioxidants. As expected, the MedDi is rich in foods with antioxidants, explaining why this diet is attributed to curtailing symptoms of AD. Additionally, nuts, seeds, and grains outlined in the diet pertain to foods categorized as rich in vitamin E. (Sofi et al., 2010). The MedDi is copious in natural foods that have not only been linked to increased cognitive function, but also increased quality of life. The wholesomeness of the foods prescribed in the diet make AD patients feel better internally (Henriquez Sanchez et al., 2012). The

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pre-existing research concludes that higher incorporation rates of specific foods contained in the MedDi are better for cognitive function, general health, and quality of life.

### **Measurement and Adherence Tactics for Diets**

The pre-existing research discovered effective approaches to enable greater adherence to diets. Researchers from Spain created an instrument to quantitatively measure adherence to the MedDi called the *14-Item Mediterranean Diet Assessment Tool*. It is a questionnaire that generates a *Mediterranean Diet Score* that classifies subjects as having high/low adherence to the MedDi (Martinez-Gonzalez et al., 2012). This instrument served as the quantitative tool for this study, further explanation is in the *Research Instruments* section (p.11). Concerning adherence tactics, it is known that individuals with AD can have trouble chewing, swallowing, or staying on task when it is mealtime. (Riley & Volicer, 1990). As a result, it is vital that meals are fed efficiently to AD residents to ensure that all proper nutrients are consumed. For example, researchers Riley and Volicer (1990) analyzed a high-calorie pudding supplement called “Frosty Cal.” They hypothesized that small quantities of high calorie supplements would be beneficial for those suffering from AD. It was concluded that the pudding supplement was beneficial because patients found Frosty Cal easier to consume than other supplements.

### **Summary**

Copious studies concluded that higher consumption of the MedDi translates to curbed symptoms and effects of AD (e.g., Scarmeas, Stern, Tang, Mayeux, & Luchsinger, 2006). The evidence of improved cognitive function was found via neuropsychological tests. Individuals

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were assessed; however, the studies did not address if the participants resided in specialized facilities or not.

To connect the prior research and to fill a gap, this study determined the extent to which Connecticut AD facilities are incorporating aspects of the MedDi into meal plans.

### RESEARCH DESIGN AND METHODOLOGY

#### Study Design

This study explores the prevalence of components of the MedDi within facilities that care for residents with AD. The goal is to increase awareness of the MedDi and thus spur further implementation of it into the design of meal plans. This is important because the decline in cognitive health can be offset by increased consumption of foods contained in the MedDi.

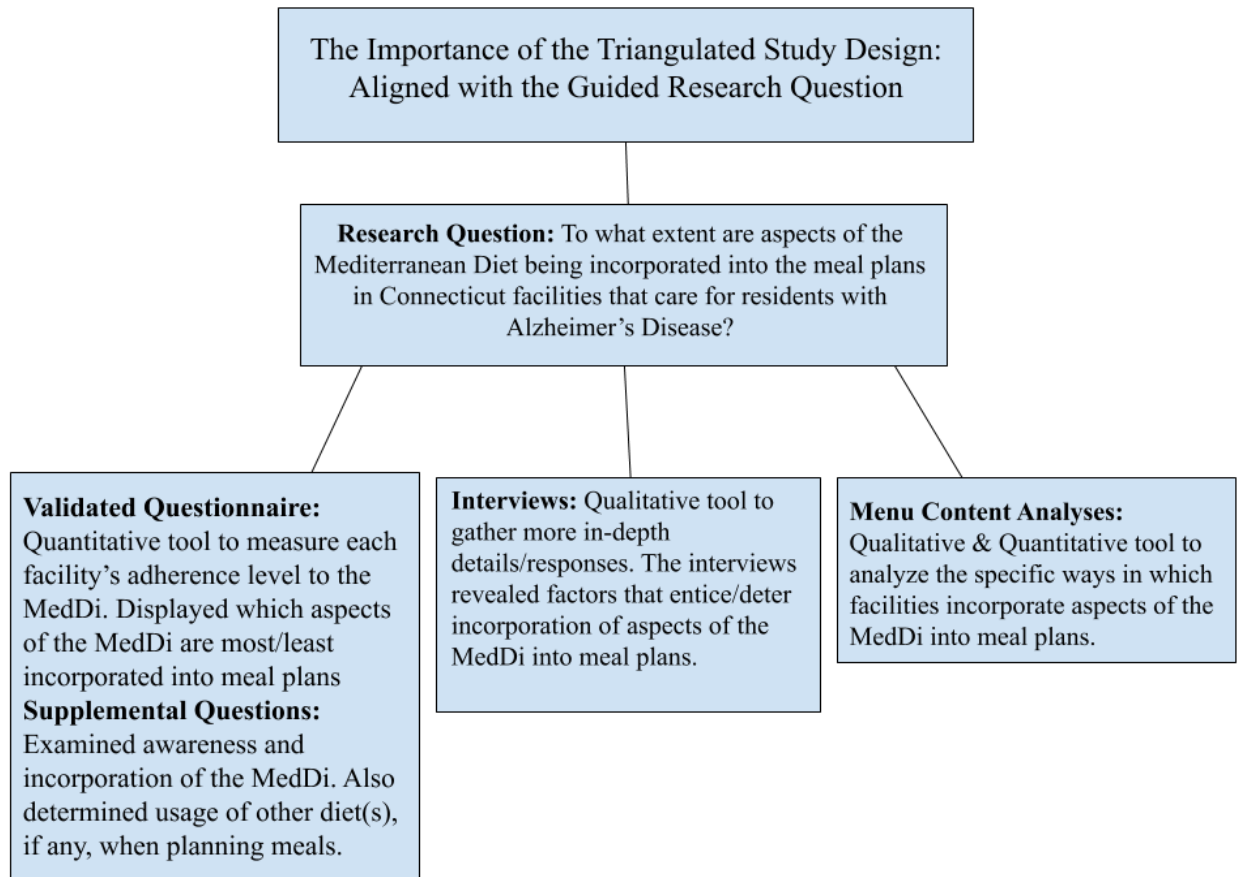
A three-part, mixed-methods study was conducted. This approach allowed for both a quantitative and qualitative analysis of compliance to the MedDi. This is important because the mixed-methods captured details that would not have been revealed had only one component of the method (e.g. the questionnaire) been utilized to gather data and formulate results (Leedy & Ormrod, 2010). The study was also triangulated. The three methods utilized to gather data were: a pre-validated quantitative questionnaire, qualitative interviews, and content analyses of the dining menus (Figure 2). As seen in the literature review, some past researchers have conducted interviews and others have created questionnaires concerning the MedDi, but not in a mixed-method approach as utilized in this study. Additionally, the pre-existing research shows no evidence of researchers performing menu content analyses. The mixed-methods design in this

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study is important as it combines methods from the literature review and adds a new qualitative measure.

**Figure 2:** *The 3-part Method Design in Alignment with the Research Question*



## Subjects

The subjects were the individuals that are responsible for designing the meal plans in facilities that care for residents with AD. These individuals consisted of nutritionists, chefs, dining directors, and dieticians. This demographic of participants was chosen because they are

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the decision-makers concerning the dining options and they are the most knowledgeable concerning the quantities of foods served. Also, they have the greatest insight pertaining to the reasons that entice/deter facilities from incorporating aspects of the MedDi into meal plans. Prospective subjects were gathered via compiling a list of all facilities in the state of Connecticut that have a residential memory care unit (n=54).

## Research Instruments

The questionnaire in this study was based on the “Validated 14-item Questionnaire of Mediterranean diet adherence” (V14Q) from Martinez-Gonzalez et al. (2012).

**Table 1:** *Original Questionnaire with Criteria to Score one Point on the Mediterranean Diet Score (Martinez-Gonzalez et al., 2012)*

Questions	Criteria for 1 point
1. Do you use olive oil as main culinary fat?	Yes
2. How much olive oil do you consume in a given day (including oil used for frying, salads, out-of-house meals, etc.)?	$\geq 4$ tbsp
3. How many vegetable servings do you consume per day? (1 serving : 200 g [consider side dishes as half a serving])	$\geq 2$ ( $\geq 1$ portion raw or as a salad)
4. How many fruit units (including natural fruit juices) do you consume per day?	$\geq 3$
5. How many servings of red meat, hamburger, or meat products (ham, sausage, etc.) do you consume per day? (1 serving: 100–150 g)	$< 1$
6. How many servings of butter, margarine, or cream do you consume per day? (1 serving: 12 g)	$< 1$
7. How many sweet or carbonated beverages do you drink per day?	$< 1$
8. How much wine do you drink per week?	$\geq 7$ glasses
9. How many servings of legumes do you consume per week? (1 serving : 150 g)	$\geq 3$
10. How many servings of fish or shellfish do you consume per week? (1 serving 100–150 g of fish or 4–5 units or 200 g of shellfish)	$\geq 3$
11. How many times per week do you consume commercial sweets or pastries (not homemade), such as cakes, cookies, biscuits, or custard?	$< 3$
12. How many servings of nuts (including peanuts) do you consume per week? (1 serving 30 g)	$\geq 3$
13. Do you preferentially consume chicken, turkey, or rabbit meat instead of veal, pork, hamburger, or sausage?	Yes
14. How many times per week do you consume vegetables, pasta, rice, or other dishes seasoned with sofrito (sauce made with tomato and onion, leek, or garlic and simmered with olive oil)?	$\geq 2$



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Approval to use the instrument was granted by Martinez-Gonzalez et al. and Schroder et al. (Appendix A). The V14Q concerns an individual's diet and answers are assigned points. Table 1 depicts the V14Q questionnaire; on the left side are the questions and on the right is the criteria to score one point. The sum of the points determines the participant's Mediterranean Diet Score. The scoring framework from the V14Q was mirrored in this study. If the response aligned with the coded answer (generated by Martinez-Gonzalez et al., 2012), one point was awarded. According to the V14Q, an overall score  $\leq 7$  is considered "low adherence" to the MedDi and an overall score  $\geq 8$  is considered "high adherence" to the MedDi. The questionnaire served as the quantitative measure for assessing overall adherence at the various facilities. The original questionnaire was designed for and effective at examining individuals with obesity risks and had not been used in the context of AD facilities. The purpose of the V14Q instrument was to measure adherence to the MedDi, thus it was useful in this study to measure adherence levels of the MedDi within facilities. Minor modifications to the questionnaire wording were made to accommodate the new context of this study (e.g. words such as "consume" were changed to "provide").

In this study, supplemental questions were added to the questionnaire. They were reviewed and approved by the Institutional Review Board (IRB). Table 2 depicts the supplemental questions. The questionnaire used in the study is located in Appendix B.

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**Table 2:** Supplemental Questions Added to the Validated Questionnaire

Q 1	Q 2	Q 3	Q 4
Prior to this questionnaire, were you aware of any link(s) between cognitive function and the Mediterranean Diet?	Do you intentionally provide/design meals that adhere to the Mediterranean Diet?	Do you provide/design meals that adhere to either the Ketogenic Diet or the MIND Diet?	Do the meals you provide/design adhere to any particular diet? If so, please specify which diet(s). If not, please respond with "N/A."

*Note.* There were two additional questions: one requesting interviews and the other requesting menus for content analyses (all questions were approved by the IRB).

## Procedures

After the compilation of potential subjects, each facility received a recruitment phone call. Subjects that did not answer the phone were left voice messages and contacted a second time. Upon agreement to participate in the study, the subjects were emailed a link to the questionnaire.

Twelve facilities completed the questionnaire, eleven facilities completed the supplemental questions, six out of the twelve provided menus, and four subjects interviewed. The consent form (Appendix C) outlined that facilities can choose which component(s) of the method to complete. To ensure confidentiality, the consent form informed participants that neither names of people nor facilities would not be disclosed. To keep names classified, each subject/location received a study code number (ex. Facility A). Throughout this study, the words “subjects” and “facilities” are used interchangeably. The study design and procedures were approved by the IRB to eliminate ethical issues.

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## Delimitations

Delimitations were established ahead of time to narrow the subject pool. First, individuals that design meal plans for individuals with AD in residential homes were excluded; only AD facilities with residents were subjects for the study. Second, only facilities located in the state of Connecticut were contacted as participants.

## RESULTS

### Quantitative Results

The questionnaire (Appendix B) was completed by twelve facilities. Table 3 depicts the frequency and percentage of criteria met/not met in total for all participating facilities per question. Provided with each question is the criteria needed to score one Mediterranean Diet Score (MDS) point according to the V14Q. For example, to score a point for question 4, a response must have been that the facility provides  $\geq 3$  units of fruit per day.

As seen in Table 3, the total number of responses that met the criteria (90) was greater than the total number of responses that did not meet the criteria (73). Therefore, this table presents an overall finding that the majority of responses to each question met the criteria to earn one MDS point. The top 3 food categorizations that met the criteria were fruits (91.7%; Q4), vegetables (75%; Q3), and legumes (75%; Q9). The top 3 food categorizations that did not meet the criteria were red meat (83.3%; Q5), commercial sweets (75%; Q11) and sweet/carbonated beverages (66.7%; Q7). It is important to note that some facilities omitted responses to questions. In order to keep the scores aligned with the 14-point MDS, scores for these facilities were proportionally calculated (Appendix D).

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**Table 3: Frequency and Percentage of Criteria Met/Not Met Per Question (n=12)**

Question with Predetermined Criteria to Score one Point on the Mediterranean Diet Score by Martinez-Gonzalez et al.	Met Criteria Frequency (%)	Did Not Meet Criteria Frequency (%)
1. Do you provide meals utilizing olive oil as main culinary fat? Criteria= Yes	8 (66.7)	4 (33.3)
2. How much olive oil do you provide in a given day (including oil used for frying, salad, out-of-house meals, etc.)? Criteria= $\geq 4$ tablespoons	8 (66.7)	4 (33.3)
3. How many vegetable servings do you provide per day? (1 serving: 200 g [consider side dishes as half a serving]) Criteria= $\geq 2$ ( $\geq 1$ portion raw or as a salad)	9 (75)	3 (25)
4. How many fruit units (including natural fruit juices) do you provide per day? Criteria= $\geq 3$	11(91.7)	1 (8.3)
5. How many servings of red meat, hamburgers, or meat products (ham, sausage, etc.) do you provide per day? (1 serving: 100-150 g) Criteria= $< 1$	2 (16.7)	10 (83.3)
6. How many servings of butter, margarine, or cream do you provide per day? Criteria= $< 1$	5 (41.7)	7 (58.3)
7. How many sweet or carbonated beverages do you provide per day? Criteria= $< 1$	4 (33.3)	8 (66.7)
8. How many glasses of wine do you provide per week? ** Criteria= $\geq 7$ glasses	6 (60)	4 (40)
9. How many servings of legumes do you provide per week? (1 serving: 150 g) Criteria= $\geq 3$	9 (75)	3 (25)
10. How many servings of fish or shellfish do you provide per week? (Serving: 100-150 g of fish or 4-5 units or 200 g of shellfish) Criteria= $\geq 3$	8 (66.7)	4 (33.3)
11. How many times per week do you provide commercial sweets or pastries (not homemade), such as cakes, cookies, biscuits, or custard? Criteria= $< 3$	3 (25)	9 (75)
12. How many servings of nuts (including peanuts) do you provide per week? (1 serving: 30 g) ** Criteria= $\geq 3$	4 (40)	6 (60)
13. Do you preferentially provide chicken, turkey, or rabbit meat instead of veal, pork, hamburger, or sausage? Criteria= Yes	6 (50)	6 (50)
14. How many times per week do you provide vegetables, pasta, rice, or other dishes seasoned with sofrito (sauce made with tomato and onion, leek, or garlic and simmered with olive oil)? * Criteria= $\geq 2$	7 (63.3)	4 (36.7)

*Note.* Total Frequency of Responses that Met the Criteria= 90, Total Frequency of Responses that Did not Meet Criteria= 73

\*One facility omitted a response to this question

\*\* Two facilities omitted responses to this question

See Appendix D for Proportional Explanations for Omitted Questions

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Table 4 illustrates the frequency and percentage of criteria met/not met in total, per facility. Facilities A, E, F, I, J, & M (50%) had a sum score  $\geq 8$  and, therefore, demonstrate “high adherence.” In other words, these facilities are most aligned with the guidelines of the MedDi. Contrastingly, facilities B, C, D, G, H, & K (50%) had a sum score  $\leq 7$  and, therefore, demonstrate “low adherence.” In other words, these facilities are least aligned with the guidelines of the MedDi. The highest MDS was 10 out of 14 (Facility A); the lowest MDS was 6 out of 14 (Facilities D & G). None of the facilities had a perfect MDS (14), but 100% incorporated MedDi food options as evidenced by each facility having a MDS  $\geq 6$ .

**Table 4:** *Frequency and Percentage of Criteria Met/Not Met in Total, Grouped by Facility (n=12)*

Facility	Frequency Met of Total Criteria (%)	Frequency Not Met of Total Criteria (%)
A	10 (71.4)	4 (28.6)
B	7 (50)	7 (50)
C	7 (50)	7 (50)
D	6 (42.9)	8 (57.1)
E	8 (57.1)	6 (42.9)
F^^	9 (64.3)	5 (35.7)
G	6 (42.9)	8 (57.1)
H	7 (50)	7 (50)
I	8 (57.1)	6 (42.9)
J	9 (64.3)	5 (35.7)
K	7 (50)	7 (50)
M^^^	8 (57.1)	6 (42.9)

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*Note.* ^^This facility omitted two questions

^^^This facility omitted three questions

See Appendix D for Proportional Explanations for Omitted Questions

Table 5 summarizes the results of Table 4. This table depicts the frequency and percentage of high and low adherence amongst all the facilities. According to the scoring framework, exactly half of the facilities demonstrated “high adherence” and exactly half of the facilities demonstrated “low adherence.”

**Table 5:** *Frequency and Percentage of High and Low Adherence in Totality for All Facilities (n=12)*

Adherence Level	Frequency (%)
High Adherence	6 (50)
Low Adherence	6 (50)

*Note.* A frequency of total met criteria  $\leq 7$  yields “low adherence”, a frequency of total met criteria  $\geq 8$  yields “high adherence.”

The supplemental questions consisted of three multiple-choice questions and one open-ended question (see Appendix E for the justifications to the supplemental questions). The responses portray that seven out of the eleven facilities were “...aware of any link(s) between cognitive function and the Mediterranean Diet.” In response to the second supplemental question, four facilities selected, “Yes, I intentionally provide/design meals that adhere to the Mediterranean Diet.” When asked if they plan meals in accordance to the MIND or Ketogenic Diet, Facility A was the only facility to select “Yes...”. Concerning the open-ended question, facilities were asked if they design meals in accordance to any diet in particular and if so, to

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specify the diet. Only one, Facility F, stated that they use “specifically Mediterranean.”

Appendix F charts all responses to the supplemental questions.

## Qualitative Results

### Interviews

The interviews (see Appendix G for questions) were conducted both in person and over the phone. The interviews were transcribed (Appendix H) and then coded in an open-coding format for each emerging theme. Qualitative coding of interview transcripts was conducted using Miles and Huberman's (1994) iterative coding process. After two iterations of open-coding, 14 final themes emerged (Appendix I) with the following four most prevalent: 1) incorporated aspects of the MedDi; 2) willingness to incorporate aspects of the MedDi into meal plans and change menus; 3) reservations regarding incorporating the MedDi and 4) budget factors.

### Incorporated Aspects of the Mediterranean Diet

When asked to list the main ingredients incorporated into meal plans, every facility highlighted foods outlined in the MedDi. Facility L stated, “I use olive oil even though it costs more money. We do fish, a lot of fish.” Facility D said, “I’d say that 90% of our vegetables are fresh. Our potatoes are all fresh, nothing comes in a box.” According to Facility K, “...for vegetables there’s a wide variety, but we do a lot of broccoli and carrots...we have and we use olive oil, extra virgin olive oil to roast our vegetables.” Facility B stated that they “...make a lot of chicken and a lot of fish...try to incorporate a lot of fresh fruits and vegetables.”

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### **Willingness to Incorporate Aspects of the Mediterranean Diet into Meal Plans and Change Menus**

All four facilities expressed their willingness to incorporate aspects of the MedDi in their meal plans. According to Facility K, "...we both were aware that it [the MedDi] helps and that is why we are working to incorporate it into our menus." As Scarneas, Stern, Tang, Mayeux, & Luchsinger (2006) concluded, subjects in this study also recognized that the MedDi is beneficial for individuals with AD. In their interview Facility K stated, "we're trying to promote if you eat this diet you will have fewer symptoms, your blood sugars will look better, there's less sodium so their blood pressure is going to look better, less pills...It's not just gonna extend your life, but you will feel better on a day to day." Additionally, when asked if their facility adheres to any particular diet, as noted prior, Facility F responded with "Specifically Mediterranean" (Appendix F). Half of the facilities (B and D) expressed that they use the MedDi. For example, Facility B stated, "To be honest, our menus do [incorporate the MedDi]." Facility D stated, "We do use that diet [the MedDi] in our building now."

### **Reservations Regarding Implementing Aspects of the Mediterranean Diet**

An obstacle subjects face regarding the incorporation of certain aspects of the MedDi is the texture of the foods. As noted by Riley & Volicer (1990) and all four facilities interviewed in this study, individuals with AD have trouble chewing, swallowing, and consuming food. During interviews, Facilities K & L discussed adjusting meal plans to compensate for the food consumption limitations of the AD residents. For example, Facility L stated that they have beverage only diets because "these guys have teeth issues, that's why a lot of them end up with



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soft diets and even puree. It's not usually the teeth it's the swallowing mechanisms that's more of the problem." Riley & Volicer also found that nutritional supplements can aid those with AD by ensuring all nutrients are consumed. Similarly, Facility K stated, "Some people cannot tolerate any food at all and I just have to give them like an Ensure or a Boost supplement that gets all their calories and proteins in."

An additional deterrent is food waste factors. Facility B stated, "We don't use things timely and as efficiently as we could...with fresh products there is always the waste factor." Another finding was that not all residents like Mediterranean food. Subjects attributed this to the way residents were raised and to the evolving sense of taste as one ages. For example, although sweets and baked goods are not highly recommended for the MedDi, Facility L mentioned, "...the sweet taste bud is the last to go. So, these guys that live here, if they could live off of sweets for the rest of their lives that's what they'd do... so we balance that." Facility B stated, "Some people...in their eighties or nineties are set in their ways of what they were raised on. I think they are not necessarily going to change, but then we also do have a small percentage that do want to learn while they're here." Also, Facility K noted that the MedDi cannot be sprung upon AD residents, "...we can't do a complete overhaul, we have to take baby steps into this. If we just did a whole Mediterranean Diet menu, the first thing that they would say is 'where is my meatloaf, where are my buttery mashed potatoes?' So we have to do trial and error." See Appendix J for additional quotes regarding each final theme.

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### **Budget Factors**

Another prominent theme that emerged was budget factors. While some facilities (K&L) budget for the cost to continuously purchase fresh foods such as ones in the MedDi, others expressed economic concerns. For example, Facility D stated, “We also have to write these menus in coordination with our budget...we write a budget for the year and we pertain to that budget monthly” (Appendices H & J). Additionally, Facility B stated, “cost of course is always a concern.” Therefore, a limitation to the MedDi is the cost of ingredients. According to researchers in Washington, “The Mediterranean diet has come to be viewed, at times, as a high-cost option for the elite, especially when transplanted from its rustic roots to an urban North American setting” (Drewnowski & Eichelsdoerfer, 2010, p.1). Consequently, a potential barrier to incorporating the MedDi are financial circumstances.

### **Content Analyses**

Content analyses were made upon the dining menus to discover how MedDi foods are incorporated into meals. This analysis was both a quantitative and qualitative measure and it triangulated the study. Two coding iterations were completed via Strauss' (2010) deductive coding process. Appendix K depicts Iteration One: deductive coding of the food categories on the V14Q, which are organized by those that align (Theme 1) with the MedDi and those that do not (Theme 2). For example, vegetables fall in Theme 1 and commercial sweets fall in Theme 2.

Iteration Two analyzed each facility's menu in accordance with the foods that fall into each theme from Iteration One. First, food categories were separated via Iteration One. Then, each food category was analyzed on facilities' menus. This iteration uncovered how the menu

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offerings do and do not incorporate aspects of the MedDi (Appendix L). For example, Facility B incorporated vegetables into the menu by providing potato soup and Facility J incorporated fish into the menu by providing baked tilapia, tuna salad and tuna melts. Based on the specific foods found, the frequencies of each food category were tabulated (Table 6).

As seen in Table 6, each menu incorporated  $\geq 1$  unit of vegetables. This was the only food category incorporated by all facilities. Facility M did not incorporate fruit and all others did. Half of the facilities incorporated fish into the menu. Not one facility listed wine as an option on their menu. This is a limitation to the menus because according to the survey responses from the facilities that provided menus, four out of the six (66.7%) indicated that they provide  $\geq 7$  glasses of wine per day. A similar situation occurred with the nuts and peanut category. Two out of the six facilities (33%) met the criteria for this category on the questionnaire, but zero units of nuts or peanuts were found on any of the menus. Facility B offered the most aspects of the MedDi on their menu (12 items). Facility M offered the least aspects of the MedDi on their menu (4 items). Please note that signs of butter/margarine, sofrito, and olive oil were not present on any menu. This serves as a limitation because these foods are not typically listed on a menu, but they are on the V14Q. Appendix M displays the final coding framework for the themes (Iteration Two).

**Table 6:** *Frequency of Each Food Category on the Dining Menus, by Facility: Foods that Align with the Mediterranean Diet*

Food Category	Facility B	Facility C	Facility I	Facility J	Facility K	Facility M
Olive Oil	0	0	0	0	0	0
Vegetables	7	6	2	6	6	1

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Fruits	3	1	2	1	1	0
Wine	0	0	0	0	0	0
Protein/Meat	0	1	0	0	1	0
Pasta	1	0	1	0	0	0
Rice	0	0	0	1	0	0
Nuts & Peanuts	0	0	0	0	0	0
Sofrito	0	0	0	0	0	0
Fish	1	0	0	3	0	1
Shellfish	0	0	0	0	0	1
Legumes	0	0	0	0	1	1

## DISCUSSION

The study was designed to examine the extent to which Connecticut facilities attending to residents with Alzheimer’s Disease are incorporating aspects of the MedDi into their meals.

### Findings

After examining the results obtained by the three methods, it can be concluded that 100% of the participating facilities incorporate aspects of the MedDi into their meal plans. This is proven by all facilities having a MDS  $\geq 6$  (Table 4). The incorporation is both intentional and unintentional (Table 2, Q2; Appendix F) and to varying extents—as displayed by the MDS scores ranging from 6-10 (Table 4).

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As depicted in Table 5, the percentage of facilities demonstrating high/low adherence was 50%/50%. Although, when triangulating the data, it became apparent that responses concerning the incorporation of MedDi foods fluctuated depending upon the tool used (questionnaire, supplemental questions, interviews and content analyses). This finding displays the importance of triangulation as evidenced by the following analysis: Facility D (along with Facility G) had the lowest MDS score of 6 (Table 4). On the questionnaire Facility D indicated, “No, I do not intentionally provide/design meals that adhere to the Mediterranean Diet.” This response correlates to their comparatively low MDS. Contrastingly, the same subject stated in their interview, “we do use that diet [the MedDi] in our facility now...we do utilize this diet so there are no deterrents.” These findings emphasize that had this study only scrutinized data via one method (e.g. the questionnaire), prevalence would have been under/over reported. This was also reinforced when the responses to the supplemental questions were compared to the questionnaire. For example, only three out of the eleven facilities (27.3%) selected, “Yes, I intentionally provide/design meals that adhere to the Mediterranean Diet” (Table 2, Q2; Appendix F). However, this number alone is misleading as the questionnaire found that six facilities (50%) scored  $\geq 8$  on the MDS and, therefore, demonstrate “high adherence.” This indicates that facilities unwittingly incorporate more aspects of the MedDi than they think.

Analysis of the menus found that each facility incorporated menu items that align with the MedDi into their meal plans (Table 6). Although non-MedDi food options were available, residents could still choose foods that would allow them to adhere to the MedDi. See Appendix N for an annotated menu.

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Another finding is that subjects are incorporating the diet, but are incognizant of the pre-existing research emphasizing the link between cognitive function and the MedDi.

According to the supplemental question responses (Appendix F), 4 out of the 11 subjects were unaware of the aforementioned link, yet two demonstrated “high adherence” according to their MDS (Facilities A & J). It is important to mention that the other two facilities also incorporate aspects of the MedDi (MDS=6 & 7). It is beneficial that subjects are incorporating the MedDi into meal plans. However, it is paramount that subjects are also cognizant of this link because ongoing implementation can improve the quality of life of residents by halting and preventing cognitive decline.

### **Fulfillment of Gaps in the Research**

This study addresses several gaps in the pre-existing research. First, the targeted subjects: nutritionists, chefs, dining directors, and dieticians were not the subjects in any of the aforementioned studies. In the pre-existing studies, the cognitive function of people was studied in accordance with dietary choices. The subjects were those actually consuming the diet, not those planning the diets. Second, the setting of this study: prior studies did not mention if the subjects were gathered from specialized facilities. In this study, subjects were only gathered from specialized AD facilities with a memory care unit. Contrastingly, the studies mentioned in the literature review do not specify if the subjects are from facilities or individuals living at home. Third, and the most prominent gap filled was the extent to which specialized AD facilities are incorporating the MedDi into their meal plans. The pre-existing literature reiterated the link

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between the MedDi and curbed symptoms and effects of AD (Scarmeas, Stern, Tang, Mayeux, & Luchsinger, 2006), but not one study mentioned how prevalent the MedDi is within specialized AD facilities. This gap served as the foundation for this study.

### **Implications**

The results of this study can spur facilities to intentionally incorporate as many aspects as possible of the MedDi into the meal plans for residents with AD. Those that were not previously aware of the correlation between the diet and cognitive function can now introduce the foods into dining plans with a meaningful purpose. As Facility L stated, “I think this topic is certainly something to be considered. I’ll even pass it on up to my people and say we are due for a new menu, why don’t we lean more in that direction. It can’t hurt.” In addition, the results of this study can inform the designers of meal plans—in and out of AD facilities—to allocate budgets to fund purchases of MedDi foods. The pre-existing research signifies that the prevalence of AD is increasing (Omar, 2019). Therefore, this study can inform the designers of meal plans at AD facilities—and on a broader scope all people taking care of an individual with AD—to be cognizant of the MedDi to help curb and deter AD symptoms (Hernandez-Galiot & Goni, 2017).

### **Limitations**

As noted, some facilities omitted questions from the questionnaire (both V14Q and supplemental questions). While scores for these facilities were calculated proportionally, more data could have been analyzed had all subjects answered all questions. Another limitation to this study was the failure to acquire Facility L’s questionnaire. Technical difficulties prevented Facility L from filling out the questionnaire. Two attempts via email were made to have them fill

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it out, but no response was returned. Had Facility L responded to the questionnaire the 50%/50% tie between the facilities for high/low adherence to the MedDi would have been broken. Also, limitations with the menus emerged as some facilities only provided dinner menus and others provided menus for all three meals. For example, Facility B showed the most signs of the MedDi, but they are also one of the two facilities that provided menus for all three meals (the other was Facility K). Also, because the menus only account for one day they do not capture the fact that facilities may incorporate more or less aspects of the MedDi on other days.

### **Areas for Future Research**

This study's delimitations are catalysts to new areas of research. The subject pool can be expanded to include those responsible for the meals of individuals with AD that reside at home. Future research can also expand beyond Connecticut to include other geographic regions in the United States and globally. Alternate diets that assist with cognitive functions can also be researched. As noted, the Ketogenic Diet and MIND Diet have also been attributed to increased cognitive function (Rusek, Pluta, Ułamek-Kozioł, & Czuczwar, 2019; Omar, 2019). One could look into the prevalence of the aforementioned diets amongst facilities in Connecticut and elsewhere.



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## APPENDICES

### **Appendix A:** *Permission for Questionnaire Instrument Utilization from Miguel Angel Martinez-Gonzalez*

*Note.* Crossed out is my name and my email. This was done to maintain anonymity. Also crossed out is Dr. Martinez-Gonzalez's email for his own privacy.

#### **Utilization Request: "Validated 14-item Questionnaire of Mediterranean diet adherence"**

Miguel Ángel Martínez González [REDACTED]  
To: [REDACTED]

Mon, Nov 25, 2019 at 1:58 AM

**Dear [REDACTED]**

**You have our permission to use this tool. However, you need to send me (an email is enough) your commitment to quote always the following three sources:**

-www.predimed.es

-Martínez-González et al. Cohort profile: design and methods of the PREDIMED study. Int J Epidemiol. 2012 Apr;41(2):377-85

-Schröder H, et al. A short screener is valid for assessing Mediterranean diet adherence among older Spanish men and women. J Nutr. 2011 Jun;141(6):1140-5.

**Thank you for you interest in our work.**

**Sincerely,**

**miguel**

Miguel A. Martinez-Gonzalez. MD, PhD, Univ. Navarra (Prof. & Chair, Prev. Med. & Public Health)  
Harvard TH Chan School Public Health, Dpt. Nutrition (Adjunct Prof.), CIBEROBN (Group Coordinator),

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## **Appendix B:** *Questionnaire Sent to Participating Facilities*

### Questionnaire: Dietary Choices within Facilities that Care for Residents with Alzheimer's Disease

This questionnaire is based on a study conducted by Martinez-Gonzalez et. al (2012).

Note: These questions pertain to what is provided/available to an individual resident at your facility. Thank you for completing the questionnaire. Your participation is greatly appreciated!

You are being asked to participate in a research study that is focused on dietary options within facilities that care for patients with Alzheimer's Disease. Please note that you have the ability to opt out of any question(s) with no penalty. The compiled results will not contain information that enables participant recognition. If you have any questions about this study, feel free to contact:

Researcher: \_\_\_\_\_

Email: \_\_\_\_\_

Teacher: \_\_\_\_\_

Email: \_\_\_\_\_

By clicking "accept," I agree to participate in the study.

Accept

1. Do you provide meals utilizing olive oil as main culinary fat?

Yes

No

2. How much olive oil do you provide in a given day (including oil used for frying, salads, out-of-house meals, etc.)?

> 4 Tablespoons

< 4 Tablespoons

4 Tablespoons

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3. How many vegetable servings do you provide per day? (1 serving: 200 g [consider side dishes as half a serving])

> 2 (>1 portion raw or as a salad)

< 2 (< 1 portion raw or as a salad)

2 (1 portion raw or as a salad)

4. How many fruit units (including natural fruit juices) do you provide per day?

> 3

< 3

3

5. How many servings of red meat, hamburgers, or meat products (ham, sausage, etc.) do you provide per day? (1 serving: 100-150 g)

> 1

< 1

1

6. How many servings of butter, margarine, or cream do you provide per day?

> 1



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&lt; 1

1

7. How many sweet or carbonated beverages do you provide per day?

&gt; 1

&lt; 1

1

8. How many glasses of wine do you provide per week?

&gt; 7

&lt; 7

7

9. How many servings of legumes do you provide per week? (1 serving: 150 g)

&gt; 3

&lt; 3

3

10. How many servings of fish or shellfish do you provide per week? (serving: 100-150 g of fish or 4-5 units or 200 g of shellfish)

&gt; 3

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&lt; 3

3

11. How many times per week do you provide commercial sweets or pastries (not homemade), such as cakes, cookies, biscuits, or custard?

&gt; 3

&lt; 3

3

12. How many servings of nuts (including peanuts) do you provide per week? (1 serving: 30 g)

&gt; 3

&lt; 3

3

13. Do you preferentially provide chicken, turkey, or rabbit meat instead of veal, pork, hamburger, or sausage?

Yes

No

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14. How many times per week do you provide vegetables, pasta, rice, or other dishes seasoned with sofrito (sauce made with tomato and onion, leek, or garlic and simmered with olive oil)?

> 2

< 2

2

15. Prior to this questionnaire, were you aware of any link(s) between cognitive function and the Mediterranean Diet?

Yes, prior to this questionnaire I was aware of any link(s) between cognitive function and the Mediterranean Diet.

No, prior to this questionnaire I was not aware of any link(s) between cognitive function and the Mediterranean Diet.

16. Do you intentionally provide/design meals that adhere to the Mediterranean Diet?

Yes, I intentionally provide/design meals that adhere to the Mediterranean Diet.

No, I do not intentionally provide/design meals that adhere to the Mediterranean Diet.

17. Do you provide/design meals that adhere to either the Ketogenic Diet or the MIND Diet?

Yes, I do provide meals that adhere to either the Ketogenic Diet or the MIND Diet.

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No, I do not provide meals that adhere to either the Ketogenic Diet or the MIND Diet.

18. Do the meals you provide/design adhere to any particular diet? If so, please specify which diet(s). If not, please respond with "N/A."

19. If you are willing, please provide me with dining menus that display the foods provided to residents with Alzheimer's Disease (which may be the same menu for the general population that you serve). Please Email the menus using the Email: \_\_\_\_\_

I will be providing menus.

20. Would you like to participate in a brief interview (10 minutes or less) over the phone? Please provide your name, phone number and/or Email to schedule a time.

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## Appendix C: Consent Form

**Project Title:** Analyzing the Prevalence of the Mediterranean Diet Within Connecticut Facilities that Care for Residents with Alzheimer's Disease

### Introduction/Purpose:

You are being asked to participate in a research study that is focused on the extent to which the Mediterranean Diet is utilized in meals for those with Alzheimer's Disease. The purpose of the research is to determine if facilities are utilizing this diet and if so, to what extent.

### Procedures:

As a participant of this study, you will be asked to fill out a questionnaire which assesses adherence to the Mediterranean Diet. At the end of the questionnaire I will ask if you would be willing to participate in an interview for a more in-depth conversation. Please note that interviews will be audio recorded. The audio recordings are for the sole purpose of transcribing the interviews. Your participation in the survey/questionnaire will require approximately 10 minutes. The interview portion will require an estimated 20 minutes. Additionally, I will request copies of your dining menus (if there is not a separate menu for Alzheimer's Disease residents that is still acceptable). Participation in the study is fully optional. If you feel uncomfortable answering any of the questions asked, you can opt out of any question(s). There will be no penalty for unanswered questions. Furthermore, if you wish to drop out of the study at any time you have the ability to do so. If you withdraw from the study after you have completed the questionnaire, I will remove you from the prospective interviewee pool (if you had indicated you would be willing to participate in an interview). When you indicate your withdrawal from the study, I will ask if the material already collected (the questionnaire data and menus) can still be used in my project.

### Risks:

Your participation in this study involves no physical risks. As noted before, you have the ability to opt out of any particular question with no penalty. You are permitted to remain in the study if you leave question(s) unanswered. You also have the ability to withdraw from the study at any time.

### Benefits:

A potential benefit to the study is increased awareness of the link between the Mediterranean Diet and cognitive function. This study may serve as a catalyst to curb further cognitive deterioration by increasing the incorporation of Mediterranean Diet foods into the meal plans for residents with Alzheimer's Disease. This study may not benefit you directly, but will

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improve the general understanding concerning the rate and extent to which Alzheimer's Disease facilities are utilizing the Mediterranean Diet.

## **Alternatives:**

You have the alternative to choose not to participate in this research study.

## **Confidentiality:**

Participation in this study will not result in a loss of privacy. Unless required by law, only I and my expert advisor will have access to your information. This study is for my AP score in the class AP Research. Therefore, the final paper which explains my study will be submitted to the College Board to be graded. To protect your identity and the identity of the facility you are affiliated with, I will assign to your facility a study code number. This means your name and your facility's name will not be released.

## **Data Collection:**

The data will be stored on my password-protected laptop. The stored results will not contain information that enables participant recognition.

## **Subject's Rights:**

Participation in this study is voluntary, you have the ability to withdraw from the study at any time. You have the authority to leave any question(s) unanswered without penalty. If you leave question(s) unanswered, you may remain in the study if desired.

## **Consent:**

I agree to participate in the research study outlined above.

Name (printed), signature, date signed, E-mail address

Name (printed) of person obtaining consent, date signed

If you have any questions, please contact me or my Research Advisor.

My email: \_\_\_\_\_

Research Advisor email: \_\_\_\_\_

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## Appendix D: Supporting Work for Proportional Scoring

Table A: Percentage for Each Question

Question:	1	2	3	4	5	6	7	8**	9	10	11	12**	13	14*
% Met Criteria $\frac{x}{12} (100)$	66.6	66.6	75	91.6	16.6	41.6	33.3	60	75	66.6	25	40	50	63.6
% Did not Meet Criteria $\frac{x}{1} (100)$	33.3	33.3	25	8.33	83.3	58.3	66.6	40	25	33.3	75	60	50	36.4

\*This question was omitted once amongst all the facilities, percentage was proportionally calculated (ex.  $\frac{7}{11} = \frac{x}{12} \rightarrow 11x=84 \rightarrow x=7.6$ , formula =  $\frac{7.6}{12} (100)$ )

\*\* This question was omitted twice amongst all the facilities, percentage was proportionally calculated (ex.  $\frac{6}{10} = \frac{x}{12} \rightarrow 10x=72 \rightarrow x=7.2$ , formula =  $\frac{7.2}{12} (100)$ )

Table B: Results from the Questionnaire, Grouped by Facility

Facility	A	B	C	D	E	F^^	G	H	I	J	K	M^^^
% Met of Total Criteria $\frac{x}{1} (100)$	71.4	50	50	42.8	57.1	66.4	42.8	50	57.1	64.2	50	54.2
% Not Met by Total Criteria $\frac{x}{1} (100)$	28.5	50	50	57.1	42.8	33.5	57.1	50	42.8	35.7	50	45.7

^^This facility omitted two questions, percentage was proportionally calculated =  $\frac{8}{12} = \frac{x}{1} \rightarrow 12x=112 \rightarrow x=9.3$ , formula =  $\frac{9.3}{1} (100)$

^^^This facility omitted three questions, percentage was proportionally calculated =  $\frac{6}{11} = \frac{x}{1} \rightarrow 11x=84 \rightarrow x=7.6$ , formula =  $\frac{7.6}{1} (100)$

Note: Facility L did not submit the questionnaire

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## Appendix E: Justification for Supplemental Questions

### *Justification for Supplemental Questions*

Question	Justification
15.	This question was important because if a subject stated that they were aware of any link(s) between cognitive function and the Mediterranean Diet it could potentially substantiate their “high adherence” result. It will also ascertain if a facility intentionally or unintentionally incorporates aspects of the MedDi.
16.	This question was needed because it is important to gather a baseline, independent of the questionnaire results if a facility believes they incorporate the Mediterranean Diet into their meal plans.
17.	This question is important because the Ketogenic Diet and the MIND Diet have been discussed in pre-existing studies regarding their link(s) to cognitive function. If a facility clicked “yes”, it could explain a potential low score on the Mediterranean Diet Score.
18.	It was important to note what other diet(s), if any, that facilities adhere to. This can substantiate a potential low score on the Mediterranean Diet Score because some facilities may already use an alternate diet. Additionally, this question brings up a future area of research: the prevalence of other diets (not the Mediterranean Diet) amongst facilities that care for residents with Alzheimer's Disease).
19.	This question was salient because it helped recruit questionnaire participants to send dining menus for the content analyses section.
20.	This question was needed as it helped recruit questionnaire participants to engage in an interview.



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## Appendix F: Each Facility's Supplemental Questionnaire Responses

### Supplemental Questionnaire Responses by Facility (n=11)

Question				
Facility	Q 1	Q 2	Q3	Q4
	Prior to this questionnaire, were you aware of any link(s) between cognitive function and the Mediterranean Diet?	Do you intentionally provide/design meals that adhere to the Mediterranean Diet?	Do you provide/design meals that adhere to either the Ketogenic Diet or the MIND Diet?	Do the meals you provide/design adhere to any particular diet? If so, please specify which diet(s). If not, please respond with "N/A."
A	"No, prior to this questionnaire I was not aware of any link(s) between cognitive function and the Mediterranean Diet."	"Yes, I intentionally provide/design meals that adhere to the Mediterranean Diet."	"Yes, I do provide meals that adhere to either the Ketogenic Diet or the MIND Diet."	"N/A"
B	"Yes, prior to this questionnaire I was aware of any link(s) between cognitive function and the Mediterranean Diet."	"No, I do not intentionally provide/design meals that adhere to the Mediterranean Diet."	"No, I do not provide meals that adhere to either the Ketogenic Diet or the MIND Diet."	"N/A"

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C	“No, prior to this questionnaire I was not aware of any link(s) between cognitive function and the Mediterranean Diet.”	“No, I do not intentionally provide/design meals that adhere to the Mediterranean Diet.”	“No, I do not provide meals that adhere to either the Ketogenic Diet or the MIND Diet.”	“N/A”
D	“Yes, prior to this questionnaire I was aware of any link(s) between cognitive function and the Mediterranean Diet.”	“No, I do not intentionally provide/design meals that adhere to the Mediterranean Diet.”	“No, I do not provide meals that adhere to either the Ketogenic Diet or the MIND Diet.”	“Our diets are a mix of residents requests along with always available heart healthy choices.”
E	“Yes, prior to this questionnaire I was aware of any link(s) between cognitive function and the Mediterranean Diet.”	“Yes, I intentionally provide/design meals that adhere to the Mediterranean Diet.”	“No, I do not provide meals that adhere to either the Ketogenic Diet or the MIND Diet.”	“Yes”
F	“Yes, prior to this questionnaire I was aware of any link(s) between cognitive function and the Mediterranean Diet.”	“Yes, I intentionally provide/design meals that adhere to the Mediterranean Diet.”	“No, I do not provide meals that adhere to either the Ketogenic Diet or the MIND Diet.”	“Specifically Mediterranean”

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G	“No, prior to this questionnaire I was not aware of any link(s) between cognitive function and the Mediterranean Diet.”	“No, I do not intentionally provide/design meals that adhere to the Mediterranean Diet.”	“No, I do not provide meals that adhere to either the Ketogenic Diet or the MIND Diet.”	“N/A”
H	“Yes, prior to this questionnaire I was aware of any link(s) between cognitive function and the Mediterranean Diet.”	“No, I do not intentionally provide/design meals that adhere to the Mediterranean Diet.”	“No, I do not provide meals that adhere to either the Ketogenic Diet or the MIND Diet.”	“NCS*, NAS”**
I	“Yes, prior to this questionnaire I was aware of any link(s) between cognitive function and the Mediterranean Diet.”	“No, I do not intentionally provide/design meals that adhere to the Mediterranean Diet.”	“No, I do not provide meals that adhere to either the Ketogenic Diet or the MIND Diet.”	“We make sure the residents have choices to order what they want to meet their dietary and nutritional needs.”
J	“No, prior to this questionnaire I was not aware of any link(s) between cognitive function and the Mediterranean Diet.”	“No, I do not intentionally provide/design meals that adhere to the Mediterranean Diet.”	“No, I do not provide meals that adhere to either the Ketogenic Diet or the MIND Diet.”	“NAS**, sugar free, gluten free”

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K	“Yes, prior to this questionnaire I was aware of any link(s) between cognitive function and the Mediterranean Diet.”	“Yes, I intentionally provide/design meals that adhere to the Mediterranean Diet.”	“No, I do not provide meals that adhere to either the Ketogenic Diet or the MIND Diet.”	“Blue Zone Diet”
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*Note.* Facility L did not fill out the questionnaire and therefore these open-ended questions. Facility M omitted responses to all supplemental questions and is therefore not included in this table.

\*Understood to mean “No Concentrated Sweets”

\*\*Understood to mean “No Added Salt”

Facility E only responded to Q 4 with “yes” without providing additional detail

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## **Appendix G:** *Interview Questions with Justification*

1. Briefly describe the main ingredients you incorporate into meals for residents.  
Justification: Shi, El-Obeid, Li, Xu, Liu, (2019), Yusuf, Weyandt, Piryatinsky, (2017), Hernandez-Galiot & Goni, (2017)
2. Briefly describe the method in which you plan meals that are served to residents with Alzheimer's Disease.  
Justification: This question provides an opportunity for justification if a facility does not adhere to the Mediterranean Diet. I would like to understand the thought process of the meal designers when creating the meal options.
3. Briefly describe what considerations you take into account when you plan meals that are served to residents with Alzheimer's Disease.  
Justification: It is important to determine the meal plan designers thought process when planning meals. This also is an opportunity for them to express any barriers, if any, such as budget.
4. Without disclosing information that will infringe upon resident confidentiality, please describe any correlations you have found between the foods you have provided and cognitive function.  
Justification: Sanchez, Ruano, Irala, Ruiz-Canela, Martinez-Gonzalez, Sanchez-Villegas (2012)
5. Were you previously aware that the Mediterranean Diet is linked to cognitive function? If so, how did you hear about this diet? If not, does this new knowledge provoke you to look into utilizing this diet in meals going forward?  
Justification: Yusuf, Weyandt, Piryatinsky, (2017), Sanchez, Ruano, Irala, Ruiz-Canela, Martinez-Gonzalez, Sanchez-Villegas, (2012), Feart, Samurai, Rondeau, et al., (2009), Scarmeas, Stern, Tang, Mayeux, & Luchsinger, (2006)
6. What are some factors that may deter you from providing the foods associated with the Mediterranean Diet?  
Justification: It is important to know the reasons behind the potential hesitations among facilities.

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7. Do you think there are factors that deter residents from consuming the Mediterranean Diet? If so, please specify some factors.

Justification: It is important to know what hurdles residents may face that may cause low consumption of the foods contained in the Mediterranean Diet.

8. Do you have any other thoughts regarding this topic you would like to share?

Justification: This question allowed for interviewees to share information they felt was necessary and that did not apply to the aforementioned questions.

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## **Appendix H: Interview Transcriptions**

Color Code	Theme
Red	Aspects of the Mediterranean Diet
Dark Blue	Timing & Occurrence
Dark Purple	Team Efforts
Pink	Willingness to Incorporate Aspects of the Mediterranean Diet into Meal Plans and Change Menus
Orange	Budget Factors
Neon Yellow	Types of Diets
Navy	Food Presentation
Green	Incorporated Aspects of the Mediterranean Diet
Light Red	Ethnic & Upbringing Factors
Dark Green	Food Consumption Limitations
Light Blue	Importance of Diet
Light Pink	Awareness of the Mediterranean Diet
Mustard Yellow	Reservations Regarding Implementing Aspects of the Mediterranean Diet
Light Purple	Abiding to Legal Guidelines

Facility D

**Can you briefly describe the main ingredients you incorporate into meals for residents?**

“I would say that 90% of our vegetables are fresh vegetables. 10% are probably frozen and that is just mainly due to certain times like peas, corn; corn you can't get in the winter time

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so we buy frozen corn and frozen peas. Occasionally spinach we will buy frozen, but I'd say that 90% of our vegetables are fresh. Our potatoes are all fresh, nothing comes in a box. We incorporate fresh garlic on a daily basis. Turmeric, rosemary, tyme, basil--all fresh again, nothing is dried. In terms of protein we use mink fish or salmon, we would actually do flounder. Seasonally we do cod. We use fresh lemons, fresh oregano, I said garlic, white wine, and olive oil."

### **Briefly describe the method in which you plan meals that are served to residents with Alzheimer's Disease.**

"So we as a team meet weekly. So it would be myself, my executive chef, my office manager, and my dietary supervisors. We try to meet at least weekly and go over the menus and what went well and what didn't go well. We also have to write these menus in coordination with our budget, our food budget costs and that comes from our financial office. I do that on a yearly basis--at the beginning of the year we write a budget for the year and we pertain to that budget monthly.

### **Briefly describe what considerations you take into account when you plan meals that are served to residents with Alzheimer's Disease.**

"So diets would be number one, all the residents' therapeutic diets we have here in house. So we have purees, and your minced, chopped, multiple different diets. I would also say presentation and how the meals kind of present on the plate for all those different diets. So for instance it might look nice on a regular meal, a pasta, but on a puree pasta it might be more difficult making it look appealing. Colors also if there is fish like a white fish, we are not gonna put cauliflower on with that white fish, we might put a carrot or greenbean something like that to bring out the color on the plate and the garnishing and what not.

### **Without disclosing information that will infringe upon resident confidentiality, please describe any correlations you have found between the foods you have provided and cognitive function.**

"Um to be honest I haven't--we probably do 700 meals a day here so it is kind of hard for me on my end. I talk to dieticians a little bit and we don't really get that information."

### **Were you previously aware that the Mediterranean Diet is linked to cognitive function? If so, how did you hear about this diet? If not, does this new knowledge provoke you to look into utilizing this diet in meals going forward?**

"We do use that Diet in our building now. So I work for [Facility D], but I also work for [undisclosed company] and that's part of our programs, the Mediterranean Diet. So actually we



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are incorporating it this month into our facilities because it is national nutrition month (March). So yeah, we do incorporate it, the olive oil, the high fats, the avocados, the fish.

### **What are some factors that may deter you from providing the foods associated with the Mediterranean Diet?**

“As I mentioned before, we do utilize this diet so there are no deterrents.”

### **Do you think there are factors that deter residents from consuming the Mediterranean Diet? If so, please specify some factors.**

“I think definitely ethnicity. I think European ethnicity, they wanna have that diet, they are used to that diet, especially if they grew up on that side of the land. Or grew up with families that incorporated that diet in their daily adult life. So I think ethnicity 100% percent and health too we're in an environment now, in a world now where health is more important than any other time and I think it's just keeping up with the trends and keeping these residents informed of these trends.

### **Do you have any other thoughts regarding this topic you would like to share?**

“Um no I'm pretty sure you know all about it so not much.”

Facility L

### **Can you briefly describe the main ingredients you incorporate into meals for residents?**

“Proteins, starches, vegetables”

### **Briefly describe the method in which you plan meals that are served to residents with Alzheimer's Disease.**

“We get all our menus from corporate. It is a 5 week cycle that has been approved by a dietician.”

### **Briefly describe what considerations you take into account when you plan meals that are served to residents with Alzheimer's Disease.**

“We have special diets that we have to consider. We have a couple allergies, nothing serious at this time though there have been--seafood is usually the one. We have different levels of diet so we have regular, we have soft, we have ground, we have chopped, we have puree. We also have different beverages. So some people as they lose the ability to swallow correctly--their body can't do it anymore there's nectar and honey and pudding thickness in drinks. So we have

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speech pathologists that come and evaluate someone that we feel they changed their eating, a lot of time these guys will pocket stuff and we need to make sure that they're safe.

**Without disclosing information that will infringe upon resident confidentiality, please describe any correlations you have found between the foods you have provided and cognitive function.**

"I don't think that's something you see immediately. But it's certainly a factor if it continues on. One of the biggest issues with old people in this world and every other world that you go to, with old people is they didn't drink water. That's not something they did. They need to drink water. With each meal here they get juice and water and coffee. During the day they have snacks, they have water, they have this and that. But one of our biggest pushes is to get them to stay hydrated. And if they are not hydrated, their behaviors can be off the wall. Like you know you can end up in a hospital because of it. So we constantly, I constantly stress that they drink water. It's amazing how much it throws people off from just simply dehydration. So in that way, yes, if someone is not eating for awhile they're going to get weak and they will not be able to participate in activities and it becomes a negative spiral where the next thing you know, their evaluating them for their diet and they don't like the level or people don't like the purees. The thing about puree is no matter how nice you make it, it's still the texture. So yes absolutely, food does influence behavior, but not immediately that you see.

**Were you previously aware that the Mediterranean Diet is linked to cognitive function? If so, how did you hear about this diet? If not, does this new knowledge provoke you to look into utilizing this diet in meals going forward?**

"I am aware of it. Just because I am into food a lot. I think we do a lot of healthy things here on the menu and off the menu. There is one little complication and that's the sweet taste bud is the last to go. So, these guys that live here, if they could live off of sweets for the rest of their lives that's what they'd do. Men usually, the family says 'he never liked sweets but now that's all he wants, he wants ice cream and cookies' and I go well you came to the right place. So we balance that. But as far as the Mediterranean itself I think in a group setting it would be a lot more difficult than doing it at home. I'm sure, look at the little Italian guys that drink their red wine every day that followed the Mediterranean Diet all their lives. Yes they do live longer, yes they do get Alzheimers. So I think it certainly helps to have a healthy diet like that, but you still gotta get them to eat.

**What are some factors that may deter you from providing the foods associated with the Mediterranean Diet?**

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"Pretty much everything I just said. I think our budget would cover it. I mean I use olive oil even though it costs more money. We do fish, a lot of fish. Cost would not be a factor, this company really wants the people to eat well and it's up to me to make it work. So obviously after twenty years I am doing something right."

### **Do you think there are factors that deter residents from consuming the Mediterranean Diet? If so, please specify some factors.**

"I don't think so, again a lot of our residents are Italian and from Italy so it's normal to them. So I don't think that's a factor. A lot of this is--picture sushi, you eat with your eyes, then you eat with your mouth. If a plate presents well which I think is very important in this population, that everything looks beautiful that says 'eat me' versus a bunch of stuff on a plate which is something I strive with any new chefs that I bring in here. This crowd more than anyone else I think needs to look good because they have forgotten what the foods are called. So instead they go 'wow that looks really good' and they'll try it. So I think truthfully with any crowd, but especially these guys more so because a lot of times they know that they don't know in the beginning stages and it's very frustrating to them. So if they can look at a plate and go 'wow that looks good, I want to eat it' then we've accomplished what we want to accomplish."

### **Do you have any other thoughts regarding this topic you would like to share?**

"I think this topic is certainly something to be considered. I'll even pass it on up to my people and say we are due for a new menu, why don't we lean more in that direction. It can't hurt. Again, these guys eat good here, we do good food here. Our food tastes good, looks good, but you can always do better. You never reach your goal and are like 'okay we are done now' so why not look in that direction and throw some more things in. We have to be careful of nuts and seeds and stuff like that, but most of the time I will do nuts here. We do have seven or eight soft diets that would not be able to have something like that, but we compensate with cooking a quarter with nuts and a quarter without so we do cover our bases with that. Another issue here and any place you deal with old people is teeth. These guys have teeth issues, that's why a lot of them end up with soft diets and even puree. It's not usually the teeth it's the swallowing mechanisms that's more of the problem. That's another consideration with this crowd. I think moving down the line it won't be such an issue because of implants and everything. Someone might have false teeth, but they don't fit properly because of the disease process so then they don't want them. Things are changing, the world of assisted living and dementia more and more people younger and younger are getting it. It's not uncommon for people in their sixties now to get it--seventies is very common and it did not used to be that way. It turns out younger for a lot of reasons and I think food is one of them. Food, stress, the whole schlemiel. So I think this whole world is evolving and there are also many many baby boomers that are going to traditional assisted living where it is still very independent. A lot of facilities you will see range from very

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very independent living all the way down to the last stop. People can stay here until the last stop, but these are people who are paying a lot of money. The world of assisted living is changing.”

### Facility B

#### **Can you briefly describe the main ingredients you incorporate into meals for residents?**

“They make a lot of chicken and a lot of fish. They try to incorporate a lot of fresh fruits and vegetables.”

#### **Briefly describe the method in which you plan meals that are served to residents with Alzheimer's Disease.**

“We do take a lot of feedback from people in the community. We have comment cards all over the different areas of the community. We do a lot of resident council meetings. We like to get their feedback on what they would like to be offered.”

#### **Briefly describe what considerations you take into account when you plan meals that are served to residents with Alzheimer's Disease.**

“We take into account the population as a whole in terms of ethnicity. We also take into account the residents input as I mentioned in the last question. Everything also has to meet the nutritional standards in terms of providing adequate nutrients, calories, that kind of stuff so we definitely plan around that.

#### **Without disclosing information that will infringe upon resident confidentiality, please describe any correlations you have found between the foods you have provided and cognitive function.**

“The only thing I would say to that and it's not really from a nutrient standpoint, but more a food presentation standpoint would be we have the ‘thrive program’ where it's basically like a finger food program where the food is made in these specialized molds and wraps that the kitchen uses for our dementia patients. That plays a huge role and then being able to consume their meals without as much assistance as they might need as if it was something they were to eat with a fork and a knife. So that is improving their cognitive function at meal time to proceed themselves and pick up stuff with their hands. I guess it's not the nutrients of the food, but more the presentation of the food.

#### **Were you previously aware that the Mediterranean Diet is linked to cognitive function? If so, how did you hear about this diet? If not, does this new knowledge provoke you to look into utilizing this diet in meals going forward?**

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"I probably have heard that back when I was in school. To be honest, our menus do--I mean they're not perfect in terms of the Mediterranean Diet--but do offer compared to other facilities I have worked with. We do provide a lot more of like whole grains, fresh fruits and vegetables, meats."

### **What are some factors that may deter you from providing the foods associated with the Mediterranean Diet?**

"Waste is a big thing to consider in a huge community like this. We don't use things timely and as efficiently as we could. You know utilize things across multiple recipes. With fresh products there is always the waste factor. Cost of course is always a concern. I don't deal too much to be honest with you regarding the food budget, but I know that's going to get mentioned anywhere."

### **Do you think there are factors that deter residents from consuming the Mediterranean Diet? If so, please specify some factors.**

"In general we always have a percentage of people that are not concerned with what they eat and how they eat. They kind of want to stick with what they are used to and order hotdogs and cheeseburgers that kind of stuff off of our always available menu. Some people I think that are in their eighties or nineties are set in their ways of what they were raised on. I think they are not necessarily going to change, but then we also do have a small percentage that do want to learn while they're here."

### **Do you have any other thoughts regarding this topic you would like to share?**

"I don't think so"

Facility K

### **Can you briefly describe the main ingredients you incorporate into meals for residents?**

"We do 4 ounces of starch at lunch and supper. 4 ounces of vegetables at lunch and supper and then we do starch portions at breakfast, it could be cereal, toast or a muffin. And the meat portions are 3 to 4 ounces depending on what the meal is. We do a lot of free starch, we do mashed potatoes, a lot of rice like rice pilaf or brown rice, risotto, different types of rice. We use grains. We do roasted potato, we do sweet potato, potato mashed. And for vegetables there's a wide variety, but we do a lot of broccoli and carrots. We have brussels sprouts we have turnips, green beans, asparagus. We are always using peppers and onions in our meals. So it is a vegetable, but they're in a lot of our meals. Mushrooms we have and we use olive oil, extra virgin olive oil to roast our vegetables or we add once the vegetables are cooked. We use a

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canola oil/extra virgin olive oil blend to fry. Everybody gets offered a salad at lunch or supper also so there they can get their raw veggies.

### **Briefly describe the method in which you plan meals that are served to residents with Alzheimer's Disease.**

"We have guidelines that tell us exactly how much milk we have to offer and meat equivalents and vegetables. Our food director \*\*undisclosed name\*\* has been trying to incorporate the Blue Zone Diet and the Mediterranean Diet into our menus. So he's been going through a lot of recipes. We meet quarterly to go over the menus, every three months. So we do a major menu overhaul twice a year where we re-do the whole menu. We meet every month to do a change here and a change there. For example, for the spring we are going to do a whole new menu. A 3-week cycle is going to be 63 meals we are going to have to come up with. And that will last for the spring and summer. We will meet a couple months in to see what's working and what's not to see what changes we need to make. And then in the fall and in the winter we do a lot more of comfort foods. Stuff you would eat more in the fall and winter versus the summer."

### **Briefly describe what considerations you take into account when you plan meals that are served to residents with Alzheimer's Disease.**

"As far as the budget we take considerations in saving money, but also keeping our quality of food high. And the way we do that is by making more of our own food. For example, we used to buy pureed fruit and it would be let's say 90 dollars a case, but now we buy whole fruit canned at a third of the price and we puree our own. We found a lot of different methods where we could--say instead of buying stuffed roasted chicken breast for 100 dollars a case, we can buy raw chicken and make our own stuffing for a fraction of the price and we can make our own fresh, stuffed chicken. So we can have quality products at a lower cost. That's something we have been doing for the last couple of years, which has contributed to our success. We also meet with the families and the residents and staff to find out what's working and what's not working when we rate the menus. We once put sauerkraut on there and they all said that nobody liked it. The families said they didn't like it, they also had a hard time chewing. A lot of our residents also have very few teeth too, we have to take that into account also--but we find out what they like and what they don't like.

### **Without disclosing information that will infringe upon resident confidentiality, please describe any correlations you have found between the foods you have provided and cognitive function.**

"As far as cognitive function, we are trying to incorporate the Blue Zone Diet into our menus because they have found that that helps cognitively with anyone that has Alzheimer's Disease. And they have a couple studies done on the Mediterranean Diet also that show that will

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definitely help. So that is why we have kind of moved our menus over to those two diets. There are more beans and legumes on the menu, definitely more than we've ever had before. Like I said before we have an olive oil/canola oil blend so we are trying to improve the oils we use even if it is just for pan frying, we are using more extra-virgin olive oil. We are definitely trying to use more sweet potatoes for example and we have a lot more fish on the menu than we used to. We are doing minimal meat portions also. For example, we are not going to put a one pound T-bone steak on the plate, which would be phenomenal if we could, but we do the minimal four ounces you know just a few slices of meat and try to help that complement a healthy starch and healthy vegetables.

**Were you previously aware that the Mediterranean Diet is linked to cognitive function? If so, how did you hear about this diet? If not, does this new knowledge provoke you to look into utilizing this diet in meals going forward?**

"Yes, we both were aware that it helps and that is why we are working to incorporate it into our menus. Basically we read about it, that's how we know it is helpful. We go online and check resources and check menus and sort of look. We also learned that we can't do a complete overhaul, we have to take baby steps into this. If we just did a whole Mediterranean Diet menu, the first thing that they would say is 'where is my meatloaf, where are my buttery mashed potatoes?' So we have to do trial and error. We have to try it, put it out there and get some feedback and then go from there. A lot of the generations that are here are in their eighties and nineties, they're all meat and potatoes, that's all they ate their whole life. So we also have to make food that they recognize. We once put food in a pita pocket and I remember that none of them knew what it was so we also have to take that into consideration.

**What are some factors that may deter you from providing the foods associated with the Mediterranean Diet?**

"Yes, the families. I meet with the resident's families daily, pretty much every family. We have 120 residents here so we meet with the families for each (10:25)unit. So basically we have four units which 30 people live on. We are in contact with the families at all times meeting with them and if somebody says 'you know my mother will never follow that diet, that's not something she would follow and I don't want her on it' then I would have to make a separate menu for that person. This is so I can make sure that they're likes and needs are available. And the amount of meat, we have specific guidelines we have to follow as far as our DTA to our state regulations. So I can't just put like beans, spinach, and asparagus on a plate and serve it, I have to meet standards that are given to me and the guidelines we have to follow. So some of the menus that we are finding there are no meat in them and there's not significant protein sources. That would deter us also, meeting our guidelines.

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### **Do you think there are factors that deter residents from consuming the Mediterranean Diet? If so, please specify some factors.**

“There are definitely factors. With our population that lives here a lot of them with Alzheimer's Disease you're going to have chewing and swallowing disabilities. And I would say that probably 90% of the people here are left with a form of dysphagia where they cannot swallow. There are 59 steps to chewing and swallowing food that we do automatically and they lose that as they're going through the disease. We have to change our diets around that. We do a more modified diet where it is a lot of chopped up foods and we do a puree diet where everything is almost like a baby food consistency. We also do a liquid diet because some people can drink, but they can't eat so we actually make the meal into a soup. And I have numerous supplements. Some people cannot tolerate any food at all and I just have to give them like an Ensure or a Boost supplement that gets all their calories and proteins in. Where if you were in a regular resting home where everybody here has Alzheimer's Disease, where if they didn't have Alzheimer's Disease some people would put a tube feed in to provide their calories or their proteins. We can't do that here because everybody has Alzheimer's Disease and it puts the people at risk because they don't know what that is and most of them will just pull it out. We have had them in the past but either the resident themselves would pull it out and their roommate doesn't know what it is and they'll pull it out. We can't risk by being in this population with the tube feeding so if they do need to have one, they will go somewhere else for that.

### **Do you have any other thoughts regarding this topic you would like to share?**

“Yes, we would like to do more Blue Zone diet and more Mediterranean Diet definitely, but we are up against some challenges that we mentioned previously. The stage of people when they move from regular diet to modified diet and puree diet, their stages of palatability change. Their families wanting certain things, not wanting to try new things for their family members. For us what we're trying to do is give education before we roll out with more vegetable based meals and move away from a lot of meat-based and a lot of unhealthy starches. Try to educate the families, we are working with the families to teach them more about the diet and how it's gonna help their loved one that lives here. Only because a lot of them say 'you know this is it for them' which I understand too. They're only here for a year or two some of them so they just want to eat whatever they want. They're not going to learn about the healthy aspects of the Mediterranean Diet, they just want to have ice cream and cookies and whatever they want. So we have to go along, kind of see where the families are at--that is why everyone is so different here. We are trying to make it homelike also, we don't want it to be so strict. This is their home and they are here. If they were to go home and they're going to eat a whole bag of m&ms, then you know we try to limit how much they eat, but if the families are bringing them in extra stuff and they're eating it and then if they're alright with that then we let them have whatever they want.



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Instead of promoting longer life with the Mediterranean Diet and the Blue Zone Diet, we are trying to promote quality of life because people are at the end stages of their lives and some families don't want to prolong that with a healthier diet that they think they might not enjoy as much. So I guess what we're trying to promote is if you eat this diet you will have fewer symptoms, your blood sugars will look better, there's less sodium so their blood pressure is going to look better, less pills. So we are trying to tell people if you eat this diet, then you'll need less pills and you'll feel better. It's not just gonna extend your life, but you will feel better on a day to day and that's the message we are trying to get across for our population. Again, if this was a restaurant or any other nursing home without dementia, residents might be a little easier. We can change the menu and they can try it, but yeah, we are doing our best.

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## **Appendix I: Interviews Second Iteration, Final Coding Framework**

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| <p>A. Aspects of the Mediterranean Diet</p> <p>1A1 — Foods found on the questionnaire/instrument by Martinez-Gonzalez et al.</p> <p>B. Timing &amp; Occurrence</p> <p>1B1 — Reasons for purchasing certain foods (ex. weather)</p> <p>1B2 — Frequency of meeting with associates</p> <p>1B3 — Frequency of meeting with residents &amp; families</p> <p>1B4 — Occurrence of certain foods (ex. more vegetables available at dinner time)</p> <p>C. Team Efforts</p> <p>1C1 — Resident's input</p> <p>1C2 — Families' input</p> <p>1C3 — Expert's input (chefs, speech pathologists, dining directors, office managers)</p> <p>D. Willingness to Incorporate Aspects of the Mediterranean Diet into Meal Plans and Change Menus</p> <p>1D1 — Mention of future development</p> <p>1D2 — Discussion of "foods that went well"</p> <p>1D3 — Mention of improvements to the menus (ex. re-do)</p> <p>E. Types of Diets</p> <p>1E1 — Mention of dietary restrictions (ex. allergies)</p> <p>1E2 — Mention of special/modified diets (puree, chopped, minced, soft)</p> <p>1E3 — The Mediterranean Diet</p> | <p>G. Food Presentation</p> <p>1G1 — Strategic color choices</p> <p>1G2 — Garnishing</p> <p>1G3 — Visual Appeal</p> <p>1G4 — Specialized molds/wraps</p> <p>H. Incorporated of Aspects of the Mediterranean Diet</p> <p>1H1 — Mention if diet is in use</p> <p>1H2 — Methods of incorporation</p> <p>I. Ethnic &amp; Upbringing Factors</p> <p>1I1 — Mention of geographical regions</p> <p>1I2 — Follow diet of their upbringing</p> <p>1I3 — How residents were raised (ex. use foods that residents will recognize)</p> <p>1I4 — Generational reasons</p> <p>J. Food Consumption Limitations</p> <p>1J1 — Limited swallowing ability</p> <p>1J2 — Lack of teeth &amp; Difficulty chewing</p> <p>1J3 — Certain food textures</p> <p>1J4 — Desire sweet foods</p> <p>1J5 — Usage of dietary supplements</p> |
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## 1E4 — The Blue Zone Diet

### F. Budget Factors

- 1F1 — Mention of food cost or money
- 1F2 — Mention of food Budget
- 1F3 — Cost efficiency & saving money

### K. Importance of Diet

- 1K1 — Drinking water
- 1K2 — Fewer symptoms
- 1K3 — Lower blood Sugars
- 1K4 — Less pills needed
- 1K5 — Improved quality of life

### L. Awareness of the Mediterranean Diet

- 1L1 — Mentioned awareness
- 1L2 — Mentioned pre-existing research
- 1L3 — Reading about the Mediterranean Diet
- 1L4 — Online Resources

### M. Reservations Regarding Implementing Aspects of the Mediterranean Diet

- 1M1 — Difficulties in a group setting
- 1M2 — Managing food waste (ex. fresh foods perish quickly)
- 1M3 — Resident's lack of concern regarding diet & unwillingness to try new foods
- 1M4 — Large change (ex. limiting meat availability can be problematic)
- 1M5 — Residents not able to recognize foods
- 1M6 — Stage of life

### N. Abiding to Nutritional Guidelines

- 1N1 — Mention of required quantities
- 1N2 — Mention of nutritional standards
- 1N3 — State regulations & guidelines

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## Appendix J: Interview Quotes Regarding each Theme, by Facility

### Interview Quotes Regarding each Theme, by Facility

Theme	Facility B	Facility D	Facility K	Facility L
Aspects of the Mediterranean Diet	<p>"They make a lot of chicken and a lot of fish. They try to incorporate a lot of fresh fruits and vegetables."</p> <p>"We offer more compared to other facilities I have worked with. We do provide a lot more of like whole grains, fresh fruits and vegetables, meats."</p>	<p>"...our vegetables are fresh vegetables...like peas and corn"</p> <p>"Occasionally spinach we will buy frozen, but I'd say that 90% of our vegetables are fresh. Our potatoes are all fresh, nothing comes in a box."</p> <p>"So yeah, we do incorporate it, the olive oil, the high fats, the avocados, the fish."</p>	<p>"We do mashed potatoes, a lot of rice like rice pilaf or brown rice, risotto, different types of rice. We use grains. We do roasted potato, we do sweet potato, potato mashed. And for vegetables there's a wide variety, but we do a lot of broccoli and carrots. We have brutal sprouts we have turnips, green beans, asparagus. We are always using peppers and onions in our meals. So it is a vegetable, but they're in a lot of our meals. Mushrooms we have and we use olive oil, extra virgin olive oil to roast our vegetables or we add once the vegetables are cooked. We use a canola oil/extra virgin olive oil blend to fry."</p>	<p>"Proteins, starches, vegetables"</p> <p>"I use olive oil even though it costs more money. We do fish, a lot of fish."</p>
Timing/Occurrence	N/A	<p>10% [of our vegetables] are probably frozen and that is just mainly due to certain times like peas, corn; corn you can't get in the winter time so we buy frozen corn and frozen peas.</p> <p>"We incorporate fresh garlic on a daily basis... seasonally we do cod."</p> <p>"We as a team meet weekly... It is a 5 week cycle [the menus]."</p>	<p>"We do 4 ounces of starch at lunch and supper. 4 ounces of vegetables at lunch and supper and then we 2 do starch portions at breakfast..."</p> <p>"Everybody gets offered a salad at lunch or supper also so there they can get their raw veggies."</p> <p>"A 3-week cycle is going to be 63 meals we are going to have to come up with. And that will last</p>	<p>"It [the dining menus] is a 5 week cycle"</p> <p>"I don't think that's [influence on cognitive function] something you see immediately. But it's certainly a factor if it continues on."</p> <p>"So yes absolutely, food does influence behavior, but not immediately that you see."</p>

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			for the spring and summer.”	
Team Efforts	<p>“We do take a lot of feedback from people in the community. We have comment cards all over the different areas of the community. We do a lot of resident council meetings.”</p>	<p>“So we as a team meet weekly. So it would be myself, my executive chef, my office manager, and my dietary supervisors.”</p>	<p>“Our food director...has been trying to incorporate the Blue Zone Diet and the Mediterranean Diet into our menus. So he's been going through a lot of recipes. We meet quarterly to go over the menus, every three months.”</p> <p>“We also meet with the families and the residents and staff to find out what's working and what's not working when we rate the menus.</p> <p>“I meet with the resident's families daily, pretty much every family. We have 120 residents here so we meet with the families for each unit.”</p> <p>“We are in contact with the families at all times meeting with them and if somebody says ‘you know my mother will never follow that diet, that's not something she would follow and I don't want her on it’ then I would have to make a separate menu for that person.”</p>	<p>“We get all our menus from corporate... that has been approved by a dietician.”</p> <p>“So we have speech pathologists that come and evaluate someone that we feel they changed their eating...”</p>
Willingness to Incorporate Aspects of the Mediterranean Diet into Meal Plans and Change Menus	<p>“We like to get their [the community's] feedback on what they would like to be offered.”</p> <p>“We also take into account the residents input”</p>	<p>“We try to meet at least weekly and go over the menus and what went well and what didn't go well.”</p>	<p>“So we do a major menu overhaul twice a year where we re-do the whole menu. We meet every month to do a change here and a change there. For example, for the spring we are going to do a whole new menu.”</p> <p>“We will meet a couple months in to see what's working and what's not to see what changes we need to make.”</p> <p>“we are trying to improve the oils we use even if it is just for pan frying, we are using more</p>	<p>“I think this topic is certainly something to be considered. I'll even pass it on up to my people and say we are due for a new menu, why don't we lean more in that direction. It can't hurt.”</p> <p>“Our food tastes good, looks good, but you can always do better. You never reach your goal and are like ‘okay we are done now’ so why not look in that direction and throw some more things in.”</p>

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			extra-virgin olive oil. We are definitely trying to use more sweet potatoes for example and we have a lot more fish on the menu than we used to. We are doing minimal meat portions also."	
Types of Diets	N/A	"So diets would be number one, all the residents' therapeutic diets we have here in house. So we have purees, and your minced, chopped, multiple different diets."	<p>"...we would like to do more Blue Zone diet and more Mediterranean Diet definitely"</p> <p>"As far as cognitive function, we are trying to incorporate the Blue Zone Diet into our menus because they have found that that helps cognitively with anyone that has Alzheimer's Disease.</p> <p>"We do a more modified diet where it is a lot of chopped up foods and we do a puree diet where everything is almost like a baby food consistency. We also do a liquid diet because some people can drink, but they can't eat so we actually make the meal into a soup."</p>	"We have special diets that we have to consider. We have a couple allergies, nothing serious at this time though there have been--seafood is usually the one. We have different levels of diet so we have regular, we have soft, we have ground, we have chopped, we have puree... we do have seven or eight soft diets."
Budget Factors	"Cost of course is always a concern. I don't deal too much to be honest with you regarding the food budget, but I know that's going to get mentioned anywhere."	"We also have to write these menus in coordination with our budget, our food budget costs and that comes from our financial office. I do that on a yearly basis--at the beginning of the year we write a budget for the year and we pertain to that budget monthly."	"As far as the budget we take considerations in saving money, but also keeping our quality of food high. And the way we do that is by making more of our own food."	"I think our budget would cover it [the Mediterranean Diet]. I mean I use olive oil even though it costs more money...cost would not be a factor, this company really wants the people to eat well and it's up to me to make it work."
Food Presentation	"a food presentation standpoint would be we have the 'thrive program' where it's basically like a finger food program where the food is made in these specialized molds and wraps that the kitchen uses for our dementia patients."	"I would also say presentation and how the meals kind of present on the plate for all those different diets. So for instance it might look nice on a regular meal, a pasta, but on a puree pasta it might be more difficult making it look appealing. Colors also if there is fish	N/A	"...you eat with your eyes , then you eat with your mouth. If a plate presents well which I think is very important in this population, that everything looks beautiful that says 'eat me' versus a bunch of stuff on a plate which is something I strive with any new chefs that I bring in here. This

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		like a white fish, we are not gonna put cauliflower on with that white fish, we might put a carrot or green bean something like that to bring out the color on the plate and the garnishing and what not."		crowd more than anyone else I think needs to look good because they have forgotten what the foods are called. So instead they go 'wow that looks really good' and they'll try it. So I think truthfully with any crowd, but especially these guys more so because a lot of times they know that they don't know in the beginning stages and it's very frustrating to them. So if they can look at a plate and go 'wow that looks good, I want to eat it' then we've accomplished what we want to accomplish."
Incorporated of Aspects of the Mediterranean Diet	"To be honest, our menus do--I mean they're not perfect in terms of the Mediterranean Diet--but do offer compared to other facilities I have worked with."	<p>"We do use that diet [the Mediterranean Diet] in our building now."</p> <p>"So actually we are incorporating it this month into our facilities because it is national nutrition month"</p> <p>"...we do utilize this diet so there are no deterrents."</p>	"Instead of promoting longer life with the Mediterranean Diet and the Blue Zone Diet, we are trying to promote quality of life because people are at the end stages of their lives and some families don't want to prolong that with a healthier diet that they think they might not enjoy as much."	N/A
Ethnic/Upbringing Limitations	<p>"Some people I think that are in their eighties or nineties are set in their ways of what they were raised on. I think they are not necessarily going to change but then we also do have a small percentage that do want to learn while they're here."</p> <p>"We take into account the population as a whole in terms of ethnicity."</p>	<p>"I think definitely ethnicity. I think European ethnicity, they wanna have that diet, they are used to that diet, especially if they grew up on that side of the land. Or grew up with families that incorporated that diet in their daily adult life. So I think ethnicity 100% percent."</p>	"A lot of the generations that are here are in their eighties and nineties, they're all meat and potatoes, that's all they ate their whole life. So we also have to make food that they recognize."	"I don't think so, again a lot of our residents are Italian and from Italy so it's normal to them. So I don't think that's a factor."
Food Consumption Limitations	"...the food is made in these specialized molds and wraps that the kitchen uses for our dementia patients. that	N/A	"they also had a hard time chewing. A lot of our residents also have very few teeth too, we have to take that into account also--but we find	"We also have different beverages. So some people as they lose the ability to swallow correctly--their body can't do it anymore..."

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plays a huge role and then being able to consume their meals without as much assistance as they might need as if it was something they were to eat with a fork and a knife. So that is improving their cognitive function at meal time to proceed themselves and pick up stuff with their hands."

out what they like and what they don't like."

"...a lot of them with Alzheimer's Disease you're going to have chewing and swallowing disabilities. And I would say that probably 90% of the people here are left with a form of dysphagia where they cannot swallow. There are 59 steps to chewing and swallowing food that we do automatically and they lose that as they're going through the disease."

"And I have numerous supplements. Some people cannot tolerate any food at all and I just have to give them like an Ensure or a Boost supplement that gets all their calories and proteins in. Where if you were in a regular resting home where everybody here has Alzheimer's Disease, where if they didn't have Alzheimer's Disease some people would put a tube feed in to provide their calories or their proteins. We can't do that here because everybody has Alzheimer's Disease and it puts the people at risk because they don't know what that is and most of them will just pull it out."

"...a lot of time these guys will pocket stuff and we need to make sure that they're safe."

"And if they are not hydrated, their behaviors can be off the wall."

There is one little complication and that's the sweet taste bud is the last to go. So, these guys that live here, if they could live off of sweets for the rest of their lives that's what they'd do...so we balance that."

Another issue here and any place you deal with old people is teeth. These guys have teeth issues, that's why a lot of them end up with soft diets and even puree. It's not usually the teeth it's the swallowing mechanisms that's more of the problem. That's another consideration with this crowd."

Awareness of the Mediterranean Diet

N/A

N/A

"And they have a couple studies done on the Mediterranean Diet also that show that will definitely help."  
"Yes, we both were aware that it helps and that is why we are working to incorporate it into our menus. Basically we read about it, that's how we know it is helpful. We go online and

"I am aware of it. Just because I am into food a lot."



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			check resources and check menus and sort of look.”	
Reservations Regarding Implementing Aspects of the Mediterranean Diet	<p>“Waste is a big thing to consider in a huge community like this. We don’t use things timely and as efficiently as we could. You know utilize things across multiple recipes. With fresh products there is always the waste factor.”</p> <p>“In general we always have a percentage of people that are not concerned with what they eat and how they eat. They kind of want to stick with what they are used to and order hotdogs and cheeseburgers that kind of stuff off of our always available menu.”</p>	“As I mentioned before, we do utilize this diet so there are no deterrents.”	<p>“We also learned that we can’t do a complete overhaul, we have to take baby steps into this. If we just did a whole Mediterranean Diet menu, the first thing that they would say is ‘where is my meatloaf, where are my buttery mashed potatoes?’ So we have to do trial and error.”</p> <p>“We once put food in a pita pocket and I remember that none of them knew what it was so we also have to take that into consideration.”</p> <p>“The stage of people when they move from regular diet to modified diet and puree diet, their stages of palatability change. Their families wanting certain things, not wanting to try new things for their family members.”</p> <p>“They’re only here for a year or two some of them so they just want to eat whatever they want. They’re not going to learn about the healthy aspects of the Mediterranean Diet, they just want to have ice cream and cookies and whatever they want.”</p>	<p>“But as far as the Mediterranean itself I think in a group setting it would be a lot more difficult than doing it at home.”</p> <p>“We have to be careful of nuts and seeds and stuff like that, but most of the time I will do nuts here.”</p>
Abiding to Nutritional Guidelines	<p>“Everything also has to meet the nutritional standards in terms of providing adequate nutrients, calories, that kind of stuff so we definitely plan around that.”</p>	N/A	<p>“We have guidelines that tell us exactly how much milk we have to offer and meat equivalents and vegetables.”</p> <p>And the amount of meat, we have specific guidelines we have to follow as far as our DTA to our state regulations. So I can’t just put like beans, spinach, and</p>	N/A

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asparagus on a plate and serve it, I have to meet standards that are given to me and the guidelines we have to follow...that would deter us also, meeting our guidelines."

Importance of Diet

N/A

N/A

"we're trying to promote is if you eat this diet you will have fewer symptoms, your blood sugars will look better, there's less sodium so their blood pressure is going to look better, less pills. So we are trying to tell people if you eat this diet, then you'll need less pills and you'll feel better. It's not just gonna extend your life, but you will feel better on a day to day and that's the message we are trying to get across for our population."

"One of the biggest issues with old people in this world and every other world that you go to, with old people is they didn't drink water. That's not something they did. They need to drink water... one of our biggest pushes is to get them to stay hydrated"

"So in that way, yes, if someone is not eating for a while they're going to get weak and they will not be able to participate in activities and it becomes a negative spiral..."

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## **Appendix K: Menu Analyses First Iteration**

### *Initial Themes for Menu Analysis*

Theme 1	Theme 2
Foods that Align with the Mediterranean Diet Based on the V14Q	Foods that Do Not Align with the Mediterranean Diet Based on the V14Q
Olive Oil	Beef
Vegetables	Hamburger
Fruits	Ham
Wine	Sausage
Legumes	Butter
Nuts	Margarine
Peanuts	Cream
Chicken	Sweet/Carbonated Beverages
Turkey	Commercial Sweets (cookies, cakes, custard, pastries)
Rabbit Meat	Pork
Veal	All other foods on the menu not mentioned
Pasta	
Rice	
Sofrito	
Fish	
Shellfish	

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## Appendix L: Second Iteration of Menu Analyses

Foods that Align with the Mediterranean Diet on the Menus (Martinez-Gonzales et al.)

Food Category	Facility B	Facility C	Facility I	Facility J	Facility K	Facility M
Olive Oil						
Vegetables	Potato Leek Soup Mixed Vegetables Yellow Squash Roasted Potato Medley Vegetable Soup Honey Glazed Brussel Sprouts Tossed Green Salad	Minestrone Soup Tossed Salad Baked Potato	Butternut Squash Garden	Mixed Green Salad Cucumber Blend	Mashed Potatoes Steamed	Caesar Salad
Green Peas Butternut Squash O'Brien Potatoes Whipped or	House Salad	Tomato Mushrooms Steamed Broccoli Garden Vegetable	Cabbage Carrots Lettuce Tomato Pickle Chips			
Fruits	Stewed Prunes Banana Diced Peaches	Fruit Cup	Apple Soup (chicken broth) Fresh Fruit	Fresh Fruit Cup	Fruit	
Wine						
Protein/Meat		Chicken Breast Bruschetta			Chicken Salad Sandwich	
Pasta	Baked Manicotti with Marinara Sauce		Spaghetti			
Rice				Rice Pilaf		
Nuts & Peanuts						
Sofrito						

Fish	ANALYZING THE PREVALENCE OF THE MEDITERRANEAN DIET WITHIN CONNECTICUT FACILITIES THAT CARE FOR RESIDENTS WITH ALZHEIMER'S DISEASE	Pan Seared Salmon Baked Grilled Salmon	72
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				Tilapia		
				Tuna Salad		
				Tuna Melt		
Shellfish						Shrimp Cocktail
Legumes					Bean Salad Sandwich	Red Bean and Lentil Stew

## Foods that Do Not Align with the Mediterranean Diet on the Menus (Martinez-Gonzales et al.)

Food Category	Facility B	Facility C	Facility I	Facility J	Facility K	Facility M
Protein/Meat		Roast Pork Tenderloin	Steak	Beef Tips Cheeseburger	Corned Beef Pot Roast Ham and Cheddar Sandwich	Rack of Lamb Classic Bacon, Lettuce, Tomato Sandwich Filet Mignon
Butter & Margarine	Butter Margarine					
Cream						
Sweet & Carbonated Beverages	Orange Juice Coffee, DeCaf Tea, DeCaf Arnold Palmer Iced Tea	Assorted Soda Juice Coffee Tea			Juice	
Commercial Sweets	Marble Cake with and without Frosting	Homemade Baked Treats	Assorted Desserts	Cheesecake Ice Cream	Carrot Cake	NY Cheesecake
Other Foods not Outlined in the V14Q	Assorted Cereal Scrambled Eggs French Toast Bacon White & Whole Wheat Toast Beverages Milk, Skim, Ice	Condiments Salad Dressing & Gravy Beverages Milk	Ham & Potato Casserole	Cottage Cheese	Hash Browns Cereal Milk Condiments Brown Sugar Potato Chips Vegetable Frittata with Onions, Peppers, and	

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Water  
Condiments  
Jelly,  
Salt,  
Pepper,  
Sugar,  
Sugar,  
Syrup  
Bacon, Lettuce,  
Tomato  
Sandwich  
Cream of Wheat  
Broccoli Quiche

Sauteed  
Mushrooms

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## **Appendix M:** *Menu Final Coding Framework Separated by Foods that Would/Would Not Score a Point on the Mediterranean Diet Score*

*Factor 1: Foods that would score one point for the Mediterranean Diet score*  
(Martinez-Gonzalez et al.)

### 1A. Olive Oil

### 1I. Sofrito

### 1B. Vegetables

### 1J. Fish

- 1B1 — Mention of Salad &  
Vegetable Blends
- 1B2 — Lettuce (ex. romaine)
- 1B3 — Fresh Vegetables (ex.  
cucumber, tomato, broccoli, butternut  
squash)
- 1B4 — Vegetable Soup & Stew (ex.  
potato leek soup, minestrone soup,  
butternut squash soup)
- 1B5 — Pickle Chips
- 1B6 — Mashed, Steamed Vegetables

- 1J1 — Tilapia
- 1J2 — Tuna & Tuna Melt
- 1J3 — Salmon

### 1K. Shellfish

- 1K1 — Shrimp

### 1L. Legumes

- 1L1 — Bean Salad
- 1L2 — Red Bean & Lentil Stew

### 1C. Fruits

- 1C1 — Mention of fresh fruits
- 1C2 — Fruit compotes
- 1C3 — Stewed fruits & Diced Fruits
- 1C4 — Fruit Soups (ex. apple soup)

### 1D. Wine

### 1E. Protein/Meat

- 1E1 — Chicken Breast Bruschetta
- 1E2 — Chicken Salad Sandwich

### 1F. Pasta

- 1F1 — Spaghetti



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1F2 — Baked Manicotti with Marinara Sauce

## 1G. Rice

1G1 — Rice Pilaf

## 1H. Nuts & Peanuts

*Factor 2: Foods that would not score one point for the Mediterranean Diet score*  
(Martinez-Gonzalez et al.)

### 2A. Protein/Meat

- 2A1 — Bacon
- 2A2 — Corned Beef
- 2A3 — Pot Roast
- 2A4 — Ham
- 2A5 — Lamb
- 2A6 — Steak (ex. filet mignon) & Beef Tips
- 2A7 — Cheeseburger
- 2A8 — Pork Tenderloin

### 2B. Butter & Margarine

### 2C. Cream

### 2D. Sweet & Carbonated Beverages

- 2C1 — Fruit Juices
- 2C2 — Coffee
- 2C3 — Tea
- 2D4 — Arnold Palmer Iced Tea
- 2D5 — Soda

### 2E. Commercial Sweets

- 2C1 — Assorted Desserts
- 2C2 — Cake & Cheesecake
- 2C3 — Ice Cream

### 2F. Other Foods not Outlined in the Questionnaire

- 2D1 — Milk (ex. skim)
- 2D2 — Condiments (ex. salad dressing, gravy, brown sugar, jelly, salt, pepper, artificial sweetener, syrup)
- 2F3 — Cottage Cheese, Cheese
- 2F4 — Potato Chips & Hash Browns
- 2F5 — Cereal
- 2F6 — Bread (ex. white toast, whole wheat toast, French toast)
- 2F7 — Eggs (ex. scrambled, vegetable quiche, vegetable frittata )
- 2F8 — Cream of Wheat

# ANALYZING THE PREVALENCE OF THE MEDITERRANEAN DIET WITHIN CONNECTICUT FACILITIES THAT CARE FOR RESIDENTS WITH ALZHEIMER'S DISEASE

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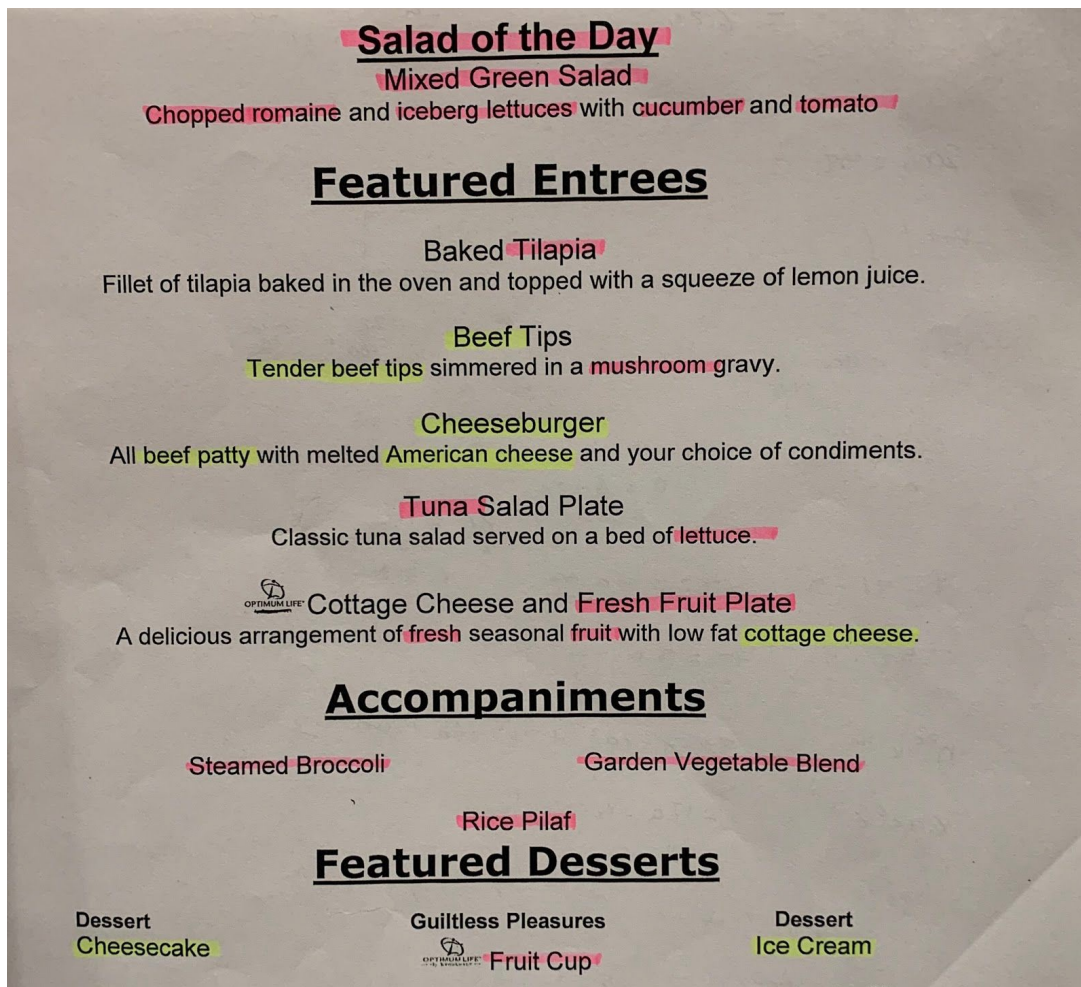
## **Appendix N:** *Annotated Menu (Facility J)*

*Note.* This is one example of a menu used in this study. To see all other menus, please contact the researcher.

Highlight Color	Categorization
Pink	Would Score 1 Point on MDS, Aligns with MedDi (Martinez-Gonzalez et al.)
Yellow	Would Not Score 1 Point on MDS, Does Not Align with MedDi (Martinez-Gonzalez et al.) or Foods Not Mentioned on the V14Q

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Conserving the Cute: A Psychological Analysis of Tucsonan Hikers

AP Research

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### **Conserving the Cute: A Psychological Analysis of Tucsonan Hikers**

In recent years, environmental concerns have become increasingly prevalent (Friedman, 1992). As the depletion of natural resources continues at a rapid rate, demolishing ecosystems in its wake, the prevalence of various animal species will starkly diminish, some potentially nearing the brink of extinction (Msuya et al., 2019). In hopes of counteracting, or at least mitigating, these dire circumstances, it is pivotal that a means of acquiring necessary funding for wildlife rehabilitation efforts be implemented. As such, it is critical that we foster greater public interest and encourage additional societal involvement in addressing such pressing environmental issues, as, by doing so, we may be able to alleviate the heavy monetary burden currently faced by these conservation-geared institutions. This research paper aims to develop such a strategy through the utilization of cuteness appeals present within many endangered mammalian species native to Arizona. Specifically, it seeks to address the question, “what effect do Behavioral Activation/Approach System sensitivities—the physiological mechanism believed to control appetitive motivation (Gray, 1981, 1987a, 1990)—coupled with animals’ kindchenschema cute features—prototypical cute features as established in pertinent scholarly literature (Alley 1981, 1983; Lorenz 1943)—have on Tucsonan adult hikers’ desires to charitably donate to endangered mammalian species native to Arizona?” Starting from intrastate endeavors, such tactics, if successfully orchestrated, can slowly be adopted on a national scale, aiding in broadening the reach of and bolstering the success of conservation efforts.

As indicated by the previously posed research question, motivating people to expend money for the sake of rehabilitation or conservation efforts cannot be fruitfully accomplished with the implementation of one universal strategy as everyone possesses differing dispositions favoring varying messages and attractions. Thus, regardless of the success rate of utilizing

cuteness appeals, not everyone will be induced to aid in this environmental undertaking.

However, mobilizing even a small cohort of supporters and contributors will prove indispensable for minimizing future environmental detriment.

## **Literature Review**

### **Conservation Marketing Strategies**

At the grassroots level, conservation efforts are heavily reliant upon donations provided by the general populace which often consists of people who are highly, though often inadvertently, perceptive to visual cues (Brambilla et al., 2013; Martín-López et al., 2009; Metrick & Weitzman, 1996). In order to best appeal to such individuals, many wildlife rehabilitation organizations have utilized species' aesthetic appeals to bolster attraction and motivate monetary provisions (Brambilla et al., 2013; Martín-López et al., 2009; Metrick & Weitzman, 1996). Demonstrating high success rates, these agencies witnessed their donation rates surge upon implementing visually-tailored marketing tactics (Connelly & Brown, 1990). In spite of these efforts, a fair amount of non-contributors remain, primarily basing their decisions on a lack of interest for wildlife, disapproval of monetary distribution within wildlife rehabilitation programs, and/or a lack of money to contribute. This research paper aims to explore what motivates rather than disincentivizes donor behavior in relation to conservation efforts. Thus, I will not delve further into the rationale behind these non-contributory resolutions. Further research can be conducted here. It is important to note, however, the general disapproval regarding the allocation of wealth within such prospective donor groups which I will discuss shortly hereafter. This research paper will also, so as to minimize the effects of monetary standing on pecuniary contributions, solely gauge "willingness-to-donate" and do so within the context of a hiker population. Thus no monetary transaction will be conducted and my

respondents will, on average, have moderate financial stability given that they can allocate time to engage in recreational activities and in my survey procedure. This will mitigate the prevalence of socioeconomic status as a confounding variable in shaping engagement in charitable behaviors. Regardless of the reason behind not contributing, a majority of non-benefactors were still found to value the preservation of threatened and endangered animal species as seen in a New York study which found that 52% of non-contributors rated this as their highest environmental priority (Connelly & Brown, 1990). Thus, conservationists don't need to solely follow a strategy of market segmentation, targeting their efforts towards those they believe are more likely to support their cause, such as past donors. Rather, they can expand their target audience to non-contributors as well, an equally viable and untapped source of revenue (e.g. Aroean & Michaelidou, 2014; Dolnicar, 2002; Holbrook, 1996). This display of heightened care shown towards "threatened " species' statuses, is also a key reason behind the selection of endangered animals as the target visual stimulus for this study.

Not only can conservation efforts broaden in terms of donor demographic, but they can also extend to fairly represent a broader spectrum of animals. A majority of these aesthetically-geared marketing strategies are primarily employed on flagship species—organisms that are publicly promoted to raise support for biodiversity conservation (Veríssimo et al., 2011). It is pivotal for these institutions to push forth such visually appealing stimuli as the more aesthetic and subsequently more popular flagships on average receive forty-six times more funds than unattractive and thus lesser known species (Colléony et al., 2017). Though promoting this standard list of animals and simultaneously fostering a sense of familiarity serves to be a fruitful tactic in acquiring much necessary funding for conservation efforts, it fails to inform the public of the dire circumstances afflicting a wider array of organisms. As many donors concentrate their



money on a narrow set of efforts, the funding received by conservationists is siphoned off disproportionately, providing inadequate care to lesser known species. In order to best aid rehabilitation efforts in a manner beneficial to all organisms, a potential future application of this paper, this research study will not be utilizing flagship species nor species of varying relative familiarities—all organisms selected for this paper were listed as “endangered” so as to maintain a limited and consistent familiarity status.

### **Impact of Behavioral Activation/Approach System Sensitivities**

Though the notion that peoples’ dispositions favoring aesthetically pleasing organisms has been established in scholarly literature, this attraction is by no means universal. In fact, only those who have high behavioral activation/approach system (BAS) sensitivities are prone to impulsive altruistic behaviors when shown a visually appealing stimulus (Wang et al., 2017). Within the realm of study concerned with brain function and behavior, psychologist Jeffrey Alan Gray postulated two dimensions of personality, namely the Behavioral Activation/Approach System (BAS) and the Behavioral Inhibition System (BIS) (Carver & White, 1994). For the purposes of this paper, I will only be discussing BAS, specifically the component of BAS tasked with reward responsiveness which centers around impulsivity rather than anxiety proneness, an emotional disposition measured by relative BIS sensitivity (Carver & White, 1994). As briefly aforementioned, BAS is the physiological mechanism believed to control appetitive motivation (Gray, 1981, 1987a, 1990). This system is sensitive to reward cues. Thus, those who display greater BAS sensitivities, if expecting an impending reward, are more motivated to work towards their goals regardless of the ensuing energy expenditure (Gray, 1977, 1981, 1990). These individuals are also prone to executing whatever task is required of them for acquisition of said prize as doing so will propel their entrance into a positive emotional state. The neural basis of the

BAS is grounded in medial orbitofrontal activity as well as ventral striatum activation which is enhanced in individuals displaying elevated approach motivations when placed within reward-affiliated situations (Simon et al., 2009).

Within a given population, BAS exists on a spectrum; thus, different people react uniquely when presented with an attractive inducement. This partially justifies the presence of non-contributors in conservation endeavors as individuals who display low BAS sensitivities may appear apathetic towards wildlife rehabilitation efforts and aesthetic cues, making them less inclined to engage altruistically and expend their money for the sake of such undertakings. This relation between BAS sensitivities and willingness-to-donate has been established by some accredited studies; however, it still lacks sufficient support in pertinent scholarly literature and has yet to be observed or measured in laypeople who have less knowledge of ecological matters and are thus more likely to act sporadically, relying primarily upon their BAS to formulate their decisions to donate.

### **Cuteness Appeal as a Tool in Conservation Efforts**

One aesthetic cue that is prevalent in many animal species and commonly utilized by conservation marketers is cuteness appeal. As defined in academia, cuteness follows two distinct forms: whimsicality and kindchenschema. Whimsicality is associated with exuberant behavioral displays whereas kindchenschema follows the more traditional manifestations of cuteness and is marked by the possession of juvenile traits such as a relatively big head, round and protruding cheeks, large eyes, and a plump body with soft-elastic surface texture (Alley 1981, 1983; Lorenz 1943). For the purposes of this research paper, I will be focusing on kindchenschema cuteness factors.

The presence of these aesthetic characteristics is pivotal in shaping human behavior. When people see an animal in possession of infantile features, they sense from it a certain level of vulnerability that elicits their instinctive nurturing tendencies. Thus, caring for that animal and aiding in its survival proves to be an inherently rewarding stimulus for many (Hildebrandt & Fitzgerald 1978; Kringelbach et al. 2016). As such is the case, it seems likely that those with high BAS sensitivities would be inclined to engage in acts of conservation if it ensured they could play a role in maintaining the livelihood of kindchenschema cute animals, an inherently rewarding endeavor. Research conducted by Tingting Wang, Anirban Mukhopadhyay, and Vanessa M. Patrick corroborates this hypothesis, establishing that sustainable behaviors can be induced in high BAS individuals through the viewing of kindchenschema cute organisms. However this contention has very minimal experimental backing and has yet to be explored in relation to donation generation. Thus, in order to better substantiate this claim, I applied it to the facilitation of another prosocial undertaking: donation generation. In addition, I tested its applicability to a niche group of individuals, namely adult Tucsonian hikers. This sample population was chosen due to their propensity for engaging in environmentally conscientious endeavors and their presumed diversity in academic background which would hamper the prevalence of ecological experts composing my participants allowing for the subject body to constitute the decisions of lay people. In order to explore this research topic, I posed the following question: what effect do BAS sensitivities coupled with animals' kindchenschema cute features have on Tucsonan adult hikers' desires to charitably donate to endangered mammalian species native to Arizona?

## Method

Spanning from January through March of 2022, I attended various hiking events hosted by the Southern Arizona Hiking Club. At each I brought with me a set of 4 endangered animal posters possessing the following visual elements: a cute stimulus paired with a high BAS slogan, a cute stimulus paired with a low BAS slogan, a noncute stimulus paired with a high BAS slogan, and a noncute stimulus paired with a low BAS slogan (See Appendix D). In each case, cuteness was defined by the possession of prototypical kindchenschema cute features as identified in literature (Alley 1981, 1983; Lorenz 1943). In order to ensure that what I discerned as being “cute” was publicly perceived as such, I asked each respondent, after recording their responses regarding their willingness-to-donate (this procedure will be explained in greater detail later on in this paper), to rate the cuteness of the animal they witnessed on their poster on a 5 point Likhert scale (1 = “not cute at all” and 5 = “extremely cute”) (See Appendix A). This data was then analyzed using a one-way analysis of variance (ANOVA) to certify that what I predicted to be “more cute” was in fact deemed as such by our target audience. At this point in time, participants were also asked to rate their relative familiarity with their assigned animal (1 = “never seen before” and 4 = “seen too often/very familiar”). This portion of the study ensured that familiarity did not influence willingness-to-donate as this has proven to be an influential variable in similar studies observing conservation marketing strategies (Lundberg et al.). In order to ensure that the slogans were respectively BAS-evoking and BAS-inhibiting, I utilized the captions employed by a similar research study that likewise sought to find the effects of kindchenschema cute stimuli on prosocial behaviors, namely recycling (Wang et al., 2017). Serving as yet another manipulation check, I administered an additional study in which participants were only provided the slogans without the accompanying animal’s image and asked

the extent to which they wish to donate on a 7 point Likert scale (1 = “very little” and 7 = “very much”). This process was undertaken so as to determine whether the slogans were the sole cause or contributing cause alongside the animal images to alterations in participant willingness-to-donate upon seeing the posters.

Once equipped with all four aforementioned posters, I met with the hikers privately. I asked for their informed consent of all procedures that were to take place, making sure to clearly state what task they were expected to perform—looking at a poster and responding to the subsequent survey questions—and what kind of data would be recorded—information regarding personality type and willingness-to-donate (See Appendix C). I also noted how said data would be collected—in oral and written formats. So as to disclose a purpose behind my data collection, I provided the following statement to each participant: “a local animal protection agency has designed a poster to generate donations to help save endangered animals native to the Sonoran Desert and I am interested to hear your reaction.” I didn’t divulge any further minutiae regarding this project’s goal so as to best prevent response bias and ensure the accuracy of my results.

After the adjournment of this briefing, I used a random number generator ranging from one to four—one representing the first poster, two the second, and so on—to randomly assign each participant a poster to view. This process of random assignment allowed me to establish a causal link between BAS sensitivity and willingness-to-donate driven by cute incentives in the analysis section of this paper. Upon assignment, the participant saw their allotted poster for no longer than 8 seconds and was promptly asked “to what extent are you willing to donate to this species?” on a 7 point Likhert scale (1 = “very little” and 7 = “very much”) that was displayed on the poster itself. The primary purpose for the imposition of this stringent time restraint was to ensure that the participant answered impulsively (Carter and White, 1994). This prevented a

more thought-out, rationalized response from being generated, ensuring that only the individual's BAS and their interactions with the cute image would be driving their decision. Additionally, I did not inquire into monetary thresholds, as what is believed to be a significant or menial financial contribution may differ based on socioeconomic status and this research's goal was solely to gauge "willingness-to-donate," not the quantity of that donation. All responses for this portion of my study were orally received and personally transcribed (See Appendix A).

Following this verbal exchange, I provided each participant with a survey gauging their BAS Reward Responsiveness (See Appendix B). The questionnaire provided was developed by Carter and White, well-established figures in the field of psychology known for their research into dimensions of personality, so as to ascertain the effect BAS had on influencing participant decisions. Whilst my respondents were completing the survey, for which they were not given a time restraint, I continued the all aforementioned procedures with the remaining participants.

## **Data Analysis**

### **Cuteness Manipulation Check**

In order to ensure that the image bank consisted of visual stimuli of varying degrees of cuteness, primarily one cute and one less cute picture, a one-way analysis of variance (ANOVA) was employed. This statistical test is used to determine whether or not the means of varying groups of interest are statistically distinct from one another. If the p-value derived from this test is less than the alpha value employed, the null hypothesis, which states that there is no difference in opinion between the cuteness of both images, can be rejected. It was deduced that the  $M_{\text{cute}} = 4.179$  and that the  $M_{\text{noncute}} = 2.071$  with a p-value of 0, which was less than our alpha value of 0.05 ( $p < 0.05$ ). Thus, what I discerned as possessing more kindchenschema cute factors and thus appearing more outwardly "cute" was, in fact, subjectively perceived as such. The chosen alpha

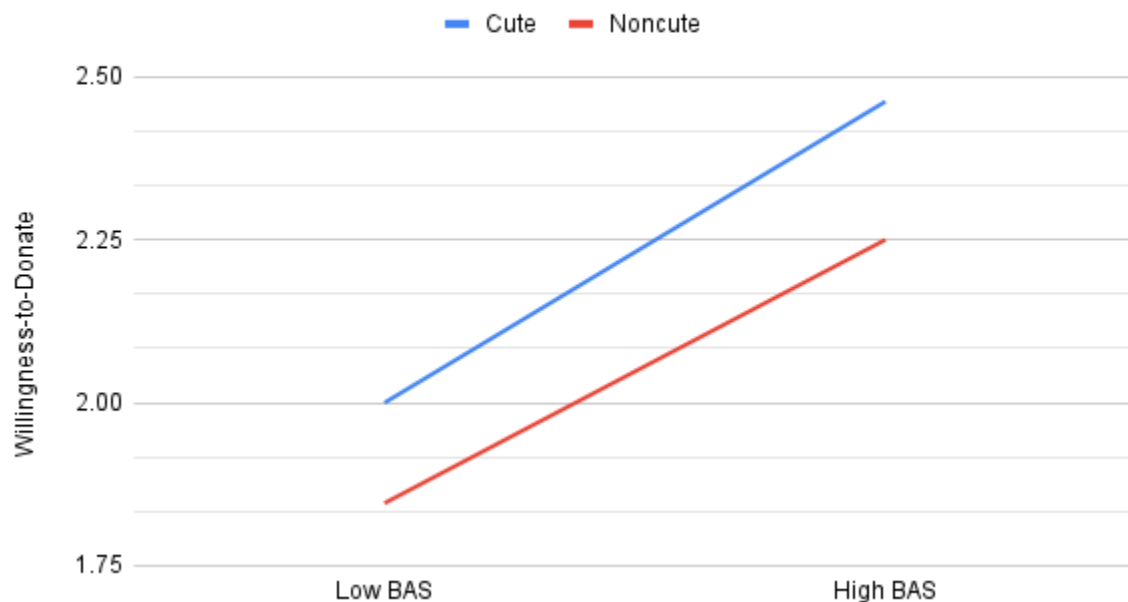
value was set at 0.05, representing a 5% chance of a Type I error/“false positive” occurring. This low risk of error ensures the maintenance of high internal consistency.

### **Familiarity Effect**

A two-way ANOVA was conducted so as to determine if familiarity, another factor proven in related scholarly texts to affect willingness to donate, was present as an additional source of variation in the measurement of this dependent variable. In doing so it was determined that the F statistic, the variable used as a test statistic in ANOVAS, valued 1.523 and that the F critical value, which is used comparatively with the F statistic to make conclusions about the acceptance or rejection of the null hypothesis, valued 1.592. As  $F_{stat} < F_{crit}$  and the p-value is 0.069 which is greater than the alpha value of 0.05, I can't obviate the influence familiarity has on willingness to donate.

### **Linear Regression Analysis**

#### **The Influence of Cuteness and BAS on Willingness-to-Donate**



Data for the mean willingness to donate based on kindchenschema “cute” visual stimuli and BAS-piquing text was calculated and a linear regression of all pertinent variables was conducted, producing the graph pictured above. As can be qualitatively deduced, the lines relating all three variables—BAS, cuteness, and willingness-to-donate—do not run strictly parallel to one another. This is indicative of an interaction effect being present which signifies that a combination of both BAS and cuteness were, in fact, in play when shaping the respondents’ willingness’-to-donate as per their survey responses. This interaction effect was significant as well given that the t-value extrapolated from running a statistical analysis on this data set measured 7.776 which is far greater than the recommended minimum threshold of +2. The presence of a larger t-value here offers greater confidence in the reliability of our data as it is indicative that the trends analyzed aren’t the result of a chance occurrence and are statistically significant. Additionally, the p-value measured 4.809E-10 which is far smaller than the alpha value of 0.05 further substantiating the link between cuteness and BAS and their joint influence on willingness-to-donate. The means of solely BAS-impacted returns as well as solely cuteness-impacted returns remained distinct from one another ( $M_{\text{cute}} = 2.231$  vs.  $M_{\text{noncute}} = 2.048$ ;  $M_{\text{highBAS}} = 2.356$  vs.  $M_{\text{lowBAS}} = 1.923$ ) which is demonstrative of their independent impacts on willingness-to-donate as well. This effect is commonly termed the main effect, of which there are two present. No other effects were recorded as they were deemed statistically insignificant with a p-value of less than the set alpha value of 0.05.

### **Spotlight Analysis: Cuteness**

Subsequent to regressing respondents’ altruistic intentions, a spotlight analysis was conducted on the following participant categories: those who received a poster with high BAS-stimulating text and those who bore witness to a poster with low BAS-stimulating text.



Within the high BAS group,  $M_{\text{cute}} = 2.6$ ,  $M_{\text{noncute}} = 2.4$ ,  $t = 2.671$ , and  $p = 0.116$ . Though the t-value is significant, being greater than 2, albeit by a small margin, the p-statistic exceeds the set alpha value of  $\alpha=0.05$  suggesting that among high BAS participants, cuteness did not have much of an effect on their willingness-to-donate. Conversely, within the low BAS group,  $M_{\text{cute}} = 2.8$ ,  $M_{\text{noncute}} = 2.6$ ,  $t = 6.553$ , and  $p = 0.023$ . Here not only is the t-value significant ( $t > 2$ ), but so too is the p-value ( $p < \alpha=0.05$ ). This suggests that among low BAS participants, there is a positive effect of cuteness on willingness-to-donate. As a random assignment of posters to respondents was employed throughout the entirety of the surveying procedure, this interaction is casual in nature, meaning that the presence of a cute image did, in fact, directly motivate those who displayed low BAS sensitivities to be more inclined to donate.

### **Spotlight Analysis: BAS**

Referring back to the aforementioned linear regression graph, the slopes of the lines displayed can be analyzed to establish a causal relationship in which the possession of a high or low BAS sensitivity can prompt an individual who bears witness to a cute image to display a heightened or minimized willingness-to-donate. Looking at the blue curve which indicates the presence of a cute image, the t-statistic for this line valued 4.364 ( $t > 2$ ) and the p-statistic for this line valued 0.049 ( $p < \alpha=0.05$ ). This is indicative of a statistically significant positive effect of BAS on bolstering one's willingness-to-donate upon looking at a cute animal. This trend is continuously present when observing the red curve which is indicative of a noncute image. The t-statistic here valued 7.303 ( $t > 2$ ) and the p-statistic valued 0.018 ( $p < \alpha=0.05$ ). This demonstrates that, regardless of cuteness, those who display an active BAS and are exposed to BAS-stimulating text are more inclined to engage in philanthropic acts such as donating to an endangered species fund. That being said, when solely shown a BAS-stimulating slogan such as

“Donate NOW!” as opposed to “Please Donate”, the participants donation tendencies weren’t significantly altered ( $t < 2$ ;  $p > \alpha=0.05$ ), underscoring the significance of designing a poster with both a visual stimulus and accompanying text in order to invigorate the participants’ willingness-to-donate.

## **Conclusion**

### **Findings**

As identified in the analysis portion of this research study, the combined effect of kindchenschema cute stimuli and BAS-evoking text does, in fact, bolster the willingness-to-donate of adult Tucsonan hikers. This both supports the findings of Tingting Wang, Anirban Mukhopadhyay, and Vanessa M. Patrick who found a similar link between BAS, cuteness, and the prosocial endeavor of recycling as well as corroborates the rationale behind Connelly and Brown’s implementation of visually-tailored marketing strategies, justifying why this strategy was as fruitful as they had observed. Furthermore, I am able to extrapolate these trends to encompass the entirety of the adult Tucsonan hiking population due to the employment of a random selection of participants and a random assignment of posters to hikers which allows for a more representative sample population with limited sampling bias.

### **Changes in Hypothesis**

Though there was, in fact, a significant positive effect of BAS and cuteness on willingness-to-donate, the isolated impact of cuteness fell short in individuals displaying a high BAS. This ran quite contrary to our initial predictions which contended that those who displayed high BAS sensitivities would be more motivated to expend money for conservation efforts if they bore witness to cute images, as doing so would ensure the acquisition of the following forthcoming reward: the preservation of cute animals in the subjects’ local ecosystem. It is

plausible, as all participants were aged well beyond 25 years old ( $M_{\text{age}} = 65$  years old), that their fully developed prefrontal cortices played a role in such displays of impulse control notwithstanding their relative BAS sensitivities (Arain et al., 2013; 2021). However, choosing elderly residents as opposed to a younger demographic as the experimental units of this study is still warranted given their comparably extensive time availabilities and readily disposable incomes; it is hypothesized that these individuals would be more generous with their expenditures given that they have already wrought monetary stability in their lives. Additionally, this unforeseen neutral influence by no means obviates the main premise of this paper which contends a statistically significant combined impact of BAS and cuteness on willingness-to-donate.

### **Limitations**

In regards to limitations that could have restricted the scope of the results computed, the following two variables are the most conceivable: variations in the participants' hiking avidity and the gender makeup of the respondency. Related closely to the concept of avidity are those of familiarity and environmental conscientiousness. When measuring the willingness to engage in conservation efforts among individuals who regularly hike, the researcher is more likely to bear witness to subjects who showcase a greater affinity to environmentally beneficial endeavors. Subsequently, members of this population possess greater knowledge regarding the threats afflicting various species in their vicinity, motivating them to display a heightened willingness to donate to our study. The inverse of this trend would presumably persist for those who are less active in their hiking pursuits. The impact of gender, on the other hand, is less clear. Though there is a chance that traditionally promulgated gender roles could elicit certain responses, whether those be endearing, and thus strengthening altruistic inclinations, or apathetic, and thus

minimizing donation tendencies, this association has yet to be substantiated by relevant texts. In fact, the impact of this potential confounding variable on prosocial endeavors has been discredited by pertinent scholarly literature, including notable studies published by Carter and White. However, in spite of this past precedent, gender cannot be completely overlooked as a potential source of response bias, especially given that it was not tested in this paper. Aside from these two viable sources of error, no other limitations were foreseeable and subsequently documented. The sample quota that was necessary to adequately establish all aforementioned conclusions was met (Required sample size for a population of 60: 52 people; Confidence Interval: 5; Confidence Level: 95%) and thus no issues stemmed from this.

### **Further Research and Implications**

Although this research paper has conjured a potential means of generating revenue for conservation efforts within the city of Tucson, no money was actually generated during the method's employment. Hence, evidence supporting the viability of this cuteness-centered marketing tactic when expecting a monetary transaction has yet to be generated. Not only can the feasibility of this strategy's application be tested going forward, but so too can its employment be extended to cover a wider array of niche populations so as to further substantiate Gray's postulated scales, utilizing proper and appropriate instrumentation to extrapolate its application to larger cohorts of the human population. This will also contribute more broadly to the scholarly conversation regarding the application of BAS-defined dimensions of personality on human subjects, a topic that the academic community has yet to render a consensus on (Carver and White, 1994).

## **Appendix A**

### **Survey Questions Orally received**

The following set of questions prevented verbatim as displayed to the respondents gauged the following variables: willingness-to-donate, cuteness, and familiarity:

1. To what extent are you willing to donate to this species?
  - 1.1. I do not wish to donate to this species at all
  - 1.2. I wish to donate to this species, but not a great deal of money
  - 1.3. I wish to donate a moderate sum of money to this species
  - 1.4. I wish to donate fair sum of money to this species (a bit more than average but not too great a quantity)
  - 1.5. I wish to donate a large sum of money to this species
2. How cute was the animal you witnessed on the poster?
  - 2.1. Not cute at all
  - 2.2. Slightly cute
  - 2.3. Moderately cute
  - 2.4. Cute
  - 2.5. Extremely cute
3. How familiar are you with the animal you witnessed on the poster?
  - 3.1. I have never seen nor heard of this animal before
  - 3.2. I have seen/heard of this animal, but very rarely (minimum: 1 time, maximum: 5 times)
  - 3.3. I regularly see/hear of this animal, with some exceptions
  - 3.4. I see/hear of this animal far too often

## Appendix B

### Transcribed Survey Questions

The following set of questions presented in a chart gauged the relative BAS sensitivity of the respective participant:

BAS Rewards Responsiveness	$\alpha$	M	SD	1	2	3	4	5	6
When I get something I want, I feel excited and energized									
When I'm doing well at something, I love to keep at it.									
When good things happen to me, it affects me strongly									
It would excite me to win a contest									
When I see an opportunity for something I like, I get excited right away									

## Appendix C

### Notice of Informed Consent

The following notice was delivered to all participants prior to retrieval of their data/responses so as to be compliant with all necessary ethical requirements/procedures:

The project at hand is intended for research purposes. Engagement in any of this study's procedures is completely voluntary. The purpose behind this project is as follows: "A local animal protection agency has designed a variety of posters so as to generate donations to help save endangered mammalian species native to the Sonoran Desert. This study seeks to gauge the effectiveness of these advertisements". The estimated duration for completion of this survey session is 5 minutes per person. This study entails that each participant looks at their assigned poster for an 8 second interval and promptly responds to a set of survey questions which will be collected in both oral and written fashions. The data recorded will be that relating to personality type and willingness to donate. The following foreseeable, reasonable risks or discomforts may arise: allocation of participant time, provision of personal information, and pandemic-related concerns. The following reasonable, expected benefits may result: contributing to the fields of personality research and conservation marketing. Participant anonymity will be maintained in all collected data.

If you have read, understood, and agreed to all aforementioned content please sign below:

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## **Appendix D**

### **Poster Schematic**

The images that were deemed as cuter were those depicting the American Ocelots (upper left and upper right images) and those that were deemed noncute were depicting Sonoran Pronghorns (lower left and lower right images). BAS-evoking text was displayed as "Donate *NOW!*" and BAS-mitigating text was displayed as "Please Donate".

Please Donate



Donate *NOW!*



Please Donate



Donate *NOW!*





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# USING SENTIMENT ANALYSIS TO PREDICT GOOGLE STOCK PRICES

Using Sentiment Analysis to Predict Google Stock Prices

Word Count: 4434

## USING SENTIMENT ANALYSIS TO PREDICT GOOGLE STOCK PRICES

**Introduction**

Stock markets play an active role in the modern-day economy. In the month of February in 2019, the NASDAQ Stock Market recorded an average of 12 million shares traded daily (NasdaqTrader 2019). Based on a survey conducted in 2016, it is estimated that 52% of Americans have money invested in the stock market (Jones and Saad 2016, 1). Despite the vast number of stock investors, they mostly strive for a common goal of profiting. Typically, traders desire to find and purchase stocks that will rise in terms of prices in the future. As time passes and their stocks' value rises, they can choose to sell it at a higher price than before and earn a profit. As a result, it is essential for traders to have the ability to foresee future stock trends. This skill of prediction enables the trader to select the stock with great potential to rise in value and acquire it at a low price.

Living in the age of the Internet, people are able to express their opinions with ease. Online news, public forums, and social media are examples of popular platforms available for people to communicate their thoughts. Facebook, an American online social media company, recorded 4 billion pieces of content posted daily in 2012 (Wilson et al. 2012, 203). Through online posts, users indirectly indicate their attitudes and views on certain events. This immense online content can be treated as data suggesting the mood of the public. The sentiment of online news attracts the attention of stock investors as it is directly related to the market. Traders read and interpret news articles related to their investments. The sentiment conveyed by the most up-to-date news will impact their decisions to buy or sell their stocks. Therefore, in logical terms, the general opinion of online reports has an impact on the stock market. By collecting the sentiment of news, analysts can derive a correlation between the public's mood with the stock market.

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**Literature Review**

Numerous studies had been done to examine the accuracy and applications of sentiment analysis. Sentiment analysis can be defined as a computational method that extracts opinions by analyzing raw text data (Kechaou et al. 2011, 1032). There are innumerable real-world applications of sentiment analysis, such as labeling customer reviews, developing recommendation systems, and etc. Studies in these areas generally reported a high accuracy in analyzing the sentiment of text data. For instance, in 2002, Bo Pang, a graduate student studying computer science at Cornell University, tested the accuracy of machine-based sentiment classification in analyzing movie reviews. He compared the sentiment results from movie reviews on IMDb with the corresponding numerical ratings (Pang et al. 2002, 80). From his results, the Naïve Bayes classifier, a popular sentiment analysis technique using simple probabilities (Explained in detail in next paragraph), obtained a 78.7% accuracy of correctly labeling movie reviews as either positive, negative, or neutral.

One study done by Sarkis Agaian and Petter Kolm in 2017 focused on the accuracy of sentiment analysis in financial news. Agaian, a consultant at Capstone Investment Advisors, compared the accuracy of measuring the sentiment of business news using support vector machine, maximum entropy, and Naïve Bayes classifiers (Agaian and Kolm 2017, 3). In detail, the Naïve Bayes classifier relies on Bayes' Theorem of Probability, which explains the probability of an event based on the conditions that could be associated with the event. Maximum entropy finds and determines a data group by considering the most extreme scenario of the dataset. The support vector machine classifies two clusters of data (In this case, whether the word is positive or negative) by finding the best-fit curve that can cut between them. Despite using various machine learning algorithms, Agaian's results revealed an average classification accuracy of around 75%. Through this study, Agaian concluded that using sentiment classification in analyzing financial articles is promising.

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Although a general consensus could be drawn that sentiment analysis can measure the mood of public opinions with high accuracy, there are not many studies focusing on the applications of sentiment analysis in predicting the stock market. Out of the studies that did focus on forecasting financial markets through sentiment analysis, the results generally revealed a low correlation between public sentiment and the stock market.

A research study was conducted to explore the influence of news reports on stocks using sentiment analysis in 2013. In his paper, XiaoDong Li, a graduate student at the City University of Hong Kong computer science department, and his colleagues examined the accuracy of using sentiment analysis to predict the Hang Seng Index (HSI). The Hang Seng Index, containing the top 50 companies in Hong Kong, is regarded as the main measure of market performance in the region. As for business articles, Li extracted news from FINET, an archive comprised of articles relating to both individual companies and the Hong Kong market from January 2003 to March 2008 (Li et al. 2014, 16). A dictionary-based method of sentiment analysis is then applied to the news articles. Li utilized both the Harvard IV-4 sentiment dictionary (HVD) and the Loughran-McDonald financial sentiment dictionary (LMD) in his study. Both sentiment dictionaries were compiled manually. The HVD contains over 10,000 words with 15 dimensions to each word while the LMD consists of more than 3,911 words with 6 dimensions. These dimensions include positive/negative connotation, cognitive orientation, motivation, and etc. By cross-referencing the news articles with the dictionaries, Li produced a data chart tallying articles that fit under specific dimensions. Essentially, he converted each article's sentiment into numerical values. Moreover, each article had a time stamp and a tag indicating its relevance to certain companies. This allowed Li to match the news sentiment data with changes in the Hang Seng Index of a certain day. With this dataset, Li extrapolated a correlation to predict changes in the stock price index based on the latest news articles. He found that both dictionary-based sentiment analysis

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techniques had around the same accuracy of 57% in predicting the rise or fall of the Hang Seng Index. Considering that a random binary guess would yield a 50% accuracy, Li concluded that his model would be 7% better than a random guess.

In 2000, another study used a different approach from Li et al. to investigate this topic. Kenneth L. Fisher, the founder of Fisher Investments, and Meir Statman discovered that there was a negative relationship between investor sentiment and stock price changes (2000, 16). To obtain data about investor sentiment, Fisher surveyed three groups of stock investors: Wall Street strategists, investment news writers, and small individual investors. Respectively, these groups represented the large, medium, and small investors in the stock market. Unlike Li's method to obtain sentiment data, Fisher conducted surveys and questionnaires on each investor group. For instance, Merrill Lynch, an American wealth management group, conducted and provided the surveys on around 15 to 20 Wall Street strategists since September 1985. In the form of questionnaires, each survey measured how *bullish* its subjects are. In stock market terms, to be *bullish* is to have a high inclination of purchasing stocks. Fisher selected data surveyed monthly from September 1985 to July 1998. He then compared each group's sentiment values with movements in the S&P 500 index according to trading days. Three scatter plots (One for each investor group) visualized the dataset and displayed the correlation of the data. Though all three groups had a negative correlation between investor mood and stock price changes, only the correlations for individual investors and Wall Street strategists were statistically significant at the 1 percent level with an adjusted R-squared value of 0.05 and 0.03 respectively. Although the R-squared values suggest that investor sentiment justifies only 3 to 5 percent of S&P 500 returns, Fisher explained that the information could be useful to stock traders. According to Clarke et al. in another study about correlations between the stock market and information, an R-squared value of 0.09 gives stock traders a 5.9 percent higher accuracy in forecasting expected stock



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return (1989, 31). Essentially, Clarke's research explained the validity and implications of Fisher's results, concluding that even a small R-squared value could give a strategic advantage to investors.

Although the aforementioned studies indicated the potential of using sentiment analysis to estimate changes in stock price indexes, there remains a significant research gap in predicting individual company stocks. In these studies mentioned above, they tended to relate sentiment with stock indexes. In my opinion, focusing on entire indexes, which typically includes a number of company stocks, could possibly be the reason why existing research yielded comparatively low correlations. As asserted by Malcolm Baker, a professor at the Harvard Business School, certain stocks are more subject to changes in public sentiment than others (Baker and Wurgler 2007, 131). For instance, the S&P 500 is an American stock market index containing 500 companies. When there is a notable change in public sentiment, some stocks within the S&P 500 may be impacted significantly while others are less affected by it. The correlation between sentiment and the S&P 500 will be less significant as only parts of the index are affected by the general view of the public.

In my experiment, I hypothesized that a higher level of correlation could be determined from investor sentiment and stocks by looking at only one company. This led to the essential question of my research: how do social media news regarding a specific company impact its stock market prices? To test my hypothesis, I centered my study on the stock return of Google based on online articles about the company. Using Python programming, I scrapped articles about Google from a news website and performed sentiment analysis on each piece. By comparing this data with the stock price change, a best-fit relationship could be derived, possibly leading to higher accuracy in predicting individual stock prices based on public sentiment.

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**Methodology**

Google was suitable to be the subject of this study as it fulfilled several requirements. Google, or officially Alphabet Inc., is one of the most valuable companies in the world with an estimated market valuation of 848 billion dollars as of April 2019 (Yahoo! Finance). The company's stock, GOOG, receives an average trade volume of 1,380,563. Google is also one of the most recognized brands in the world (Casella 2017). The company's focus matches the characteristics of stocks more subject to sentiment as shown in a study done by Baker and Wurgler. From their experiment, they concluded that well-recognized companies following the modern business trend are more affected by changes in public sentiment (Baker and Wurgler 2007, 131). Google's renowned reputation in Internet-related services thus fits the criteria well.

**Downloading Online Articles**

As for extracting news sentiment of a company, Bhardwaj et al. described a reasonable method to obtain news archives using Python programming. By using Beautiful Soup, a Python package for scrapping online content, Bhardwaj et al. were able to fetch Indian news articles on the Internet (Bhardwaj et al. 2015, 89). Bhardwaj's procedure suited my study because it was manageable for a high schooler like me to implement and fulfilled the purpose of retrieving online news content.

For my experiment, I extracted articles about Google from Techmeme, a technology news aggregator. In order to ensure multiple news sources were taken into account, I selected Techmeme as my data provider since it compiles its content from dozens of other online news sites, including the New York Times, TechCrunch, and etc. Similar to Bhardwaj's method, I utilized Beautiful Soup and Selenium, another Python package for automated web

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browsing, to extract news articles onto my computer. My algorithm in Python worked as follows:

1. Use Selenium to open web browser with the address of <https://www.techmeme.com/search/query?q=google&wm=false> (Search query of “Google” on Techmeme)
2. For each article on the page, use BeautifulSoup to parse article’s text, title, and publishing time.
3. Write each article’s text, title, and publishing time onto a local CSV (Comma-separated values) file on my computer. Each article would be a single row with 3 columns.
4. Use Selenium to flip to next page of results.
5. Loop the above steps for 100 times.

Each results page from Techmeme displays 10 articles at a time. By flipping the page 100 times and recording each article, the above algorithm would theoretically retrieve 1,000 most recent articles about Google. However, nearly half of the articles had alternate formats and layouts, causing it to be inaccessible for BeautifulSoup to parse. As a result, the above procedure yielded 573 articles about Google from Techmeme. The retrieved articles had publishing dates ranging from June 19<sup>th</sup>, 2018 to March 20<sup>th</sup>, 2019 with an average of 3.12 articles per day.

### Extracting Stock Price

From Yahoo! Finance, I downloaded the recent stock prices of Alphabet Inc. (GOOG). With the news sentiment of Google as the independent variable in my experiment, I used the percent change in stock prices as the dependent variable, which is given by

$$\text{Percent Change} = \frac{(\text{Current Price} - \text{Previous Price}) / \text{Previous Price}}{(\text{Current Price} - \text{Previous Price}) / \text{Previous Price}}$$

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As opposed to other similar studies, I used the percent change between closing prices across trading days, also known as the close-to-close return. Li et al. measured the percent change between the opening price and the closing price in one trading day, or the open-to-close return, in their study. They justified their means since it resolved the issue of non-trading day gaps, where close-to-close return behaves differently over weekends and holidays (Li et al. 2014, 17). However, in my opinion, the open-to-close method only measures the change happening in the market hours. Due to pre-market and after-market trading, the opening price does not necessarily equal to the previous trading day's closing price. News published before the opening time of the market could potentially impact the market's opening price. Thus, I chose the close-to-close return method as it accounted for news not published during the market hours.

**Applying Sentiment Analysis**

To apply sentiment analysis on each article, I used another Python library, TextBlob. Rather than other text analysis methods, I chose TextBlob because it was feasible for a high school student like me to use. TextBlob is also more efficient in performing sentiment analysis due to its relatively simple algorithm. By inputting raw text, TextBlob is able to return the polarity and subjectivity of the text. The polarity score is a value between -1.0 and 1.0 with -1.0 being very negative and 1.0 being very positive. The subjectivity score is a value within the range of 0.0 and 1.0 where 0.0 is very objective and 1.0 is very subjective. For instance, the sentence "TextBlob is amazing" would yield a polarity of 0.6 and a subjectivity of 0.9.

TextBlob's underlying concept to derive these values is based on bayes' theorem in conditional probability. Bayes' theorem describes the probability of an outcome occurring given a linked precondition. TextBlob takes into account the likelihood of a phrase being

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positive or negative based on other information related to it. An example would be to give a high value in the subjectivity score of a phrase with an exclamation mark since exclamation marks typically meant an outburst of emotion. TextBlob adds or subtracts the probability of the text being positive/negative or objective/subjective based on the many characteristics of the passage. After adding the values together, the outcome with the highest probability is declared to be the correct answer. This method, known as the Naïve Bayes classifier, consists of only counting and multiplication, enabling a quick and efficient runtime. Despite the simplistic algorithm, the accuracy of using a Naïve Bayes classifier for sentiment analysis is similar to other text classifiers (Agaian and Kolm 2017, 3).

To match the derived sentiment values from the articles with the stock trading days, I averaged all of the articles' polarity and subjectivity in the same time interval. NASDAQ, the stock exchange handling Alphabet Inc. (GOOG), operates its market regularly from 9:30 AM to 4:00 PM (EST). For my experiment, each time interval is defined as 4:00 PM to the next trading day's 4:00 PM (EST). All in all, the procedures I took to apply TextBlob on the article text and match the sentiment data with the corresponding trading times can be described as the following:

1. Starting with the most recent article, use python to read the article text from the CSV file.
2. Apply TextBlob to retrieve polarity and subjectivity value of 1 article.
3. Repeat Steps 1-2 for every article within the same day and add up the polarity and subjectivity values.
4. When the next article is not of the same day, divide the polarity and subjectivity values with the number of articles in this day (This will derive the average polarity and subjectivity of the articles in that day). Write the starting time, ending time, number of articles in that day, average polarity, average subjectivity, and stock price

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percent change onto a separate CSV file. Each day would be a single row with 6 columns.

5. Loop the above steps until the last article.

Start Time	End Time	No. of Articles	Avg. Polarity	Avg. Subjectivity	Percent Change
03/19/2019	03/20/2019	4	0.097	0.41	2.1
03/18/2019	03/19/2019	8	0.074	0.42	1.2
03/15/2019	03/18/2019	1	0.089	0.38	-0.017
03/14/2019	03/15/2019	3	0.1	0.41	-0.092
03/13/2019	03/14/2019	3	0.024	0.41	-0.65
03/12/2019	03/13/2019	6	0.13	0.43	0.01
03/11/2019	03/12/2019	2	0.13	0.43	1.5
03/08/2019	03/11/2019	5	0.09	0.41	2.9
03/07/2019	03/08/2019	1	0.14	0.47	-0.086
03/06/2019	03/07/2019	1	0.17	0.47	-1.3
03/05/2019	03/06/2019	8	0.12	0.42	-0.36
03/04/2019	03/05/2019	3	0.091	0.36	1.2
03/01/2019	03/04/2019	2	0.14	0.36	0.6
02/28/2019	03/01/2019	1	0.15	0.42	1.9
02/27/2019	02/28/2019	2	0.11	0.49	0.35
02/26/2019	02/27/2019	1	0.16	0.41	0.083

Sample data

The resulting dataset contains 175 time intervals between trading days spanning from June 19<sup>th</sup>, 2018 to March 20<sup>th</sup>, 2019. Each row represents a time interval and contains the sentiment values from the articles published within that interval. The percent change is the close-to-close stock price change. All values were rounded to 2 significant digits. A further analysis of this dataset is explored in the results section of this paper.

### Predicting Stock Returns using Machine Learning

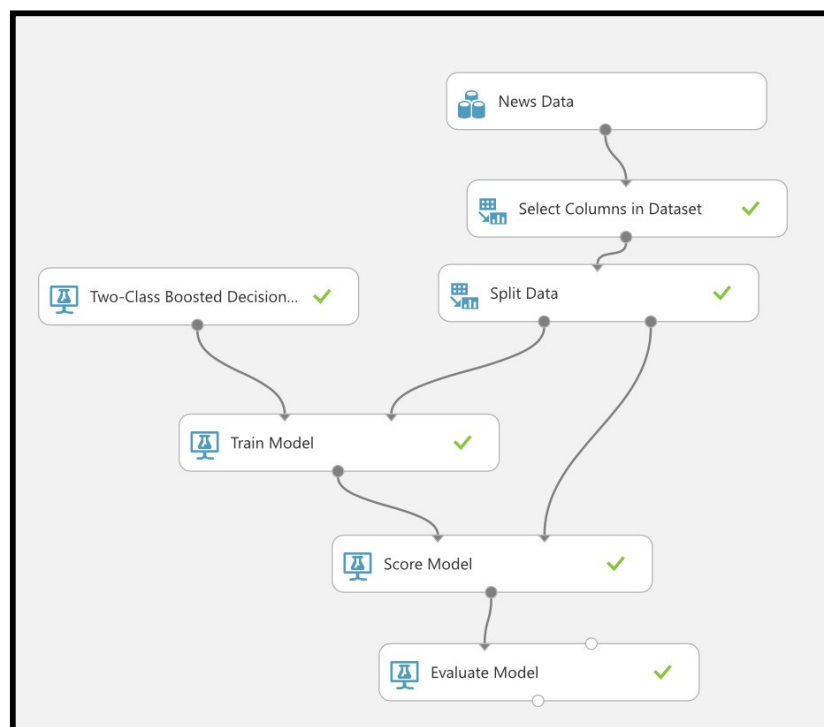
After gathering the news sentiment, I uploaded the compiled data onto Microsoft Azure Machine Learning Studio, a free-to-use cloud computing service for machine learning. Azure was suited for me as it provides a simple drag-and-drop user interface to run machine learning. To predict stock prices from the news sentiment, I employed a supervised machine learning algorithm. According to Andrew Ng, the founder of Landing AI and an adjunct

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professor of computer science at Stanford University, supervised learning is essentially training the machine with a dataset and asking the machine to then predict values (2012).

This fits my goal of predicting future stock prices based on news sentiment.

There are two general types of supervised machine learning algorithms: regression and classification. Regression models can predict a continuous output of values while classification models can only predict discrete valued outputs (Ng 2012). Both methods would serve the purpose of my experiment as I could predict future price returns using a regression model or I could predict whether the future price return would increase or decrease using a classification model. Ultimately, I chose to implement a classification algorithm due to its higher accuracy and efficiency as compared to regression (Ng 2012). My study's trained machine thus predicted whether the stock return of Google will increase or decrease.



A basic diagram of the machine learning procedure

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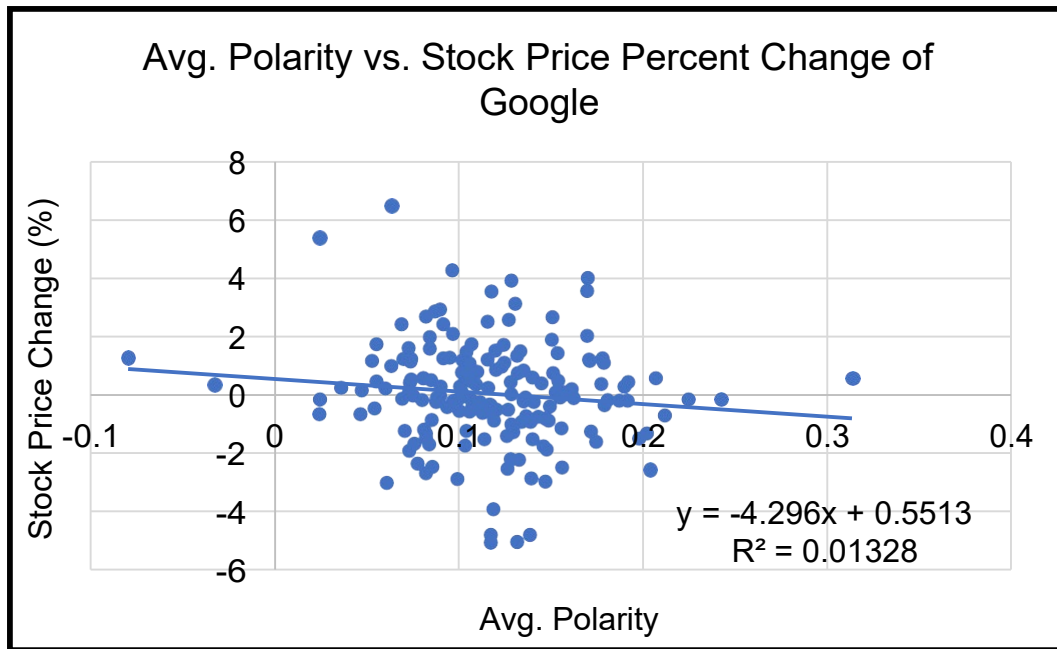
After uploading the dataset onto Azure, I filtered the data by selecting the columns with the number of articles, polarity, and subjectivity as the independent variables and the stock return percent change as the dependent variable. In order to give the machine the ability to predict the stock price change, I needed to train it with a training set. As a result, I split 80% of the data into a training set and the rest 20% as the final test set. I then selected the two-class boosted decision tree classifier as the algorithm for the machine to learn from the training set with 140 rows. Essentially, the machine would learn the pattern in producing binary outputs based on given inputs. In my experiment, the binary output was whether the stock price increased or decreased while the inputs were the number of articles, average polarity, and average subjectivity. The end result is a trained machine. That trained machine, or trained model, was then applied on the test set with the remaining 35 rows and predicted whether the stock price increased or decreased based on the aforementioned independent variables. Lastly, Azure evaluated the accuracy of the trained model in predicting the values of the test set.

### **Results**

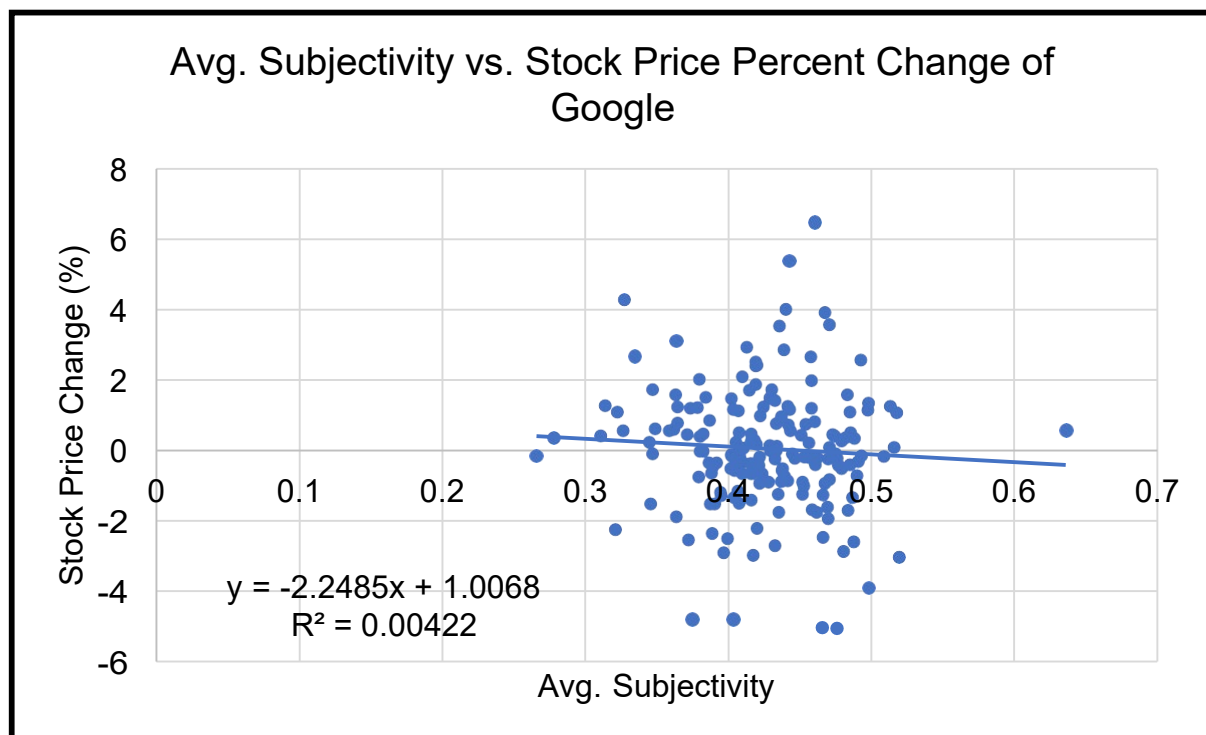
A preliminary examination of the dataset revealed that the correlation between news sentiment and the stock return of Google is low. By graphing the values on Microsoft Excel, there was a negative sloped relationship of -4.30 between the average polarity and stock return. However, the R-squared value of 0.01 meant that the data was not statistically significant at the 0.05 level.



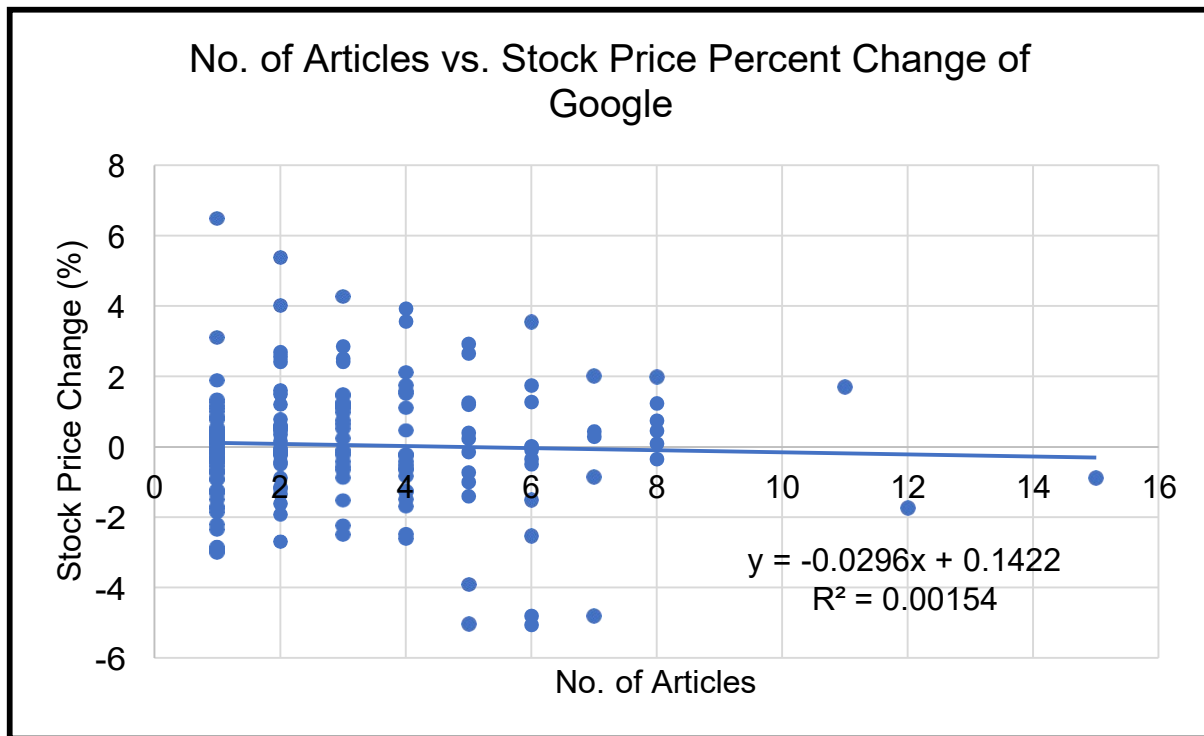
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When switching the independent variable to the average subjectivity and number of articles, a similar negative sloped trend line could be seen with a smaller R-squared value, causing the data to be statistically insignificant as well.



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After uploading this dataset to Azure, the resulting prediction accuracy from machine learning was low as well. A sample of the predicted data by the machine is shown below. All values were rounded to 2 significant values.

No. of Articles	Avg. Polarity	Avg. Subjectivity	Change	Scored Labels	Scored Probabilities
2	0.073	0.47	Decrease	Increase	0.67
6	0.13	0.37	Decrease	Increase	1
5	0.12	0.5	Decrease	Increase	0.55
4	0.13	0.39	Decrease	Decrease	0.00018
7	0.12	0.4	Decrease	Decrease	0.12
4	0.085	0.47	Decrease	Decrease	0.0014
2	0.12	0.37	Increase	Increase	0.82
2	0.025	0.27	Decrease	Increase	1
4	0.082	0.41	Decrease	Decrease	0.03
2	0.091	0.42	Increase	Increase	0.9
2	0.08	0.42	Decrease	Decrease	0.05
3	0.12	0.44	Increase	Decrease	0.41
8	0.12	0.42	Decrease	Increase	0.98
2	0.024	0.44	Increase	Increase	0.8
2	0.11	0.47	Decrease	Decrease	0.0086
1	0.12	0.39	Increase	Decrease	0.0084
2	0.12	0.44	Decrease	Decrease	0.00086
2	0.31	0.64	Increase	Decrease	0.11

Sample Data of Predicted Output from Trained Model

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Unlike the previous scatter graphs, the machine learning algorithm takes into account all 3 features (Number of articles, average polarity, and average subjectivity). The Scored Labels column is the prediction made by the machine of whether the stock price will increase or decrease. The Scored Probabilities column shows the probability of the stock increasing as predicted by the machine. By comparing the predictions with the actual outcome in the Change column, the machine yielded a 51.4% accuracy. Considering that a random guess would be 50% accurate, this prediction model using news sentiment is 1.4% better than a random guess.

### **Discussion**

#### **Implications**

The scatter graphs from the dataset implicated a negative relationship between Google's news sentiment and stock return. The slope value of -4.30 implied that a 0.1 increase in news polarity (as calculated by TextBlob) would mean a decrease of 0.43% in stock prices. However, despite the negative slope, there was little to no statistical correlation between Google's news sentiment and stock return since the data revealed a statistically insignificant R-squared value of 0.01. From a logical standpoint, the data's negative slope also appeared counterintuitive. Typically, one would expect an increase in public sentiment to increase stock prices as well. As a result, from both a statistical and logical perspective, no correlation could be determined from investor sentiment and stocks by looking at Google.

The prediction model therefore could not be trained to provide an accurate prediction. With an accuracy of 51.4%, my model focusing on an individual company stock performed worse than other similar studies measuring entire stock indexes. Li et al.'s research, for instance, produced a 57% accuracy in predicting the Hang Seng Index (HSI) (2014, 16). Therefore, a conclusion could be drawn that focusing on the sentiment and stock returns of

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individual companies, specifically Google, does not improve the accuracy. Since this experiment focused on Google only, the same conclusion cannot be drawn for other companies. New research in this area is thus advised to measure stock indexes or other companies different from Google.

### Limitations

Apart from the rejection of my hypothesis, there were limitations in my study worth mentioning. Firstly, the sentiment analysis done on the news articles could potentially be less accurate than expected. Compared to online opinions, news articles tend to convey a more objectivity stance with facts. It would be harder for a machine to judge the polarity of the text. As most previous studies about sentiment analysis were done on opinion-based text, TextBlob's accuracy thus could be lower than expected in this study.

Another possibility is that the general sentiment of the public plays a more important factor in influencing the stock price than the mood of the news regarding a company. In my experiment, I only considered the sentiment of the news about Google. However, the business cycle of the overall economy could skew the effects of news sentiment. Mian et al. support this notion by stating that “stock price sensitivity to good earnings news is higher during high sentiment periods than during periods of low sentiment” (2012, 1357).

I did not address these limitations earlier because it occurred to me late into the research process. Due to the complexity of the coding aspect in my research mythology, I spent much of my research time on that. There were no forewarnings of the low correlation from the data as well. These possible mistakes came to me only after the results came out. Despite these potential limitations, one would expect to see at least some correlation between news sentiment and stock prices. Nevertheless, it is important to consider the statistical insignificance of my results as it could have been caused by these discrepancies. Future

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research in this field could look at other sentiment analysis algorithms suited for analyzing less biased business news. Taking into account the broad economic state of the country could also lead to better results.

### Future Studies

In conclusion, more research should be conducted to address these limitations in my experiment. As seen from the low correlation of my results, news sentiment cannot fully explain the changes in Google's stock prices. Future directions in this area can measure individual companies other than Google to confirm whether this study's conclusions can be applied to other companies as well. External variables other than public sentiment can also be included in future studies to better predict the stock market.

I plan to continue this study by taking into consideration the possible limitations of this experiment. To avoid repetition with research done before, I will still focus on measuring the stock prices of individual companies. However, this time, I will select multiple other companies of varying types as my test subjects. By using different company types, I can analyze which type of company stocks is best predicted using sentiment analysis. Secondly, I will include the general state of the economy as one of the independent variables for my research. Since the stock price responds differently to the news at different economic phases, including a quantitative indicator of the economic state could perhaps derive a better correlation between news sentiment and the stock price. The US Federal Reserve's discount rate, or the "interest rate that the Federal Reserve charges on loans", is an example indicator of whether the United States' economy is in a recessionary or expansionary phase (Ray and Anderson 2015, 262). Lastly, I will compare other sentiment analysis algorithms to validate which one is best at analyzing non-biased business text. By refining the process of this

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research, we would then be one step closer to truly finding out whether social media news impacts the stock market.

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Drosophila Insulin Like Peptides: Causal Neuropeptide for Fly Aggression?

Word Count: 4287

## **Introduction**

A high frequency of aggressive disorders in the population is one of many American health concerns. Today America is home to over 3.5 million diagnosed patients with schizophrenia, over 3 million with bipolar disorder, and over 8 million diagnoses of Post-Traumatic Stress Disorder (NAMI). The cost borne by society for the treatment of aggression borne out by these mental disorders can be sobering. For instance, the government funded Veterans Health Administration reports that treating PTSD in veterans returning from various theatres of conflict, costs four to six times more than unaffected veterans, totaling around \$8,300 per PTSD affected veteran as opposed to \$2,400 per unaffected veteran, assuming all other health conditions remain constant. (CBO, 2012) With nearly 1.3 million active duty soldiers in the armed forces, these costs put a significant drain on resources which can be better used elsewhere (DOD, 2016).

On the other hand, a large number of psychopathies, such as schizophrenia and bipolar disorder can exact a similar toll on the already extended healthcare system in the country. There is significant evidence that patients with these psychopathies have an increased risk for aggression and violent behavior, including homicide. Data for this relationship comes from a study carried out by Fazel and Grann, which indicated that 5.2% of severe acts of violence are committed by individuals with a major psychiatric disorder, most commonly schizophrenia (Fazel et al., 2006). A 10-year follow-up study by Soyka and Graz of 1662 former schizophrenic inpatients in Germany showed that 10.7% were convicted of a crime, 94 of which were violent in nature (Sokya et al., 2007). Although attempts have been made to address such conditions with cognitive based therapy as well as pharmacological treatments, these are either marginally effective or carry significant side-effect profiles. Genome-wide association studies for the

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neurobiological basis of aggression are either lacking or currently being investigated by very few researchers.

### **Literature Review**

In 2002, Young et al. found that a homozygous deletion in mice *NR2E1* gene resulted in hyper-aggression (with significantly increased violent tendencies). The deletion of this gene also caused various developmental deficiencies, such as hypoplasia of the cerebrum and olfactory lobes (Young et al., 2002). These mice, although noticeably smaller in size would aggressively attack siblings, unrelated mice, and even mating partners, resulting in serious injury or death. Additionally, an array of sensorimotor tests measuring the efficiency of neuronal sensory-response pathways, showed that the mutant mice took longer to turn around corners and alleys and exhibited less exploratory behavior with fewer arm stretches to feel their surroundings. The time taken by them to find hidden food sources was also of several magnitudes as compared to wild type mice. Dr. Young concluded that the *NR2E1* gene was likely causal for decreased sensorimotor control. Although the degree of aggression and developmental abnormalities might be at least partially dependent on genetic background, violent behavior and behavioral deficits were found in all phenotypes with a homozygous *NR2E1* gene deletion. This study however, failed to explore whether the developmental deficiencies could have been at least partially responsible for causing the aforementioned violent behavior and decreased sensorimotor skills.

Another approach to better understand the genetic source of violent psychopathy is to use the extensively studied *Drosophila melanogaster*, the common fruit fly. In this species, the tailless gene (abbreviated *tll*) plays an important role in brain and body size development, Dr.

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Ruth T. Yu found that the mammalian *NR2E1* gene was similar to the *tailless* gene in *Drosophila melanogaster* (Yu et al., 1994) shown by in-vitro DNA-binding assays exhibiting similarity in function. Both proteins would regulate another set of genes in the organism's genome, and these regulated genes showed resemblance despite belonging to different organisms. The study confirmed this finding by replacing the *tailless* gene in *Drosophila* with the mammalian *NR2E1* gene, which functioned as the *tailless* gene and allowed for almost normal fly development (Yu et al., 1994).

A recent study of the analogous *tailless* genes in *Drosophila* also provides evidence that the *tailless* gene is responsible for regulating aggressive behavior (Dierick et al., 2014). Dr. Herman Dierick at Baylor College of Medicine found that when mRNA from the *tailless* gene was continuously broken down by RNA interference, fly aggression increased dramatically. This study sorted flies of each genotype into groups of two and placed them on opposite sides of a small cubic ring separated by a thin removable wall allowing for controlled interactions between the flies. These were recorded using high resolution video, analysis of which affirmed that the *tailless* gene, analogous to the mammalian *NR2E1* gene, also had a high degree of correlation with aggression. Specifically, *tll* and *NR2E1* coded for transcription factors that prevent uncontrolled transcription of an aggression neuropeptide in the fruit fly and mice models. Dr. Dierick also hypothesized that the *tailless* gene interacted with corepressor molecules Scribbler and Atrophin. By comparing aggression between these three set of flies, namely those unable to produce Scribbler, those unable to produce Atrophin, and finally flies that lacked a functional *tailless* gene, he discovered that only Atrophin negative flies and *tailless* negative flies displayed increased aggression. This allowed him to conclude that the *tailless* gene interacted with Atrophin to regulate transcription. Furthermore, tagging the *tailless* gene with a fluorescent

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protein showed that it was prolifically expressed in the region of the fly brain which is analogous to the mammalian hypothalamus. Thus, one could conclude that the hitherto unknown gene responsible for expression of the aggression neuropeptide was regulated by the *tailless* gene and was present in the *pars intercerebralis*.

To determine potential neuropeptides that could be the cause of aggression in *Drosophila melanogaster*, one can look to two major parameters: their location and associated symptoms. Since the *tailless* gene is expressed mostly in the *pars intercerebralis*, one can extrapolate that its regulated protein would also be found in the same area. One family of prominent neuropeptides that are often found in the *pars intercerebralis* neurons are the *Drosophila* Insulin Like Peptides or dILPs (specifically dILP 1, dILP 2, dILP 3, and dILP 4). A study published by Dr. Kavitha Kannan at the University of Connecticut-Storrs found a similar array of developmental deficiencies in the knockdown of dILPs as those with deficiencies of the *tailless* gene knockdown (Kannan et al., 2013). This, coupled with dILPs 1, 2, 3, and 4 localizations in the *pars intercerebralis* neurons of the brain, suggested that dILPs may be the unknown neuropeptides that cause aggression. Although the studies mentioned above and others proposed the significance of dILPs, there remains a significant gap in the literature as far as decisive evidence of dILPs' role as the aggression neuropeptide.

These dILPs were the subject protein of my experiment, which examined their role in regulating aggression. I hypothesized that flies without the ability to produce dILPs would have lower quantifiable aggression than those that could produce dILPs. I tested my hypothesis by examining and directly comparing flies that did not have the ability to produce dILPs to flies that did have the ability to produce dILPs. This led to the development of my leading question: are the *Drosophila* Insulin Like Proteins (dILPs) 1 to 4 causal for aggression in *Drosophila*

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*melanogaster*? The experiment that this paper will expound upon involved ordering *Drosophila* flies that had a mutation within each specific dILP gene which rendered them ineffective. The flies were then ‘pitted against’ flies from the same genotype to determine the level of aggression and thus the presence or absence of a neuropeptide responsible for aggression. Once this neuropeptide has been identified, it can be used to identify analogous mammalian proteins leading to potential advancements in identifying the etiology of aggression in human psychopathies.

## **Methods**

### **Behavioral Observation**

*Drosophila melanogaster* males are characterized by smaller size, a solid black coloration on the abdomen, and a tendency to “fight” under certain circumstances, including fighting for a mate, for territory and for dominance over a food source (Asahina et al., 2015). High intensity fights include exchanging blows with various appendages (mostly legs and wings) and grappling each other with limbs alone. These fights are rare but are found largely in territorial disputes or disputes over dominance of a food source. Using a high-resolution position tracking software JABBA developed by Dr. Kabra and Dr. Robie at the Howard Hughes Medical Institute, one can calculate the number of “lunges” that the flies attempt at each other (Kabra et al., 2012). The software tracks eleven essential positions on each fly’s body: two wings, six legs, two sides of the abdomen and finally the head. The two sides and head are used to track each fly’s unique position. Based on pre-defined parameters, the software starts detecting ‘lunges’ when these fly’s are near each other. A ‘lunge’ occurs when a fly quickly moves its limbs or wings against the other. Using this method, the aggression of individual flies (in the number of lunges) can be

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quantified or fighting frequency among large groups of flies with similar traits (in terms of percentages) can be determined (Kabra et al., 2012).

For my experiment, flies in the wildtype control group had no genetic mutations and were fully capable of producing the dILP neuropeptide. Conversely, the experimental group consisted of flies with the mutated dILP gene, lacking the dILP neuropeptide. In order to ensure that all the flies in the control group had the same genotype, I used a breed of genetically identical flies called Canton Special, abbreviated Canton-S. Although these flies are not truly “wild”, most researchers use them in their control groups because they tend to exhibit characteristics one would expect in flies collected from the wild. On the other hand, the experimental group consisted of four genotypes: each with an inability to produce dILP 1, dILP 2, dILP 3, and dILP 4 (notated *dILP 1 negative*, *dILP 2 negative*, *dILP 3 negative* and *dILP 4 negative* respectively). Each of these strains were ordered online from the Indiana University Bloomington Drosophila Stock Center via FlyBase (a database of *Drosophila* genes and labs that produce several different strains) Each strain of *Drosophila* was unable to produce only one type of dILP while adequately producing all the others.

The observed behavioral aspect of my experiment comprised of three steps. First, I placed a parental generation of flies into a test tube, waited for them to produce offspring, and then removed the offspring immediately after hatching. I did so by first administering carbon dioxide into the sealed tubes to anesthetize the flies. Then I used a brush to move flies onto a plate, and separated 30 male flies of each genotype into two separate smaller tubes (totaling two tubes of 15 flies each). This was done to ensure that the flies would have no interactions with each other prior to their first contact in the ring. I did not want the flies to recognize each other during the recorded fight nor did I want the flies to fight before the recording was initiated. This



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was followed by a waiting period of four days which allowed the flies to mature in their tubes. The flies that would eventually fight were seven days old since it has been well established that flies become more aggressive as they attain maturity. I then took a fly from each of the two tubes of a single genotype and placed them into separated compartments of a square ring, 14 millimeters on each side and 3 millimeters deep. This ring was bisected by a removable sheath of plastic. After being placed in their respective compartments, the flies were allowed to acclimate to their new surroundings and explore the ring for three days, so that any individual exploratory behavior would not interfere with the aggressive interactions being tracked.

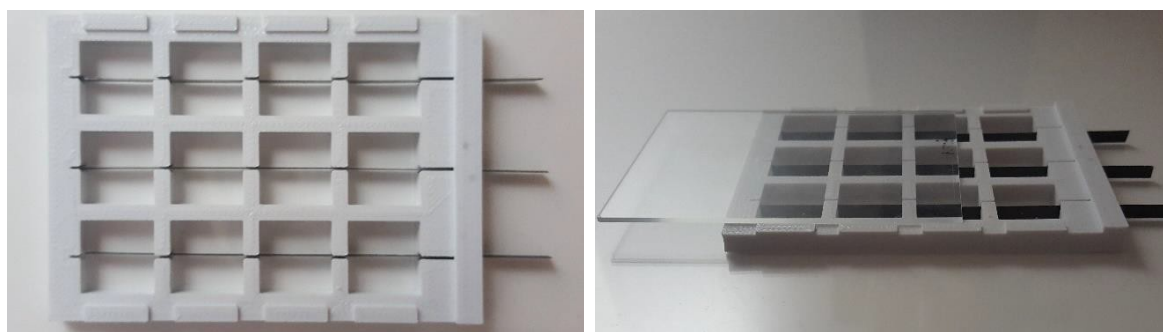


Figure 1a (left) and 1b (right). Images of sixteen fly rings, bisected by removable black plastic dividers. Figure 1a depicts an aerial view of the ring, while Figure 1b depicts a diagonal view with glass cover.

Finally, both compartments of the ring were placed under a high-definition camera which recorded 20 minutes of fly interactions immediately after the compartmental divider was removed. The camera was programmed to record images in the Tagged Image File Format (.tiff files) at 20 frames per second. Because the camera's field of vision was quite large, up to sixteen rings could be recorded simultaneously. Following the recordings, the images were converted to Audio Video Interleave (.avi files) video format via a custom MATLAB script so that they could be played back to identify lunges.

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Figure 2. Image of behavioral observation setup, featuring fly rings positioned under an HD camera and the computer used to record and store the images.

### Data Analysis

The video was then analyzed by the software program JABBA, (Janelia Automatic Animal Behavior Annotator), coded in MATLAB. JABBA used measurements known as classifiers to identify important aspects of each image; two important ones being distance between flies and limb velocity. Using these, JABBA identifies that flies which are close together and have high forelimb velocity have lunged at each other. After detecting the number of lunges in each video using JABBA, I reviewed each video and confirmed that each automatically detected lunge was indeed a lunge and not a computer measurement error. The total number of lunges per pair over a 20-minute period was calculated and transferred to an Excel document. This document contained details about the genotype, number of lunges and pair

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ID (numbering system used to keep track of each pair in a genotype). We repeated this procedure for 25 pairs of flies per genotype for a total of 125 pairs of flies.

Although my flies should have been genetically identical, I expected some pairs of flies to exhibit high lunge numbers as a result of random mutation or chance. However, these outliers had to be eliminated to accurately compare the effect of *dILP negative* mutations on fly aggression. In order to do this, I first found the interquartile range of my data set (the upper quartile value subtracted from the lower quartile value) and then multiplied this value by three. This new value was added to the upper quartile and subtracted from the lower quartile to calculate the outer fence range for my data set. Finally, I eliminated all the data points that exceeded the outer fences as major outliers.

After eliminating the outliers, I performed three statistical analyses to identify the average, median, and p-value generated by a T-test for significance. The T-test is a statistical tool used to decide whether the differences in values are significant between two groups. Since my experiment called for comparing each dILP to the wildtype genotype, I performed T-tests between each dILP and the Canton-S stock, rather than T-tests between different types of dILP. Furthermore, I used a two-tailed distribution because I was unsure of which data set would be higher and used a two-sample equal variance because I was comparing two similar variance sets. If the p-value generated was below 0.05, I could consider the difference between sets significant. However, if this value was above 0.05, then my results would be regarded as insignificant. Following this analysis, I created a histogram comparing the average number of lunges for each genotype over twenty minutes of exposure to another fly.

With this methodology, I could form my final hypothesis concerning the role of different dILPs in fly aggression: *Drosophila melanogaster* that are incapable of producing the dILP

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protein will have fewer lunges over a twenty-minute period than that of wildtype flies which can produce an effective dILP protein.

The methods that I used to answer my research question align with my project goal because they directly compared quantitative aggression in flies without an effective dILP protein to flies with a functioning dILP protein. Due to an absence of other confounding factors between the control group and the experimental group, my experiment provides a side-by-side comparison of the effect of dILPs on aggression in *Drosophila melanogaster*. Conclusive evidence that this experiment could provide can be used to identify the analogous mammalian protein that is responsible for aggression in rodent models, leading to potential advancements in identifying the etiology of aggression in human psychopathies.

## **Results**

After obtaining the lunge number for wildtype Canton-S flies, as well as those for mutant flies unable to produce each type of dILP these were plotted on a histogram and analyzed in detail. Prior to eliminating outliers, flies unable to produce dILP 1 had an average lunge number of 5.48 over the twenty-minute period, those unable to produce dILP 2 had an average of 14.29, those unable to produce dILP 3 had an average of 4.77, and those unable to produce dILP 4 had an average lunge number of 1.08. On the other hand, the Canton-S stock with an intact capacity to produce dILP had an average lunge number of 2.60. Flies without the ability to produce either dILPs 1, 2, or 3 actually tended to have a higher lunge number than the wildtype, but *dILP 4* had a lower lunge number.

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Table 1. The table depicts statistical analyses, including mean value, median, first (1<sup>st</sup> Q) and third (3<sup>rd</sup> Q) quartile, and outer fences, of lunge number over the 20-minute interaction period. All genotypes were compared to the same wildtype control group using T-tests; P-value is the result of each test. Pair ID denotes the identification number given to each pair of flies.

	No dl1p1	No dl1p2	No dl1p3	No dl1p4	Wildtype - CS
Pair ID	Lunge Number per 20 minute Interaction Period				
1	Outlier	1	0	0	0
2	2	12	10	2	2
3	8	1	15	1	3
4	1	6	1	0	6
5	3	5	0	2	3
6	3	Outlier	10	0	0
7	Outlier	1	1	1	2
8	2	2	0	2	6
9	0	0	3	2	0
10	0	6	13	0	2
11	3	0	5	3	0
12	0	3	Outlier	0	3
13	0	3	1	0	Outlier
14	Outlier	1	0	1	0
15	5	3	1	0	0
16	2	1	0	2	0
17	1	Outlier	4	0	1
18	3	4	4	2	3
19	4	Outlier	0	4	2
20	2	0	2	3	0
21	3	2	2	0	2
22	0	19	0	2	1
23	2	0	NaN	0	5
24	1	18	NaN	0	2
25	2	NaN	NaN	0	0
Average	2.14	4.19	3.43	1.08	1.79
Median	2.00	2.00	1.00	1.00	2.00
1st Q	1	1	0	0	0
3rd Q	3	5	4	2	3
Interquartile Range	6	12	12	6	9
Outer Fences	0 to 9	0 to 27	0 to 19	0 to 8	0 to 12
Outliers	24, 27, 39	160, 28, 67	33	None	22
P-value	0.54158844	0.05222738	0.11798863	0.12242311	

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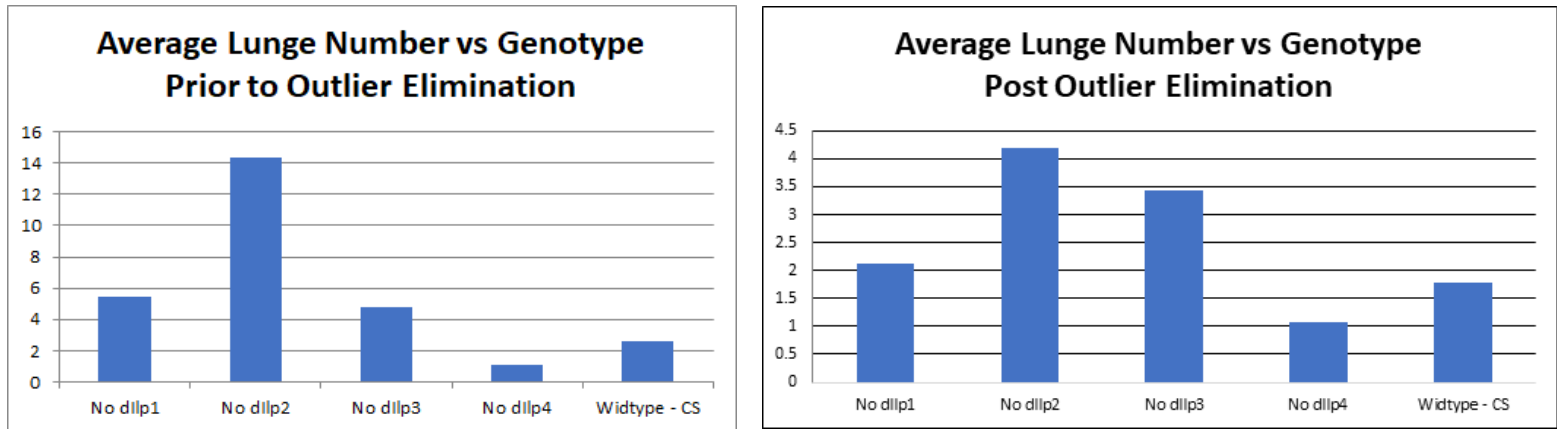


Figure 3a (left) and 3b (right). Average lunge number per genotype prior to elimination of outliers (Fig. 2a) and post-elimination (Fig. 2b) in mutated dILP gene 1, mutated dILP gene 2, mutated dILP gene 3, mutated dILP gene 4, and wildtype *Drosophila melanogaster*. Y-axis represents average lunge number per 20-minute period.

During my analysis, I found that experimental genotypes *dILP 1 negative* and *dILP 2 negative* had three outliers each while genotype *dILP 3 negative* and the wildtype control group each had one outlier in their data set, and experimental genotype *dILP 4* had no outliers whatsoever. However, after eliminating outliers, the range of averages decreased dramatically.

Flies incapable of producing dILP 1 had an average lunge number of 2.14, those unable to produce dILP 2 had an average of 4.19, those unable to produce dILP 3 had an average of 3.43, and those unable to produce dILP 4 remained at an average of 1.08. Furthermore, the Canton-S stock exhibited a lunge number of 1.79.

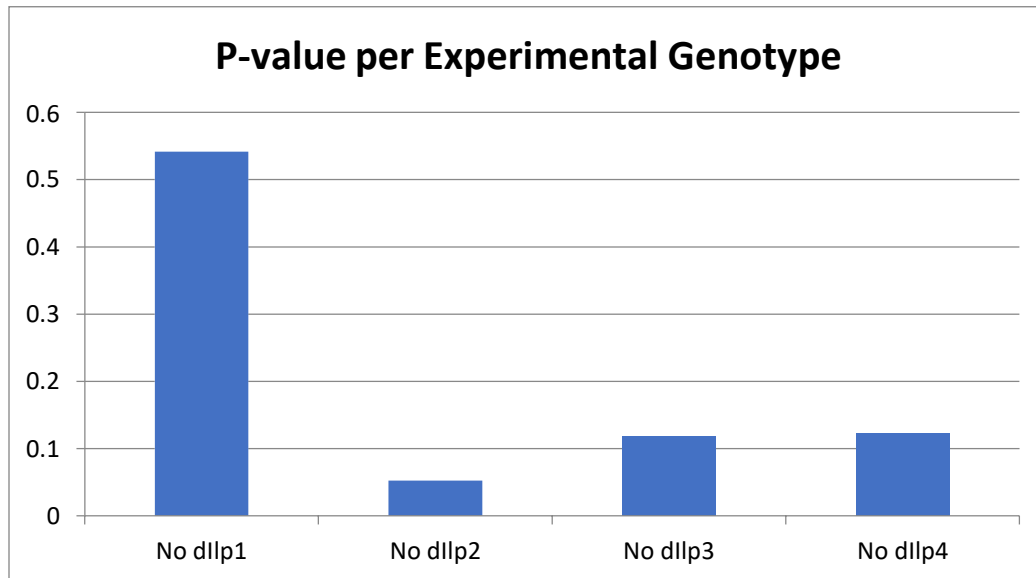


Figure 4. Statistical P-value (result of T-test) per mutated dILP genotype data sets compared to wildtype genotype data set post elimination of outliers (Fig. 2b).

I then performed four T-tests to determine the significance of my results after eliminating outliers. The p-value for the experimental groups *dILP 1 negative*, *dILP 2 negative*, *dILP 3 negative*, and *dILP 4 negative* as opposed to the wildtype data set were 0.542, 0.052, 0.118, and 0.122 respectively. From this, I was able to conclude that the differences in lunge number between each data set were insignificant and that the flies which were unable to produce dILP did not have a significant difference in lunge number from the wildtype flies with an intact ability to produce dILPs.

## Discussion

As seen in Figures 3a and 3b, *dILP 1 negative*, *dILP 2 negative*, and *dILP 3 negative* feature pairs that have an average lunge number higher than that of the wildtype flies over the twenty-minute period. Although this may suggest that these dILPs could be another type of transcription factor for aggression, further analysis revealed that the p-values for these data sets

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are higher than 0.05, deeming that the averages were insignificantly different from that of the wildtype flies, that could produce functional versions of the same dILPs (Fig. 4). However, the p-value for flies that could not produce dILP 2 approached 0.05, which might be due to the fact that dILP 2 may be another transcription factor for the unknown gene producing the aggression neuropeptide. On the other hand, *dILP 4 negative* appears to show a lower average lunge number over the twenty-minute period when compared to the wildtype lunge number. However, the T-test (p-value greater than 0.05) between them reveals that the difference is insignificant.

Thus, because the difference between wildtype flies capable of producing dILPs and experimental mutants that are incapable of doing so, is insignificant, I rejected my hypothesis: flies with the inability to produce dILPs have a lower lunge number than those of flies capable of producing dILPs. Due to this, it is unlikely that dILP 1, dILP 2, dILP 3, or dILP 4 are individually causal for aggression in *Drosophila melanogaster*. However, it is possible that multiple dILPs are causal for aggression, in which case a decrease in aggression would only be present if all dILPs were mutated. Moreover, further study into flies without dILP 4 (those that exhibited decreased lunge number in my experiment) might reveal a significant decrease in aggression if a similar experiment is performed in the background of more aggressive flies.

Having understood that dILPs are unlikely to be the cause of aggression in *Drosophila melanogaster*, we can now discuss the implications of this finding. First and foremost, looking back at Dr. Dierick's research of the *tailless* gene as a transcription factor, it is doubtful that the dILP genes 1 to 4 are the target genes of the *tailless* gene, because the *tailless* gene should regulate the aggression neuropeptide producing gene (Dierick, 2014). Next, it is improbable that the mammalian analogues of dILPs are responsible for aggression in mice models or humans. Because Dr. Ruth T. Yu's research found that the *tailless* gene and the analogous *NR2E1* gene



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share target genes, Dr. Yu concluded that the target genes that produce the aggression peptides share a similar base pair sequence in both mice models and *Drosophila melanogaster* (Yu et al., 1994). One can then extrapolate that the protein produced by the unknown target gene should be similar between both species. Thus, because dILPs are unlikely to cause aggression in *Drosophila melanogaster*, its analogues are unlikely to cause aggression in mice models or humans. Knowing this, further study into possible causal aggression peptides in *Drosophila melanogaster* models or mice models should exclude dILPs and their mammalian analogues as potential candidates. Rather, researchers in the field should focus on other possible aggression neuropeptides in the PI region of the brain (where the *tailless* gene is expressed the most) that may be regulated by the *tailless* gene. These neuropeptides should also have analogous mammalian proteins that are regulated by NR2E1. By following these guidelines and by excluding dILPs, researchers would be more likely to isolate neuropeptides that cause aggression in *Drosophila melanogaster* and eventually those in mammals.

**Limitations**

In light of rejecting my hypothesis, there are certain limitations to the experiment that need to be mentioned. It is possible that multiple neuropeptides are causal for aggression, which would explain why *dILP 4 negative* exhibited a slight decrease in quantifiable aggression. Conversely, it is also possible that dILP 2 is another transcription factor for the unknown gene that produces the aggression neuropeptide. This would support the hypothesis that aggression in *Drosophila melanogaster* is caused by multiple neuropeptides and regulated by multiple transcription factors (such as the *tailless* gene). However, although the *tailless* gene has co-repressors (such as the Atrophin molecule), Dr. Herman Dierick proved that the *tailless* gene is

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the principal transcription factor by finding that Atrophin works with the *tailless* gene to regulate transcription. Moreover, it is unlikely that *dILP 2* alone is a transcription factor; one could infer that the peptides in the *dILP* family share similar functions. Thus, the biggest limitation of this experiment would be the background in which it was performed. The experiment was conducted with flies that had functional *tailless* genes. These may have suppressed the transcription of *dILPs* in the control group Canton-S flies (Dierick et al., 2014). Therefore, it is possible that all flies had minimal *dILP* present in the brain to begin with, and this, in turn, caused insignificant differences between the data sets. However, this limitation is mitigated by the fact that one would expect to see some difference between flies that have transcription factors that simply regulate the production of a potential neuropeptide and flies that cannot produce the potential neuropeptide whatsoever. Regulation of genes via transcription factors depend on the concentration of the transcription factors and the concentration of the DNA it regulates; it is possible – even probable – that some neuropeptide is produced, evidenced by the fact that wildtype flies with functional *tailless* genes must produce aggression neuropeptides when fighting. On the other hand, flies without the DNA to even begin transcription of an aggression neuropeptide would have almost no chance to produce any neuropeptide at all. Nevertheless, it is important to note that differences between data sets were considered insignificant in this paper and might have been caused by this discrepancy. Performing a similar experiment with flies that are more aggressive (specifically those that have a knocked down *tailless* gene) may reveal a profound difference in aggression phenotypes, especially for *dILP 4* that exhibited some decrease in aggression. Such an experiment would eliminate the possibility that the *tailless* gene was hindering significant production of aggression neuropeptides, solving for this potential limitation.

### Future Research

Further research that should be performed in the future could address these limitations by testing flies that are incapable of producing multiple dILPs (as compared to an inability to produce only a single dILP) as well as by using flies that display a higher level of aggression. Future testing will focus on recreating this experiment in the presence of a *tailless* gene knockdown because differences in aggression between flies that cannot produce aggression neuropeptides at all versus flies produce the same neuropeptides in significantly increased quantities would be more obvious.

In continuance of this research, I plan to use the RNA interference system (RNAi) to nullify mRNA produced by the *tailless* gene (Dierick et al., 2014). By crossing flies with RNA interference of the *tailless* gene and flies that cannot produce dILPs, I should be able to compare the differences in aggression and subvert the limitations that my original experiment encountered. Nullifying the *tailless* gene would allow me to conduct my experiment with flies having a higher level of aggression, and in doing so, any decrease in aggressive behavior would be more profound and readily observable. Furthermore, to test the possibility that aggression is the result of multiple proteins, this experiment will also test more *dILP negative* genotypes and *dILP negative* genotype combinations, including *dILP 1 negative*, *dILP 2 negative*, *dILP 3 negative*, *dILP 4 negative*, *dILP 5 negative*, *dILP 6 negative*, *dILP 7 negative*, *dILP 1-4 negative*, and *dILP 5-7 negative* (these are the only combinations available on FlyBase, the commercial site where mutated flies are bought). This experiment would then be able to conclusively

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determine if proteins dILPs 1 to 4 are individually causal or whether they are collectively contributory towards aggression.

By knocking down the *tailless* gene in flies that are incapable of producing these neuropeptides, one should not see an increase in aggression. This would prove that the said neuropeptides are those that the *tailless* gene regulates. The goal of such future research would then be to answer the question whether Drosophila Insulin Like Proteins (dILPs) 1 to 4 cause increased fighting frequency in the simultaneous presence of a ‘knocked down’ *tailless* gene.

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A Slice of Instagram:

A Content Analysis of Cakes Slice Posts on Instagram

AP Research

May 21, 2020

Word Count: 5,143

**Abstract:**

With the rise of social media, “foodie” culture and “food porn” have skyrocketed in pop culture. The social media platform, Instagram, is greatly responsible for this trend due to its focus on photos. My research investigated Instagram “foodie” culture and social media's influence over the perception of food, specifically cake. It aimed to answer the question “Which visual aspects of a popular cake slice post make the photo more or less appetizing to Instagram ‘foodies’ in early 2020?” To do this, I analyzed popular cake slice posts through the #cakeslice page on Instagram. I categorized the visual characteristics of the cake and photograph. After analyzing it alongside various measurements of appetizingness, I concluded that the most appetizing cake slice posts to Instagram “foodies” are chocolate and follow the themes of luxury and indulgence. However, for many visual aspects there was not enough evidence to claim that they influence the perception of the post. The results of this study gives insight to how society treats food online and how social media can be used as a marketing tool for the food industry. It can also guide bakeries on how to make their Instagram posts more appetizing to potential customers.



## **Introduction:**

My research project aims to answer the question “Which visual aspects of a popular cake slice post makes the photo more or less appetizing to Instagram ‘foodies’ in early 2020?” Many choices go into taking a food picture such as, the appearance of the food itself and how it is plated and photographed. To analyze these features, I will perform a content analysis, categorizing the visual characteristics (V.C.s) and analyzing them alongside measurements of “appetizingness”. “Appetizingness” reflects how well the post inflicts hunger in the viewer. In this study, appetizing and appealing are not one in the same. While the first reflects the desire to eat something based on one’s senses, the second does not involve hunger. The viewers in this case are “Instagram foodies.” or someone who interacts with food posts on Instagram. They may be a content creator or simply a viewer. For this study we are only analyzing popular cake slice posts (P.C.S.P). These are food posts that meet pre established criteria, specified later, and are not posted by personal accounts. Furthermore, I am only analyzing traditional cakes which I define as baked sponges accompanied by some kind of icing/frosting. Cheese cake, and potato cakes are not included in this study.

I aim to explain how the presentation of food can have an affect on how people perceive it online. I hypothesize that the most appetizing cake slice posts will follow one of two extremes, minimalist and plain or extravagant and over the top. Additionally, I hypothesized that the characteristics which influence appetizingness most, are those that affect how the cake tastes such as flavor and the ratio of cake to filling.

## **Significance**

“Foodie culture” has grown greatly with the popularity of instagram. As a result, social media (S.M.) has greatly transformed the food industry as well as many others, becoming the most efficient way to reach the younger audiences. Thus, it is important to understand how S.M. can change one’s perspective.

My research can not only aid bakeries in advertising their cakes better, but can help other parts of the food industry advertise their products more efficiently to the younger demographic. Research demonstrating the effectiveness of S.M. advertisements based on other post components have already been done. The ice cream chain, Hokey Pokey, started advertising over S.M. for a study and saw “a positive sales lift in almost all the months during the campaign.”<sup>1</sup> Similarly, a study on carbonated soft drinks evaluated the effect of word of mouth on S.M. and showed that “ a successful social media campaign will increase the exposure and awareness of a brand and create more buzz on social media sites, which will lead to a greater probability of a

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<sup>1</sup> Kumar et al, “Creating a Measurable Social Media Marketing Strategy: Increasing the value and ROI of Intangibles and Tangibles for Hokey Pokey,” *Inform*s 32, no.2 (2013): 208, <https://www.jstor.org/stable/24544940>. Accessed 15 Jan. 2020.

product being chosen by consumers.”<sup>2</sup> These studies and my own can demonstrate that a healthy understanding of S.M. and its users can increase profit for food businesses.

### **Literature Review:**

#### **“Foodie Culture”:**

With the rise of S.M., foodie culture has gradually risen over recent years and food’s presentation online has redefined how we look at food. Writer at Gastronomica, Sara McGuire, believes “the saying ‘we eat with our eyes’ rings truer than ever in the age of information,”<sup>3</sup> leading to an important term in “foodie culture” today, “Food Porn.” The term was coined by Micheal Jacobson “to connote a food that was so sensationally out of bounds of what food should be that it deserved to be considered pornographic.”<sup>4</sup> The term has since sexualized the idea of food. Many experts in the restaurant industry are against the notion of food porn claiming that the eye-catching nature will cause food to lose its meaning<sup>5</sup>. From the consumer side of Food Porn, the internet trend’s popularity may be boiled down to its science. In a report from *Brain Research*, researchers establish that the presentation of food images triggers a response in the reward center of the brain.<sup>6</sup> In contrast, Signe Rousseau takes a more social approach to “foodie culture” and explores the structure of S.M., specifically Twitter, that fosters a healthy environment in her book *You Are What You Tweet*. She contributes its success to the capability of the content creators interacting with the consumers<sup>7</sup>. Ryan S Eanes identifies a pitfall in Rousseau’s book explaining that it “fails to consider Instagram entirely which is arguably the most important social media ‘apps’ used to share photos of food.”<sup>8</sup> So by studying Instagram I am studying what Rousseau and other food authors failed to do and filling this gap in the conversation surrounding food online.

#### **Plating and Photography:**

The success of food porn does not solely rely on the food itself, but also the way it is plated and photographed. In “Looks Good Enough to Eat” researchers presented food pictures of various platings to participants of three nationalities who would then choose which was most

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<sup>2</sup> Yizao Liu and Rigoberto A. Lopez, “The Impact of Social Media Conversations on Consumer Brand Choices,” *Marketing Letters*, vol. 27, no. 1 (2016):11, [www.jstor.org/stable/26177931](http://www.jstor.org/stable/26177931).

<sup>3</sup> Sara McGuire, “Food Photo Frenzy: Inside the Instagram Craze and Travel Trend,” *buisness.com*, <https://www.business.com/articles/food-photo-frenzy-inside-the-instagram-craze-and-travel-trend/>.

<sup>4</sup> Anne E McBride, “Food Porn,” *Gastronomica*, Vol. 10, no. 1 (2010): 33-46, <https://www.jstor.org/stable/10.1525/gfc.2010.10.1.38>.

<sup>5</sup> McBride, “Food Porn,”: 38-41

<sup>6</sup> Frank et al, “Processing of Food Pictures: Influence of Hunger, Gender and Calorie Content.(Report).” *Brain Research* 1350 (2010): 159-60, [https://arizona-primo.hosted.exlibrisgroup.com/permalink/f/1h28lag/TN\\_gale\\_ofa235303125](https://arizona-primo.hosted.exlibrisgroup.com/permalink/f/1h28lag/TN_gale_ofa235303125)

<sup>7</sup> Ryan S. Eanes, “ Books in Review: Food and Social Media: You Are What You Tweet,” *Gastronomica*, Vol. 14, No. 4 (2014): 86-93, <https://www.jstor.org/stable/10.1525/gfc.2014.14.4.86>.

<sup>8</sup> Eanes, “ Food and Social Media: You Are What You Tweet,”:87

aesthetically pleasing. They found that “across six visual dimensions of food there was a consistent preference for the number of colors on a plate (three), components on a plate (three to four) and the fill level of the plate”<sup>9</sup>. Using a similar method, Austin Jacobs at the University of San Diego, analyzed the impact of photo angle on the perception of food. Unlike the previous study, Jacobs narrowed his focus to one visual component and was able to differentiate the participant’s reaction to the food picture as tasty or aesthetically pleasing. He found that side angle photos were tastier and more aesthetically pleasing than overhead shots. Additionally, Jacobs’ study occurred in 2017 and he investigated food perception on print vs Instagram to advise bakeries marketing strategies. He suggests when advertising on Instagram use side angles and the opposite for magazines.<sup>10</sup> Both researchers presented participants with food pictures and recorded their response with surveys. My research differs in that I recorded viewers’ responses based on likes and comments. While my research will less accurately measure responses, it avoids volunteer bias and studies a wider population. My research also builds upon their method by analyzing a larger range of visual aspects regarding both the food itself and the way it is plated and photographed. Additionally, with my research taking place during the rise of S.M. like Jacobs’, I am focusing strictly on Instagram food pictures.

### Social Media and Marketing

Research methods that more closely resemble my own have been conducted about food marketing on Instagram. The studies of Hokey Pokey and soft drink companies previously mentioned, claim S.M. is an efficient marketing tool for the food industries<sup>11 12</sup>, other researchers attempt to explain why. To do this they looked at S.M. through different lenses. By looking at S.M. as a vehicle for ads, the article, “Junk Food Marketing on Instagram: Content Analysis” discovered companies use S.M. to target specific audiences and market individual’s interests and that they companies can condition young minds to incorporate their products into their diet through constant exposure<sup>13</sup>. By looking at S.M. as a “pre-crisis monitoring tool”, authors of “From #mcdonaldfail to #dominossucks: An analysis of Instagram images about the 10 largest fast-food companies” suggests that Instagram can be used to identify and solve problems arising in the food industry such as a poor working environment, problematic customer service or questionable food practice.<sup>14</sup> Thus attributing Instagram’s power to its accessibility to businesses,

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<sup>9</sup> Francesca Zampollo et al, “Looks Good Enough to Eat: How Food Plating Preferences Differ Across Cultures and Continents,” *Cross Cultural Research* 46, (2012): 31-46, [https://www.researchgate.net/publication/227343992\\_Looks\\_Good\\_Enough\\_to\\_Eat\\_How\\_Food\\_Plating\\_Preferences\\_Differ\\_Across\\_Cultures\\_and\\_Continents](https://www.researchgate.net/publication/227343992_Looks_Good_Enough_to_Eat_How_Food_Plating_Preferences_Differ_Across_Cultures_and_Continents).

<sup>10</sup> Austin Bradley Jacobs, “Impact of Photo Angle on Food Perceptions and Evaluation,” *University of San Diego*, (2017), [https://digital.sandiego.edu/cgi/viewcontent.cgi?article=1042&context=honors\\_theses](https://digital.sandiego.edu/cgi/viewcontent.cgi?article=1042&context=honors_theses).

<sup>11</sup> Yizao Liu and Rigoberto A. Lopez, “The Impact of Social Media Conversations on Consumer Brand Choices,”<sup>11</sup>

<sup>12</sup> Kumar et al, “Creating a Measurable Social Media,”<sup>12</sup>: 208,

<sup>13</sup> Amy Vallaso et al, “Junk Food Marketing on Instagram Content Analysis,” *JMIR Public Health Surveill*, vol. 4, no. 2, (2018): E54. <https://publichealth.jmir.org/2018/2/e54/>.

<sup>14</sup> Jeanine Guidry et al. “From #mcdonaldfail to #dominossucks: An analysis of Instagram images about the 10 largest fast food companies,” *Researchgate*, accessed March 17, 2020,

employees, and customers. While the first focused on how the product was marketed, the second called attention to the reputation of the company. My own research aims to achieve the same goal of explaining the marketing power of Instagram. While these researchers used an analysis of target audiences and producer-consumer relations, my research investigates the visual content to explain this phenomenon.

## **Method:**

### **Overview:**

There are four main steps in my method: 1) collect popular cake slice posts, PCSPs, from the #cakeslice page, 2) categorize and record the V.C.s of the post, 3) record data measuring the “appetizingness” of the post from the likes, comments, and account details, and 4) analyze the data for correlations between V.C.s in (2) and measures of “appetizingness”.

### **Sampling:**

In this study, I analyzed 100 cake slice posts, collected from the #cakeslice page. I did not aim for a sample of 100 posts, rather it was the number of posts from the #cakeslice page, posted in the period from January 1st to March 5th and satisfied my conditions for a PCSP. I chose to collect my sample from the #cakeslice page, because it would result in a representative sample of all PCSPs on Instagram in early 2020. The hashtag page should create a representative sample because food accounts would tag their posts to widen their reach. #cakeslice would be the simplest and most common tag. Additionally both large and small accounts use hashtags. Moreover, english is the most prevalent language on instagram, so foreign posts should appear on the page as well. This method of sampling most closely resembles that of the study “From #mcdonaldfail to #dominosucks”, where researchers also used the tag pages to collect posts to analyze<sup>15</sup>. However, while these researchers use multiple tags to analyze multiple companies, I used one. A large majority of the results for the tag #cakeslice could not be analyzed because they were irrelevant, not popular enough, from personal accounts, or did not satisfy my conditions. Also, by sampling from the tag page, I am filtering out posts from personal accounts, because they often don’t use tags.

The conditions for a post to qualify as a PCSP are as follows: First, the post must include a cake slice, which I define as a portion no more than a quarter of the whole cake that has been removed from the original cake. More than one slice is allowed in the picture, but each slice must be identical. Second, there must be a clear view of the cake slice, which I consider to be true if all layers of the cake are visible. A few bites may be taken from the slice, but the majority of the slice should be intact. Third, The cake slice needs to be the focal point of the photo. A focal point is defined by Cambridge Dictionary as “the feature of a work of art that is the most

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<sup>15</sup> Jeanine Guidry et al. “From #mcdonaldfail to #dominosucks.”

interesting or important or the most strongly emphasized.”<sup>16</sup> Fourth, the photo may not include a person’s face. This would affect the rationale behind liking the post. Fifth, a post must be at least 1 week old before it is analyzed. After that point the like count usually plateaus. Sixth, the post must reach a popularity threshold by having at least 100 likes and the account must have at least 800 followers. I chose these numbers because I noticed that cake slice posts with more than 100 likes often originated from food accounts. If I had increased the minimum like count, it would have greatly decreased the number of posts I could analyze in the weeks from which I recorded data. I could have increased my time frame, but that could have led to inconclusive results since trends can change quickly online. A follower count greater than 800 ensures that people of the general public also see and have the opportunity to like the post, not just close friends of the account holder. These conditions guarantee that viewers are liking and commenting on the post because of the photo and cake slice, not from external factors. As a result, the data will more accurately show evidence of appetizingness.

#### Categorizing Visual Characteristics:

After I establish that a post satisfies these conditions I record their V.C. This part of my method is similar to that of the study “Junk Food Marketing on Instagram”. The researcher also categorized their Instagram posts and looked for correlations between their categories and data about how the consumers reacted. However, they categorize their posts by marketing strategy while I analyze the visual aspect of the photo.<sup>17</sup>

For the coding process, I used google forms as a tool to collect and organize data. I first collect information for identification. I then performed a qualitative analysis of the V.C.s for the post. This included categorizing each V.C. of the post. I analyzed characteristics of the slice itself and how it is presented. The characteristics of the cake I chose to analyze are: number of cake layers, ration between filling and cake, flavor of the sponge, type of filling, extra components in the cake, external cover, color theme and cake aesthetic. V.C.s that pertain to how the cake is styled and photographed are: cake stance, cake face closest to viewer, slice shape, background, plate, angle of shot, bite, presence of utensils, other decor on plate, full cake in background and slice size. The V.C.s’ definitions, categories and examples are provided in table 1 and 2 of the appendix. Table 1 refers to characteristics of the cake itself and table 2 refers to the plating and photographic choices in the photo. All example photos provided were posts analyzed in the study.

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<sup>16</sup> *Cambridge Dictionary*, s.v. “Focal Point,” accessed Mar. 16, 2020, <https://dictionary.cambridge.org/us/dictionary/english/focal-point>.

<sup>17</sup> Amy Vallaso et al, “Junk Food Marketing on Instagram”

### Gathering “appetizingness” data:

After I recorded which categories a cake slice fell into for each V.C, I recorded data about the post’s perceived “appetizingness” from the likes and comments. First I record the like count. There are multiple reasons to like a post. The two main reasons to like food posts are 1)to support the content creator and 2)because you find the post appealing/ appetizing. By looking at posts from accounts that revolve around food and do not have a visual persona, I am minimizing the amount of likes that stem from reason #1. Thus one can assume that the majority of users liked the post because they found the food photographed, appealing/appetizing. Therefore you can use likes as a measurement for how appetizing the instagram masses find a plate. I used a like to follower ratio in my calculation so that it was reflective of the proportion of people who liked the post out of the amount of people who it was shown to.

$$\text{like to follower ratio} = \text{like count} \div \text{follower count}$$

The pictures posted by larger accounts automatically obtain more likes simply because it was shown to more people. Thus I am accounting for the disparity between larger and smaller food accounts using a ratio.

Second, I record the comment count and the amount of signal words in the comment section. The signal words suggest that the commenter finds the picture appetizing. These are words and emojis that are connected to taste not just looks. A list of signal words and emojis are as follow: yum, 😋, treat, delicious, sinful, heavenly, divine, taste, tasty, nom, devour, eat, drooling/ salivate/ salivating/ watering, scrumptious, 🍷, craving and mmm(with 3 or more m’s). Other variations, abbreviations, and spellings of these words were included. Words with biblical origin were included, because of their connection to gluttony. Verbs like taste and eat were included because they were almost always followed by synonyms of “good” and thus displayed a desire to eat the cake pictured. The reason I excluded words such as “good” from the list is because I would not be able to differentiate between “looks good”, which signals visual appeal, and “tastes good”, which connotes appetizingness. For convenience, I used the text analyzer from online-utility.org.<sup>18</sup> The signal count is the number of signal words in the comments. I manipulated the data in a similar fashion using signal word frequency:

$$\text{signal word frequency} = \text{signal word count} \div \text{number of comments}$$

This equation only accounts for the people that see and care to comment on this post, thus eliminating the problem that accounts that have more exposure will automatically have a higher frequency of signal words regardless of what kind of cake is pictured. Combining the comment and like measurement creates the “Total Appetizing Measurement,” (TAM):

$$\text{Total measurement of appetizingness} = \text{signal word frequency} + \text{like to follower ratio}$$

This measurement should be small and was designed to measure how appetizing the viewers of the post, found the cake slice pictured, based on all the information given. Equal priority was given to the signal word score and like measurement, because although the signal word score is a

<sup>18</sup> Text Analyzer, online-utility.org, <https://www.online-utility.org/text/analyzer.jsp> .

better indicator of “appetizingness” it is less accurate, due to the small proportion of commenters. In contrast, a higher proportion of viewers like the post than comment on it, so one like is less impactful than one comment.

These measurements of appetizingness were then analyzed along the V.C.s of the post to find correlations.

### **Data & Analysis:**

#### **Statistical Test:**

To assess whether a specific V.C had an influence over how appetizing the picture was overall, I calculated the average TAM for every category of each characteristic. I then compared that category’s average to the average TAM for the entire sample, 0.2781, using a one-sample t-test. I am using this test to determine if the mean from one category is statistically different from the mean of the entire sample. This would answer the question “does the presence of a chocolate sponge make the post more or less appetizing?” To further investigate, I used a pair t-test to determine if there was a statistically significant difference between categories of the same characteristic. I chose to use a paired t-test instead of the two-sample t-test because the variables are not independent of each other. I compared the category with the highest average TAM to the rest, excluding the categories such as other and multiple. This would answer questions such as “are cakes with chocolate sponge more appetizing than those with vanilla?” What determines if there is a statistical difference is the p value given from both tests. The p value is the probability that the difference seen between the two means is due to random variations in the sample. Traditionally when p is less than 0.05 the difference is statistically significant. For this study, a small p value indicates the category is more or less appetizing than what it is being compared to.

For both tests there are 3 conditions that the sample must uphold. First the data must be randomly sampled from the population. The population is all PCSPs on Instagram posted during early 2020. Not every PCSP will be tagged with #cakeslice, but there is no variable that would dictate if the creator tagged the post or not. Thus by sourcing the sample from this page, I am collecting a random sample of the population. Second the sample must be less than 10% of the entire population. I believe that with the popularity of food porn and the large scope of Instagram, it is reasonable to assume there are more than one thousand cake PCSPs posted on Instagram during the research period and thus my sample of one hundred posts is less than ten percent of the population. Third the data must be normally distributed.

The histogram below describes the distribution of the sample's T.A.M scores:

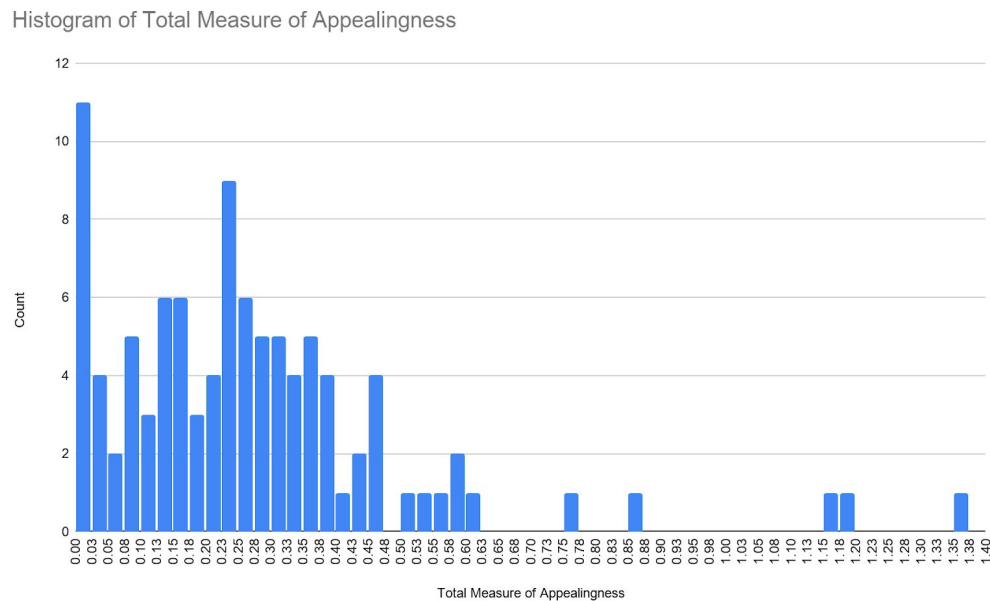


Figure 1: Histogram of sample's T.A.M

It is clear that the data does not have the perfect bell shape due to the outliers and peak in the first bucket with T.A.M.s from 0 to 0.05. I believe this is due to the way posts with Instagram's structure. A post's popularity will snowball. After people like a post rapidly, it will trend, causing Instagram to show the post to more people and exponentially increase the likes and comments resulting in the outliers to the left. This algorithm also makes it difficult, but not impossible, for posts from small accounts to trend and achieve a higher T.A.M. score. Due to this phenomenon I am choosing to continue with these tests despite the data not fitting all of the conditions.



### Results:

In the tables following is the data and calculations made from the sample collected. The calculations shown include: frequency of each category, average TAM, standard deviation of the category, S.D., and the p-value found from the one sample t- test and the paired t test. After each table is an interpretation of the data.

Table 3: Visual Characteristic: Number of Cake Layers					
Categories	Frequency	Average TAM	SD	1 sample t-test	Paired t-test
1	0.1	0.2029	0.1409	0.1262	0.135
2	0.18	0.3786	0.315	0.1939	0.346
3	0.46	0.2089	0.1415406887	0.0018	0.0001
4	0.19	0.3281	0.2669	0.4236	0.1564
5	0	----	---	---	---
6+	0.07	0.5211	0.3771	0.139	Compared to

Almost half the cakes had 3 layers. However, cakes with 6 or more layers had the highest average TAM. There were no P.C.S.P.s with 5 layers. None of the categories had a statistically significant difference with the whole sample's average T.A.M. Initially, that suggested the number of cake layers does not influence the "appetizingness" of the cake, but the the p value of the paired t test between 6+ and 3 layers is 0.0001, statistically significant. Thus, this data suggests that viewers find cake slices with 6+ layers more appetizing than those with 3 layers, but not much else. That is due to the large standard deviations in reference to the average TAMs. The TAMs are varying greatly within each category suggesting that the V.C. is not of great influence.

Table 4: Visual Characteristic: External Cover					
Categories	Frequency	Average TAM	SD	one sample t-test	Paired t-test
Buttercream etc.	0.91	0.2601	0.2204	0.4377	0.0917
Ganache	0.05	0.5197	0.4899	0.3319	Compared to
None	0.03	0.3827	0.2072	0.4739	0.669
Other	0.01	0.3952	n/a	n/a	---

Most cakes were covered with buttercream. Ganache had the highest average TAM, and there is a statistically significant difference between buttercream and ganache, suggesting that viewers find ganache more appetizing than buttercream.

Table 5: Visual Characteristic: Cake Flavor					
Categories	Frequency	Average TAM	SD	one sample t-test	Paired t-test
Vanilla etc.	0.39	0.2600	0.1607	0.4879	0.0922
Chocolate	0.29	0.3611	0.3196	0.1726	Compared against
Red Velvet	0.06	0.1165	0.3637	0.3264	0.1046
Other	0.15	0.2331	0.1419	0.2403	---
Multiple	0.11	0.2723	0.1903	0.2204	---

Although none of the tests suggest statistical significance under conventional standards, the p value of the paired t-test between vanilla and chocolate and red velvet and chocolate are quite low, suggesting that viewers may have some preference to chocolate over vanilla and red velvet. Due to the small sample in respect to the population and large SDs, I argue that these slightly larger p-values can suggest significance.

Table 6: Visual Characteristic: Cake Filling					
Categories	Frequency	Average TAM	SD	one sample t-test	Paired t-test
Buttercream etc.	0.79	0.2562	0.2277	0.3959	0.1254
Buttercream & Jam	0.1	0.3716	0.1693	0.1142	compared against
Buttercream & Caramel	0.03	0.1718	0.177	0.4077	0.1029
Buttercream & Other	0.02	0.3056	0.1281	0.8118	---
Other	0.06	0.4539	0.4609	0.393	---

Almost all posts had cakes filled with buttercream etc and 6 posts had an accompanying filling. Buttercream and jam had the highest average TAM and it had a low p value for the one sample t-test, weakly suggesting a buttercream and jam filling makes a slice more appetizing. There is a low p-value from the paired t test between the buttercream combination with jam and caramel, possibly indicating a viewer preference for jam over caramel.

Table 7: Visual Characteristic: Cake Aesthetic					
Categories	Frequency	Average TAM	SD	1 sample t-test	Paired t-test
Minimalist	0.19	0.2416	0.2488	0.5309	0.139
Rustic	0.23	0.3379	0.1517	0.0719	0.3096
Extravagant	0.09	0.414	0.4002	0.3381	0.8849
Luxurious	0.08	0.4436	0.4296	0.3118	compared against
Classic	0.24	0.1798	0.1343	0.001583	0.0111
Themed	0.07	0.2099	0.1786	0.3521	0.2043
Elegant	0.1	0.2383	0.1543	0.4370	0.1776

Luxurious cakes have the highest average TAM. The one sample t-test suggests that consumers find rustic and classic cakes less appetizing than the average cake. Similarly, the paired t-test indicates that viewers find luxurious cakes more appetizing than classic cakes.

Table 8: Visual Characteristic: Cake Face Closest to Viewer					
Categories	Frequency	Average TAM	SD	one sample t-test	Paired t-test
Cutside	0.56	0.2803	0.259	0.9477	0.9996
Exterior	0.03	0.1423	0.0638	0.0664	0.4569
Top	0.12	0.2804	0.3021	0.9792	compared to
Point	0.05	0.2627	0.201	0.8725	0.9067
Combination	0.24	0.2918	0.1938	0.7324	---

The cut side most commonly faced viewer. The one sample t-test for the exterior side, suggests that viewers find cakes with the outside facing them, less appetizing than the average cake.

Table 10: Visual Characteristic: Cake Slice Shape					
Categories	Frequency	Average TAM	SD	1 sample t-test	Paired t-test
Pie	0.74	0.290838277	0.259007	0.672674	0.3756
Rectangular	0.26	0.2417143813	0.18394	0.323244	Compared to

Although cakes sliced pie style were more common and had a higher average TAM, there was so much variance within the category that the tests do not suggest that viewers find pie style slices more appetizing than rectangular slices.

Table 11: Visual Characteristic: Plate					
Categories	Frequency	Average TAM	SD	one sample t-test	Paired t-test
Plain	0.67	0.2863	0.2774	0.8089	0.4076
Decorative	0.26	0.2426	0.1382	0.2028	0.0196
Other	0.01	0.026	n/a	n/a	---
None	0.06	0.3819	0.1159	0.0797	compared to

Plain plates were the most common, while posts with no plates had the highest average TAM. The paired t test revealed viewers find a post with no plate more appetizing than a decorative plate.

Table 12: Visual Characteristic: Presence of a Utensil					
Categories	Frequency	Average TAM	SD	one sample t-test	Paired t-test
Yes	0.33	0.2205	0.1645	0.062	0.0957
No	0.67	0.3064	0.2692	0.3918	compared to

Posts without utensils pictured were more common and have a higher average TAM. Additionally the tests suggest that a utensil can make a post less appetizing

Table 13: Visual Characteristic: Full Cake in Background					
Categories	Frequency	Average TAM	SD	one sample t-test	Paired t-test
Yes	0.24	0.2004	0.1461	0.0159	0.0694
No	0.76	0.3026	0.2593	0.4124	compared to

Most PCSPs from the #cakeslice did not have the full cake pictured, but the tests suggest that a full cake in the background will make the post less appetizing.

Table 14: Visual Characteristic: Cake Size					
Categories	Frequency	Average TAM	SD	one sample t-test	Paired t-test
small	0.29	0.2571	0.1879	0.5521	0.6647
regular	0.54	0.285	0.2615	0.0846	0.9427
large	0.17	0.2919	0.2691	0.8345	compared to

There appears to be a positive relationship between size and appetizingness, because as size increases so does the average TAM. The one sample t-test supports this, because it's low p-value indicates viewers find regular sized slices more appetizing than the average cake slice, which is between small and regular.

For eight visual characteristics I did not find evidence of an influence over a post's appetizingness. These characteristics include: extra components in the cake, ratio between icing and sponge, color palette, cake stance, background, angle of the shot, whether the cake is complete, and extra decor on the plate. The data tables for these characteristics are listed in the appendix (tables 15-22). The p-values of all the tests conducted for these characteristics are below 0.1 and show no statistical differences between means.

### **Conclusion:**

The results of the nineteen V.C.s analyzed can be explained and categorized into six overarching trends. First, it appears that in the foodie realm the expression "more is more" rings true. Viewers find cakes with six or more layers more appetizing than those with only three layers. Similarly larger cakes are more appetizing than smaller ones. Second, evidence suggests that chocolate is the most appetizing flavor. Ganache appeals to the audience more than buttercream alone and chocolate sponge is more appetizing to the viewers than vanilla and red velvet. Third, the most appetizing aesthetic is luxurious. This harmonizes with the previous trend. Larger proportions, lots of layers, and chocolate have connotations of luxury and indulgence. The data also suggest that rustic and classic cakes are less appetizing. Fourth, when the exterior of the cake slice is facing the camera, the consumers find the cake less appetizing. Similarly, the same occurs when the full cake is also pictured. This is to be expected, because the cake's exterior can be seen as decoration, while the interior is what's eaten. Fifth, slicing cakes the traditional pie style is more appetizing than a rectangular slice. Rectangular slices are a newer trend and often fit the minimalist aesthetic, which had a below average T.A.M. score. Sixth, all focus should be on the cake slice itself. Slices are less appetizing when they are on a decorative plate, because they pull attention away from the cake. Additionally, utensils in the shot also make the cake less appetizing. I initially thought a fork would be inviting to the viewer, but forks pictured are often metallic and flashy thus pulling attention away from the cake. Similarly, characteristics of the post that do not affect the taste of the slice have no or a negative influence over the post's appetizingness. This accounts for some of the characteristics whose data showed no evidence of influence. Six out of the eight (color palette, cake stance, background, angle of shot, completeness and extra decor) do not affect the taste of the cake. Therefore, the data suggests that when an Instagram foodie becomes hungry from a post, that reaction is mainly caused by aspects of the slice itself.

In total, an appetizing cake slice post in 2020 is luxurious while focusing on the slice itself, which is exactly what the post with the highest T.A.M. did:



This post had a TAM of 1.3559. The cake itself is chocolate, large, and appears luxurious and indulgent. Additionally, all focus is on the cake itself. This post strengthens my conclusions, because almost all the trends the data pointed to early are combined into this one very popular and seemingly appetizing post.

Initially I hypothesized that the most appetizing cake would be one of two extremes, modern and minimalist or extravagant. While foodies do not appreciate a modern take on cake slices, the evidence suggests that they find extravagant and luxurious cakes the most appetizing. I also hypothesized that the characteristics that affect the taste of the cake will have the most influence over how appetizing the cake appears. This appears to be accurate, because six out of the eight characteristics that had no influence over the appetizingness of the slice pertained to the styling and plating of the cake. Additionally, in his paper “The Impact of Photo Angle on Food Perceptions and Evaluations”, Austin Jacobs found that on Instagram, viewers find a side angle shot more appetizing than an overhead one, while I found no relationship between photo angle and appetizingness. However, Jacobs suggests that overhead angles were more trendy so viewer preference could have leaned that way in the three years between Jacobs’ research and my own.

There are few ethical considerations for this project. However, it is unclear if the Instagram posts analyzed are of the public domain with copyright rules being extremely flexible on social media platforms. Fortunately, I can use these photos under the “fair use” doctrine, since I am using them for educational purposes and am not profiting from them.<sup>20</sup> Additionally, it is unlikely for the results of this research to harm a business only aid in increasing their popularity.

### Error and Future Research:

While the data mostly appears to support the same conclusion, there were relatively large standard deviations, which suggested that there was too much variation for the categories. In terms of likes and follower counts, a normal distribution or bell shaped curve would be more ideal and could have led to more accurate results. However a sample like that may not be representative due to the distribution of popularity on Instagram.

<sup>19</sup> @thatlondonduo, “Mmmm chocolate cake,” Instagram photo.

<sup>20</sup> “Copyright,” Help Center, *Instagram*, [https://help.instagram.com/126382350847838?helpref=page\\_content](https://help.instagram.com/126382350847838?helpref=page_content), accessed 21, May 2020.

Below are histograms of the like count and follower count of the posts I analyzed:

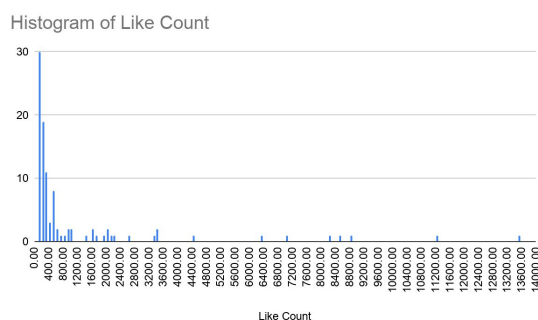


Figure 1: Histogram of sample's like count

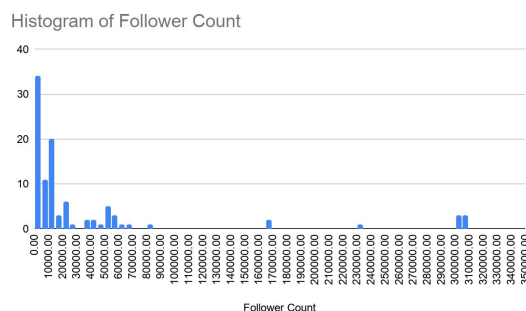


Figure 2: Histogram of sample's follower count

Notice how both are shifted left with peaks on the left side and outliers far right.

To achieve a normally distributed sample, based on like and follower count, would use a stratified sampling method, instead of taking posts solely from the tag page. I would choose accounts of increasing popularity and follower counts. This would ensure a normal distribution of predetermined popularity in the sample, but, again, this may not be the most representative method of sampling.

Sources of error are in the manipulation of like and comment count. If an account owner “bought” likes or followers, that would skew the data. Additionally large accounts have a great disparity in their like to follower ratio, because many of the followers are inactive accounts and do not like or comment. Additionally when the content creator responds to comments that increases the comment count without increasing the signal word count, because they often simply reply “thank you”. As a result the TAM of that post decreases significantly.

### Significance:

My study has combined two areas of interest, “food porn” and marketing over S.M. By placing my study on Instagram, I am doing what Ryan Eanes identified was lacking in Signe Rousseau’s book.<sup>21</sup> I also built upon the foundations set by Jacobs and Zapallo and her peers in their studies of food photography<sup>22</sup> and plating<sup>23</sup>. Additionally, my conclusion supports the notion that food is sexualized online, topics debated by restaurant professionals in Anne McBrides article<sup>24</sup>. A photo of a large chocolate cake, can be interpreted as pornographic. In the process of my research, I noticed that food is no longer being treated as such. This was evident in the comment section, where users were describing a slice as aesthetically pleasing and beautiful more often than delicious. More research should be done to explore these phenomenons. Additionally, the results of similar research have aided the food industry in marketing their products. Based on the results of my research, I would advise bakeries to post cakes on instagram that follow the appetizing trends described previously. Many pictures in the sample were posted

<sup>21</sup> Eanes, “Food and Social Media: You Are What You Tweet,”: 86- 87.

<sup>22</sup> Austin Bradley Jacobs, “Impact of Photo Angle.”




<sup>23</sup> Francesca Zampollo et al, “Looks Good Enough to Eat”: 31-46.

<sup>24</sup> McBride, “Food Porn,”: 38-41

by avid bakers and food accounts, but a large amount were posted by bakeries, advertising their cakes. Many are already utilising S.M. as a marketing tool, but the results of my research can heighten the effectiveness of their accounts, showing them what to post and what not to.






## Appendix

Table 1		
Visual Characteristic	Definition	Categories
Number of Cake Layers	A sheet of sponge. A spread of icing or filling does not qualify as a layer.	 <p>1</p>
		 <p>2</p>
		 <p>3</p>
		4
		5
		6+

<sup>25</sup> Noshu (@noshufoods), “Party time at breakfast with a slice of Funfetti,” Instagram photo, February 29, 2020, <https://www.instagram.com/p/B9KiofCFSHD/>

<sup>26</sup> Carlie (@carlieeeeats), “Self-Car(ot),” Instagram photo, March 5, 2020, <https://www.instagram.com/p/B9Wsj4llbn4/>

<sup>27</sup> Courtney Rich (@cakebycourtney), “Votes are in and my new Vanilla Cake will hit the blog tomorrow,” Instagram photo, February 23, 2020, <https://www.instagram.com/p/B86jVUZpiK7/>

<p>Ratio between filling and cake</p>	<p>The ratio between the filling(substance between layers i.e. buttercream) and the cake sponge. This does not include the side and top layers of icing, unless there is only one layer of cake. If the layers of filling vary, the largest filling layer is references. To determine if the ratio is low, medium, or high, I looked at the thickest cake layer and thickest filling layer.</p>	<p>Low: a 6+ to 1 ratio (filling to cake)<sup>28</sup></p>  <p>cakebycourtney • Follow Love your helpful tips in this morning's post! Isn't it crazy how much weather can affect what we're baking! Also wanted to hop on and see what you're baking this weekend! I'm going to test out one or two of the brownie recipes you sent me and get my Oreo Brownie Banana Caramel Trifle posted too 🍪</p> <p>2,186 likes JANUARY 10</p> <p>Add a comment... Post</p> <p>Medium: a ratio that varies between 2:1 and 5:1</p>  <p>carlieeeeats • Follow Bourke Street Bakery NYC</p> <p>carlieeeeats Self-Car(rot) 🥕 🍰 Buying myself a slice of carrot walnut cake with cream cheese frosting is my version of self-care, what's yours?</p> <p>1w</p> <p>1,404 likes 7 DAYS AGO</p> <p>Add a comment... Post</p> <p>High: a ratio of 1:1+</p>  <p>daiannanistor • Follow</p> <p>jensbake_away So pretty 🍷 4w 1 like Reply View replies (1)</p> <p>andreabakerella Looks amazing! 4w Reply</p> <p>ramonanegrean Ce bine arataaa!! 🍷 1w Reply</p> <p>389 likes FEBRUARY 13</p> <p>Add a comment... Post</p>
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<sup>28</sup> Courtney Rich (@cakebycourtney), "Love your helpful tips in this morning's post," Instagram photo, January 10, 2020, <https://www.instagram.com/p/B7Jm1YOJukq/>.

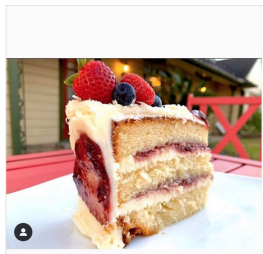
<sup>29</sup> Carlie (@carlieeeeats), "Self-Car(rot)," Instagram photo, March 5, 2020, <https://www.instagram.com/p/B9Wsj4llbn4/>.

<sup>30</sup> Daiana Nistor (@daiannanistor), "Raspberry mousse cake," Instagram photo, February 13, 2020, <https://www.instagram.com/p/B8gB8i6AIFE/>.



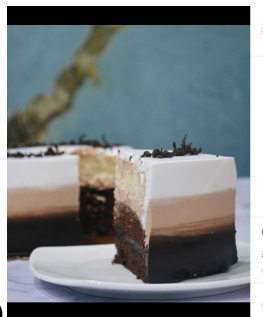
Filling	The substance used to separate the layers of sponge	Buttercream and similar looking fillings (cream cheese frosting, fudge, etc)
		Jam
		Caramel
		Other
		Multiple: These cakes may have more than one filling between each layer of cake(a) or have a different filling for each layer(b). The differing fillings may be of different flavors(b) or entirely different substances(a).

a)



35


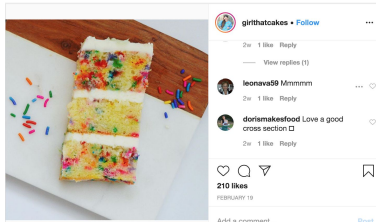

b)



36

<sup>35</sup> Rustika Cafe and Bakery (@rustikacafe), “White Chocolate raspberry,” Instagram photo, March 1, 2020, <https://www.instagram.com/p/B9MoQQ7JJUm/>.




<sup>36</sup> Le Story Vijayawad, “Grab a slice,” Instagram photo

Inclusion of extra components	These components other than the sponge, filling or external cover. They may be located in the icing or sponge, but have not been fully incorporated for flavor.	<p>Yes, fruit</p>  <p>In this case the fruit is in the filling</p> <p>Yes, sprinkles or sweets</p>  <p>In this case the sprinkles are in the sponge</p> <p>Yes, other</p> <p>Yes, multiple</p> <p>No</p>
External Cover	The main substance that enrobes the cake.	<p>Buttercream and similar looking substances (cream cheese frosting, icing, etc)</p> <p>Ganache: melted chocolate</p> 

<sup>37</sup> Nistor, "Raspberry mousse cake," Instagram photo.

<sup>38</sup> Ashley (@girlthatcakes), "Who wants a slice," Instagram photo, February 19, 2020, <https://www.instagram.com/p/B8wLQBHpWL7/>.

<sup>39</sup> (@thatlondonduo), "Mmmm chocolate cake," Instagram photo, February 19, 2020, <https://www.instagram.com/p/B8Yr7e8JWW6/>



		<p>Other: fondant, glaze, sprinkle coating, powdered sugar</p> <p>Multiple: in this case there must be multiple types of external cover. Cakes with covering of differing flavors are not included in this category.</p>  <p>thatlondonduo • Follow Arizona</p> <p>👍👍👍 I want this nowwww👍👍</p> <p>8w 1 like Reply</p> <p>chocogifts_ 🍫🍫🍫</p> <p>8w Reply</p> <p>thegoodfoodguidelondon Wow 🍫🍫🍫</p> <p>8w Reply</p> <p>1,085 likes JANUARY 13</p> <p>Add a comment... Post 40</p> <p>This cake has buttercream and ganache.</p>
Color theme of the cake slice	The color palet that the cakes interior and exterior follows	<p>Neutrals and naturals: typically beige and yellow tones. The colors of the cake have not been manipulated from anything other than the flavors used.</p>  <p>cakebycortney • Follow</p> <p>cakebycortney Love your helpful tips in this morning's post! Isn't it crazy how much weather can affect what we're baking! Also wanted to hop on and see what you're baking this weekend! I'm going to test out one or two of the brownie recipes you sent me and get my Oreo Brownie Banana Caramel Trifle posted too 🍫</p> <p>2,186 likes JANUARY 16</p> <p>Add a comment... Post 41</p> <p>Black, White, and or Grey: elements of the cake have been manipulated to fit these tones</p>  <p>cakebycortney • Following</p> <p>cakebycortney Votes are in and my new Vanilla Cake will hit the blog tomorrow!</p> <p>Gotta say, I was a little surprised but I'm not at all disappointed! This classic Vanilla Cake is flavorful and delicious, and I have no doubt it will show up in your kitchen over and over. It's the perfect base for different fruit or custard pairings, so you'll be able to turn it into</p> <p>7,040 likes FEBRUARY 23</p> <p>Add a comment... Post 42</p>

<sup>40</sup> (@thatlondonduo), “Yummy cake,” Instagram photo, January 13, 2020, <https://www.instagram.com/p/B7QzTRepOJj/>.

<sup>41</sup> Rich, “Love your helpful tips,” Instagram photo.

<sup>42</sup> Rich, “Votes are in,” Instagram photo.



		<p>Pastels: elements of the cake were manipulated to be colorful, yet muted</p>  <p>43</p> <p>Colorful: the cake colorful and vibrant, this theme is often created with sprinkles or bright sponge colors.</p>  <p>44</p> <p>Brown: almost all elements are shades of brown, typically from chocolate flavoring</p>  <p>45</p>
<p>Cake Aesthetic</p>	<p>The artistic style that the cake generally follows. Multiple categories can be identified for a single cake.</p>	<p>Minimalist: identified by clean lines and fewer elements</p>  <p>46</p>

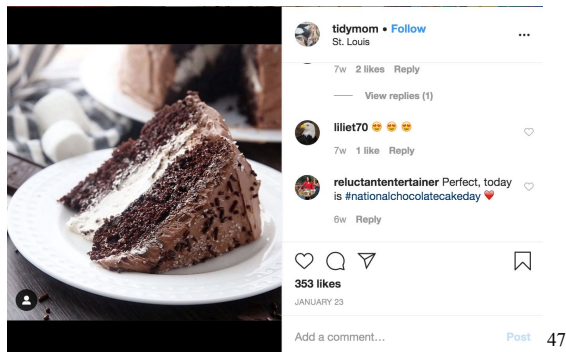
<sup>43</sup> Nistor, "Raspberry mousse cake," Instagram photo.

<sup>44</sup> Carlie (@carlieeeeats), "Give Your Heart A Cake," Instagram photo, February 20, 2020, <https://www.instagram.com/p/B8zgMXglGwf/>.

<sup>45</sup> @thatlondonduo, "Mmmm chocolate cake," Instagram photo.

<sup>46</sup> Rich, "Votes are in," Instagram photo.

Rustic: appears more homemade, fewer clean lines



Note how in this cake the top is slopped and the buttercream coating is more sloppily put on.

Extravagant: complex decor, abundance or different elements and techniques, extreme features (ie lots of layer or toppings)



Luxurious: metallic tones, expensive decor (gold leaf, pearls, etc)



<sup>47</sup> Cheryl (@tidymom), "Sometimes you need a rich, fudgy chocolate cake," Instagram photo, January 23, 2020, <https://www.instagram.com/p/B7rU2YwhcIX/>.

<sup>48</sup> (@thatlondonduo), "Yummy cake," Instagram photo, January 13, 2020, <https://www.instagram.com/p/B7QzTRepOJj/>.

<sup>49</sup> Miriam Schultz (@bakingbysmiriam), "Just couldn't resist sharing," Instagram photo, January 27, 2020, <https://www.instagram.com/p/B7106yApWBu/>.

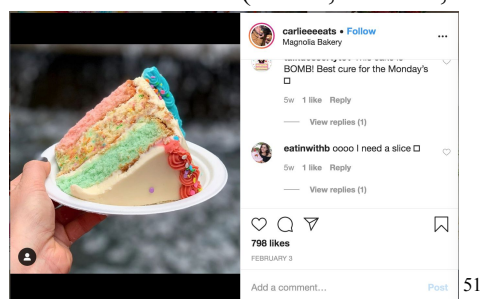


Themed: cake designed for a purpose such as a holiday or birthday



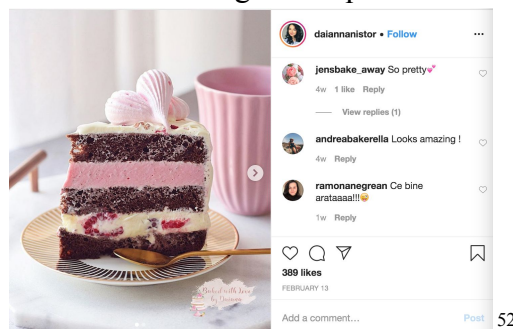
The cake pictured is new years themed.

Classic: simple decorate, decorating techniques common in stores (swirls, borders, etc)



The borders and generic sprinkles are reminiscent of a typical children's cake.




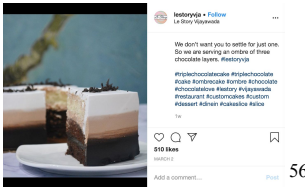
Elegant: looks professional, clean lines, more difficult decorating techniques.



<sup>50</sup> Mandy Merriman (@bakingwithblondie), "It's a brand new year," Instagram photo, January 1, 2020, <https://www.instagram.com/p/B6yGLGKB4iK/>.

<sup>51</sup> Carlie (@carlieeeeats), "This Too Shall Pastel," Instagram Photo, February 3, 2020, <https://www.instagram.com/p/B8HviQxFnxj/>.

<sup>52</sup> Nistor, "Raspberry mousse cake," Instagram photo.

Table 2		
Visual Characteristic	Definition	Categories and examples
Cake position	The stance the cake slice takes.	<p>Standing up:</p>  <p>53</p>
		<p>Laying down:</p>  <p>54</p>
Cake face	The side of the cake closest to the viewer or the side that is the most visible.	<p>Cutside:</p>  <p>55</p>
		<p>Exterior:</p>  <p>56</p>

<sup>53</sup> Nistor, “Raspberry mousse cake,” Instagram photo.

<sup>54</sup> Rich, “Votes are in,” Instagram photo.

<sup>55</sup> Nistor, “Raspberry mousse cake,” Instagram photo.

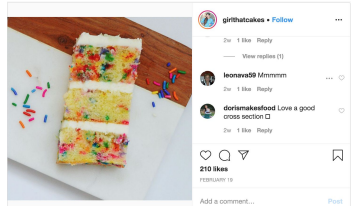

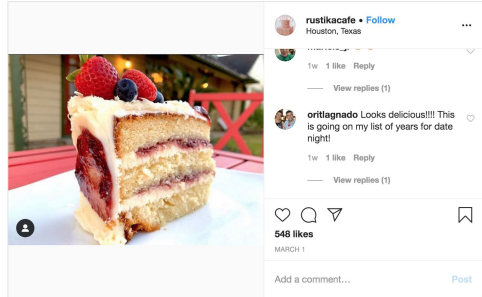
<sup>56</sup> Le Story Vijayawad, “Grab a slice,” Instagram photo

		<p>Point:</p>  <p>Top:</p>  <p>Combination:</p>  <p>In this photo the edge where the outside and the exterior meet is closest to the viewer.</p>
Slice Shape	The way that the cake is cut, resulting in a certain shape	Pie Style: most common way a round cake is cut.

<sup>57</sup> Katie Severn (@bakingbutterlylove), “Whats your favorite vanilla cake filling,” February 6, 2020, <https://www.instagram.com/p/B8PqL5spZXH/>.

<sup>58</sup> Carlie, “This Too Shall Pastel,” Instagram Photo.

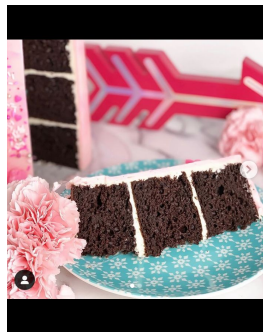


<sup>59</sup> (@thatlondonduo), “Yummy cake,” Instagram photo.

		<p>Rectangular:</p> 
Background	The environment around the cake, when the photo is taken	<p>Plain: blank, one color</p> 
		<p>Casual: taken at the scene of consumption (cafe, kitchen, table, etc)</p> 
		<p>Styled: extra decor to compliment the cake</p>

<sup>60</sup> Ashley, “Who wants a slice,” Instagram photo.

<sup>61</sup> Saltadena Bakery & Cake Shop (@saltadenabakery), “Introducing our new P.O.G. -inspired Cake,” Instagram photo, February 18, 2020, <https://www.instagram.com/p/B8uGvskAE3X/>.




<sup>62</sup> Rustika Cafe and Bakery, “White Chocolate raspberry,” Instagram photo.

		
Plate	What the cake slice is rested on	Plain: solid white, black or grey plate
		Decorative: a plate with patterns or a vibrant color
		None
Angle of the shot	The perspective from which the cake is photographed in reference to the cake	Overhead: Camera directly over the cake 
		Side: camera lens perpendicular to the surface 
		Downward: angle is between side and overhead

<sup>63</sup> Jessica (@cakingadventure), "Slice pic," February 15, 2020, <https://www.instagram.com/p/B8mc5RKJvI3/>.

<sup>64</sup> Saltadena Bakery & Cake Shop, "Introducing our new P.O.G.," Instagram photo.




<sup>65</sup> Severn, "What's your favorite vanilla ," Instagram photo.

		 <p>cakebycortney • Follow</p> <p>cakebycortney Love your helpful tips in this morning's post! Isn't it crazy how much weather can affect what we're baking? Also wanted to hop on and see what you're baking this weekend! I'm going to test out one or two of the brownie recipes you sent me and get my Oreo Brownie Banana Caramel Trifle posted too!</p> <p>2,100 likes JANUARY 10</p> <p>Add a comment... Post 66</p>
Is the slice complete?	Has a piece or bite been taken from the slice? If a piece is separated from the slice, but is still on the plate, the slice is incomplete.	<p>Yes</p> <p>No</p>  <p>thecakepopkitchen • Follow</p> <p>thecakepopkitchen Yummmmm how can come and pick. Slice! @thecakepopkitchen</p> <p>168 likes FEBRUARY 21</p> <p>Add a comment... Post 67</p>
Utensils	Is there a fork, spoon, or knife in frame	<p>Yes</p> <p>No</p>
Other decor on plate	Are there elements on the plate that are not part of the cake?	<p>None</p> <p>Flowers</p>  <p>thecakepopkitchen • Follow</p> <p>thecakepopkitchen Yummmmm how can come and pick. Slice! @thecakepopkitchen</p> <p>168 likes FEBRUARY 21</p> <p>Add a comment... Post 68</p>

<sup>66</sup> Rich, “Love your helpful tips,” Instagram photo.

<sup>67</sup> @thecakepopkitchen, “Don’t forget to treat yourself,” Instagram photo, February 21, 2020, <https://www.instagram.com/p/B81y-tlBlsz/>.

<sup>68</sup> @thecakepopkitchen, “Don’t forget to treat yourself,” Instagram photo.

		<p><b>Fruit</b></p>  <p>cakebycourtney • Following ...</p> <p>cakebycourtney • Votes are in and my new Vanilla Cake will hit the blog tomorrow! .</p> <p>Gotta say, I was a little surprised but I'm not at all disappointed! This classic Vanilla Cake is flavorful and delicious, and I have no doubt it will show up in your kitchen over and over. It's the perfect base for different fruit or custard pairings, so you'll be able to turn it into</p> <p>7,040 likes FEBRUARY 23</p> <p>Add a comment... Post 69</p> <p><b>Other</b></p> <p>Multiple: more than 1 type of decor, i.e. flowers and fruit, not 2 types of fruit</p>
Full cake	Is the full cake in the background?	<p><b>Yes</b></p>  <p>bakingwithblondie • Follow ...</p> <p>year. 2020! 🎉</p> <p>New beginnings are my favorite because I can start fresh, turn the page, begin a new chapter, and mark the beginning of a something new. It's also a great time to refresh (or continue) personal goals or affirmations of times past. Some of my goals have been in place for a while, some started last week, and some are beginning today. I know there are some who aren't exactly into new year's resolutions, and that's</p> <p>3,457 likes JANUARY 1</p> <p>Add a comment... Post 70</p> <p><b>No</b></p>
Cake Size	The size of the slice in reference to the whole cake.	<p><b>Small: the slice is less than 1/8th of the entire cake</b></p>  <p>saltadenabakery • Follow ...</p> <p>surprised me with a slice of this tonight and it is incredible. Each fruit note is so perfectly pronounced and the cake is this cloud carrying the flavors along. Well done! 🍌 🍌 🍌</p> <p>3w Reply</p> <p>americanbutcher Need this!!! 🍌</p> <p>2w Reply</p> <p>527 likes FEBRUARY 18</p> <p>Add a comment... Post 71</p> <p><b>The slice is between 1/8th and 1/6th of the entire cake</b></p>

<sup>69</sup> Rich, "Votes are in," Instagram photo.

<sup>70</sup> Merriman, "It's a brand new year," Instagram photo.

<sup>71</sup> Saltadena Bakery & Cake Shop, "Introducing our new P.O.G.," Instagram photo.



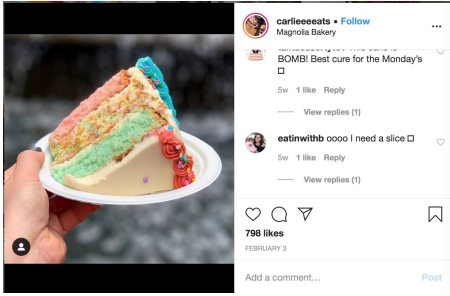

		 <p>Large: the slice is greater than 1/6th of the whole cake.</p> 
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Table 15: Visual Characteristic: Extra Components in Cake

Categories	Frequency	Average TAM	SD	one sample t-test	Paired t-test
yes, fruit	0.04	0.2585	0.0936	0.7048	0.819
yes, sprinkles/sweets	0.13	0.237	0.1387	0.3129	0.4934
yes, others	0.03	0.1705	0.1409	0.3172	---
yes, multiple	0.03	0.3087	0.2447	0.8482	---
none	0.77	0.2889	0.2623	0.7177	Compared against

Table 16: Visual Characteristic: Ratio of Filling to Cake

Categories	Frequency	Average TAM	SD	One sample t-test	Paired t-test
low	0.35	0.2534	0.1514	0.3428	0.1806
medium	0.54	0.2771	0.2530	0.9786	0.367
high	0.11	0.3609	0.3898	0.4967	Compared against

<sup>72</sup> Carlie, “This Too Shall Pastel,” Instagram Photo.

<sup>73</sup> Severn, “What’s your favorite vanilla ,” Instagram photo.



Table 17: Visual Characteristic: Color Palette					
Categories	Frequency	Average TAM	SD	one sample t-test	Paired t-test
Neutrals	0.39	0.3052	0.2602	0.5182	0.9381
Black, White & Gray	0.1	0.2421	0.3459	0.3459	0.5632
Pastels	0.19	0.2634	0.2605	0.8094	0.5905
Colorful	0.2	0.2368	0.1464	0.2233	0.2354
Brown	0.12	0.3116	0.2025	0.5773	compared against

Table 18: Visual Characteristic: Cake Position					
Categories	Frequency	Average TAM	SD	1 sample t-test	Paired t-test
Standing Up	0.5	0.3032	0.2968	0.5995	0.3986
Lying Down	0.5	0.2529	0.1696	0.2994	Compared to

Table 19: Visual Characteristic: Background					
Categories	Frequency	Average TAM	SD	one sample t-test	Paired t-test
Plain	0.29	0.2577	0.1534	0.4805	0.5029
Casual	0.31	0.3022	0.3228	0.6804	compared to
Styled	0.4	0.2741	0.2248	0.9128	0.6678

Table 20: Visual Characteristic: Angle of Shot					
Categories	Frequency	Average TAM	SD	one sample t-test	Paired t-test
Side	0.32	0.3161	Side	0.2851	compared to
Overhead	0.15	0.276	Overhead	0.1887	0.6232
Downward	0.53	0.2556	Downward	0.2277	0.2847

Table 21: Visual Characteristic: Complete slice					
Categories	Frequency	Average TAM	SD	one sample t-test	Paired t-test
Yes	0.94	0.282	0.2475	0.8778	compared to
No	0.06	0.2164	0.1162	0.2501	0.5221

Table 22: Visual Characteristic: Extra Decor on Plate					
Categories	Frequency	Average TAM	SD	one sample t-test	Paired t-test
Yes, flowers	0.03	0.2647	0.2207	0.9261	0.4084
Yes, fruit	0.04	0.4102	0.1959	0.2702	compared to
Yes, other	0.09	0.2769	0.2014	0.9871	---
None	0.84	0.2724	0.2497	0.835	0.3482

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