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| RESEARCH ARTICLE

Moderate Aerobic Exercise in College Students' Memory Retention

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| ABSTRACT

This study was conducted to determine the effect of moderate aerobic exercise on memory retention of 1st-year Political Science students at the University of Cebu Main- Campus, Academic Year 2022-2023. It utilized the quantitative research method; thus, this study used a quasi-experimental pre-test and post-test design. The researchers used this design in conducting this study to evaluate if the intervention known as moderate aerobic exercise, precisely the brisk walk-in-place exercise, positively affects the students' memory retention. Moreover, this research design helps determine the effect of the treatment on the respondents before and after manipulation. Physical exercise has undeniably positive effects on both our bodies and minds. The scientific literature emphasizes its impact on our memory. The idea that something as simple as exercise, which anyone can do, has the potential to improve our memory is reason enough to investigate further. This will be especially beneficial for students, as having a good memory is a requirement for academic success. They chose them as the respondents in this study because their major requires much memorization, and they recently switched from online to face-to-face classes. This research aims to see if there is a difference in students' memory retention before and after moderate aerobic exercise. The research was motivated by the recognized positive influence of physical exercise on memory. It focused on its relevance to students who require strong memorization skills for academic success, especially considering the transition from online to in-person classes. The primary objective was to examine any variations in memory retention before and after moderate aerobic exercise. Individuals were given the challenge of memorizing 50 pairs of words within a ten-minute time frame. This task was repeated on the second, third, and fourth days, and a memory retention test was administered on the fifth day. While the overall results did not reveal a significant difference in memory recall, some participants showed modest improvements, suggesting potential benefits for certain students. The study recommends that future investigations consider factors such as IQ levels, learning preferences, diet, sleep duration, and life stressors, which could influence students' memory abilities.

| KEYWORDS

Aerobic Exercise, College Students, Memory Retention, Quasi-experimental, Quantitative Study, Physical Education

| ARTICLE INFORMATION

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1. Introduction

Humans have always engaged in physical activity to survive and stay fit. It is natural to believe that exercising only benefits the body, but numerous studies have been conducted worldwide linking physical exercise to improved memory function. Memory retention has always been a concern, particularly among students, because education necessitates a great deal of memorization, but physical exercise may alleviate that concern. Remembering or recalling information is valuable for any student seeking

academic success. Aside from the fact that aerobic exercise improves physical fitness, it can also boost the size of the hippocampus, improving verbal and spatial memory and learning (Godman., 2014 & Erickson et al., 2011).

On the other hand, during the COVID-19 lockdown, people become unmotivated to exercise (Kaur et al., 2020), which causes the brain to be at risk. Furthermore, the COVID-19 outbreak caused the schools to discontinue face-to-face sessions and transition to online learning and modular distance learning, causing significant changes and adjustments to students' learning and retaining the lessons obtained. According to Idris et al. (2021), online learning negatively impacts students' physical health, such as back problems and other computer-related physical stress. In addition, online and modular learning leads students to possess sedentary behavior, which reveals many health risks and conditions (Mangis, 2016).

On an international scale, various studies have been conducted on the effect of exercise on memory. However, the most extensive research institution in the United States, Wisconsin Madison, stands out for its numerous studies on the effect of exercise on memory. They have provided many insights into the effect of moderate aerobic exercise on recall and memory retention. Even though, at first, the results of their study did not support their hypothesis that physical activity affects memory, this did not stop them from researching more about this topic because the benefits are promising, and thus opens a path for researchers to explore more on this topic. It arouses a desire to learn more about how exercise affects memory function in the academic literature.

In the Philippines, the school system places little to no emphasis on the benefits of physical exercise to students' memory function. Some subjects teach the importance of physical activity, such as Physical Education, but the importance of exercising in improving brain function is only sometimes highlighted. However, the link between exercise and memory is present in the Philippine academic literature, as a 2013 study found that aerobic exercise improved the cognitive ability of first-year Physical Therapy students. This demonstrates that the country, at least to some extent, recognizes the benefits of researching the effect of physical exercise on memory functions. Even though that study should be enough to make Filipinos value exercise, statistics show that 67% of Filipinos still do not exercise and prefer to live a sedentary lifestyle, according to the findings of WHO in 2019 that out of 1.6 million teens in 146 countries surveyed, the Philippines had an overall physical inactivity prevalence of 93.4 percent (Rappler, 2021). For that reason, students' learning will be negatively affected since physical activity is linked to how the brain functions. Being physically inactive dramatically affects students' mental processes, specifically having weaker working memory, slow attention span, cognitive inflexibility, and indecisiveness.

The researchers discovered no studies in Cebu City on the effect of moderate aerobic exercise on students' memory retention after conducting an extensive literature review. As a result, a knowledge gap must be filled to understand the effect of exercise on memory in the local setting. Furthermore, as researchers, this study applies to any course. However, this is more helpful for Political Science students since this course requires strong cognitive abilities, and the subjects accessible in this field focus on retaining vital and significant facts. Students in this field must have good memory retention skills (Schnieders, 2021). This study will be highly beneficial for Political Science students in terms of developing a high level of memory retention and encouraging them to engage in effective mild exercise.

The researchers set out to investigate the effects of moderate aerobic exercise on memory retention of first-year Political Science college students in the academic year 2022-2023 at the University of Cebu Main Campus. This study aims to examine whether the intervention known as "moderate aerobic exercise" improves memory retention.

2. Theoretical Background

This study is anchored on the Multiple Trace Theory (MTT), which Lynn Nadel and Morris Moscovitch created in 1997, as well as two supporting theories, the Two Stage Theory of Watkins and Gardiner (1979) and the Encoding Specificity Principle of Memory of Tulving and Thomson (1973).

Multiple Trace Theory (MTT) of Lynn Nadel and Morris Moscovitch (1997) proposes that the hippocampus is essential in retrieving all episodic memories. According to MTT, the hippocampal complex rapidly and obligatorily encodes all information attended to and binds neocortical neurons representing that experience into a memory trace.

In addition, the proponents of this theory claim that both old and new episodic memories rely on the hippocampus and should activate the Medial Temporal Hippocampal System (MTH), which is critical for episodic and spatial memory, allowing them to encode, consolidate, and retrieve memories. Moderate aerobic exercise enables an individual to increase the size of their hippocampus and improve memory. Although hippocampal volume loss is not unavoidable, it can be reversed by engaging in moderate-intensity exercise (Erickson et al., 2011 & Barnard, 2020).

Physical activity plays a role in both forming and maintaining memory traces, which evolve through three stages: memory encoding (acquisition), consolidation (storage), and retrieval (recall). Multiple Trace Theory is a memory consolidation model that contends the hippocampus is always involved in retrieving and storing episodic memories. It has been established that MTT is one of the

most unique and significant modern memory theories. It has been crucial in influencing perceptions of system-level memory consolidation (Sutherland et al., 2019).

According to this theory, whenever certain information is supplied to a person, it is neutrally encoded into a unique trace of a range of attributes. The properties of an object constitute its trace and may be divided into a spectrum of disciplines. Furthermore, when an item is retained in memory, the information is saved in each attributional category and subsequently encoded to the item trace. MTT introduces four types of attribution, namely: Physical attributes, which encode information about the physical properties of a presented item; Contextual attributes, which are primarily known for their broad class of attributes that define internal (mood/semantic association) and external (spatial and temporal) features; Modal attributes, which refer to the use of any sensory modality yet, the most frequent types of modalities are auditory and visual which are commonly utilized in the experiment setting. Finally, classifying attributes refers to the classification of objects provided, with each item categorized and placed in the exact attributes.

MTT fits nicely into the recognition concept when applied to memory phenomena. Individuals must determine whether or not they have previously seen the item presented in order for recognition to function. Moderate aerobic exercise plays a vital role in achieving high memory recognition. According to the current research, exercise improves the brain for memory consolidation by boosting brain connections and improving memory functions such as visual or verbal memory (Denworth, 2018). Dongen et al. (2016) stated that during their examination of the influence of acute exercise on memory consolidation and retrieval-related brain processes, they discovered that conducting exercise increased the retention of picture location associations.

Furthermore, in the context of memory phenomena, MTT can account for recall, notably cued recall, which is the recollection of information from the past. The two most fundamental recall theories are the two-stage theory and the idea of encoding specificity. Hence, Nadel and Moscovitch's (1997) Multiple Trace Theory will be applied during the research process. Researchers will conduct experiments that are entirely transparent to the theory during data collection. Furthermore, the researcher used a quasi-experimental pre-test and post-test approach, a type of quantitative research focusing on one group, the experimental group, which will undergo the pre-test and post-test, and after the activity, the Post-test. Following data collection, information from participants will be analyzed and interpreted to provide an answer to the study's main problem.

Watkins and Gardiner's two-staged theory, presented in 1979, claims that the recall process begins with a search and retrieval phase, followed by a recognition phase in which the pertinent information is picked from what has been obtained. According to this theory, recall has two phases, while recognition has just one. Based on this theory, recall works by searching for information and then moving into the retrieval phase, which causes the individual to recognize the information.

Furthermore, recognition works when the stimulus leads to a previously discovered memory, and this phase requires just the second step, making recognition superior to recall. It asserts that while trying to get someone to remember something, it is far preferable to notice it first rather than wait for it to be remembered. As a result, cued recall is critical at this phase for efficiently remembering things. To simplify this theory, searching through memory might help retrieve the searched memory. When memory is already remembered, the recalled memory is compared to the details being sought for or recalled (Abel, 2023).

In addition, some studies claim that recognition is superior to recall, and this is supported by the study of Srivastava and Vul (2017), who proposed a model of human memory that explains why recognition is generally more accurate than recall. They argued that recognition involves comparing the current input to a set of stored exemplars, while recall requires reconstructing a target from memory. The proposed model is based on the idea that a memory trace consists of a set of neurons that encode the trace and that recognition and recall rely on different properties of these neurons. The study compared the proposed model to data from various recognition and recall experiments and found that the model accurately predicted the observed performance patterns. The researchers concluded that recognition is superior to recall because it relies on a more reliable comparison process that is less affected by noise and interference in the memory system.

Moreover, Bastin et al. (2013) conducted a study examining unitization's impact on source memory in older adults. The study found that older adults had better recognition than recall memory. Moreover, the difference between recognition and recall memory was more tremendous for unitized than non-unitized items. The researchers suggested that these findings support the two-stage model of memory processing, where unitization may facilitate the familiarity assessment stage of recognition memory. Unitization refers to processing information as a single, integrated unit rather than separate components. The study highlights the importance of considering cognitive strategies such as unitization and how they can impact memory performance in aging individuals. These findings have important implications for developing memory training programs for older adults.

The other theory, Tulving and Thomson's (1973) Encoding Specificity Principle of Memory, in this study it contends that memory improves when information present during encoding is also available at retrieval. According to this theory, to correctly recall the memory, the conditions of encoding the memory must match the retrieval conditions. The environment or location, mental state, and physical state are all essential factors in encoding and retaining information. This theory states that the memory uses information from the memory trace or the setting in which it was learned and the environment in which it was retrieved. In a nutshell, it implies that if people were tested in the exact location where they had studied, they would have a better chance of remembering the information. Additionally, Davelaar., (2013) noted that the efficacy of recognition memory occurs when a previously experienced event is reexperienced, and the environmental information is matched to stored memory representations, evoking matching signals.

Several studies have been provided that serve as further evidence for the encoding specificity principle, and Dede and Schacter (2017) are one of those researchers who investigated background music's impact on memory retrieval. In this study, participants studied a list of words while listening to either instrumental music or silence. They were then tested on their memory for the words in the same or different listening conditions. The results showed that memory retrieval was significantly better when the participants were tested in the same listening condition as they had studied, demonstrating the importance of environmental cues in memory retrieval. Another study by Kurilla and Lovett (2019) investigated the role of emotional context in memory retrieval. In this study, participants studied a list of words paired with either positive or negative images. They were then tested on their memory for the words in the same or different emotional context. The results showed that participants had better memory retrieval when the emotional context matched between encoding and retrieval, further supporting the encoding specificity principle.

In addition, several neuroimaging studies have provided evidence for the neural mechanisms underlying the encoding specificity principle. The confirmation of this phenomenon comes from a study conducted by Vilberg and Rugg in 2012, where they employed functional magnetic resonance imaging (fMRI) to explore the neural mechanisms associated with successful memory retrieval. They found that brain regions involved in sensory processing were more active when participants retrieved information in the same sensory modality as it was encoded, providing neural evidence for the importance of environmental cues in memory retrieval. These studies further support the encoding specificity principle, emphasizing the importance of contextual cues, emotional states, and sensory modalities in memory retrieval.

However, both of the supporting theories listed above may fail in some cases, mainly if the objects to be recalled contain nonsensical information or if an individual is suffering from sleep deprivation and stress, which may be the cause of their difficulty recalling and cause them to forget the information for days or weeks. It is proven in the study of Hermann Ebbinghaus, in which he developed a model known as the Ebbinghaus Forgetting Curve Model (1885). In this model, the most considerable reduction in retention occurs when the knowledge is not retained and the memory is lost or forgotten in a matter of days or weeks. An individual's memory is frequently lost when absorbing meaningless knowledge, especially if the topic could be more enjoyable. This model also suggested that not getting enough sleep and being stressed are two more variables that might affect memory. Hence, to keep the information intact in the memory, it is essential to revisit the information sooner instead of later, and in that way, it helps to retain the information longer (Murre & Dros, 2015; Rasch & Born, 2013; Ezeh et al., 2018., & Mind Tools, 2022).

When COVID-19 struck the whole world, it led people to stay at their respective houses and caused them to experience a sudden and extreme change in lifestyle, specifically the individual's physical activity, sedentary behavior, and dietary habits. (Legido-Quigley et al., 2020 & Sidebottom et al., 2021). Schools worldwide were forced to stop traditional face-to-face classes and shift to online learning *(OECD., 2020)*. Online learning led students to possess sedentary behavior, which harmed their health (Mangis, 2016).

Numerous physical health issues arise among students while they are engaged in online learning, such as back pain and other computer-related issues (Idris et al., 2021). The arousal of those physical problems was because people became too comfortable with online learning setups, which caused them not to engage in any exercise. This is proven in a 2020 survey done by University College London, wherein 85% of individuals did not engage in moderate or intense activity, while 40% did not engage in easy exercise such as going for a walk. On the other hand, during the COVID-19 lockdown, people become unmotivated to exercise (Kaur et al., 2020), and being physically inactive for too long, the brain will be at risk, which will cause people to suffer from brain fog. It affects people's memory, including the ability to store and recall information (Vaiana, 2019; Bangkok Hospital, 2022, & Wilson, 2019).

To address such concern, aerobic exercise can reduce brain fog since regular exercise gets the heart rate pumping and the sweat glands pumping, which boosts the size of the hippocampus and results in sharpening and improved memory (Bauer., 2020; Godman., 2014 & Erickson et al., 2011).

Furthermore, it was discovered that physical exercise can affect how much specific proteins, which is known as the Brain-Derived Neurotrophic Factor (BDNF), increase after exercise. To successfully recall information, increasing the level of BDNF is critical due to its benefits to the brain. BDNF helps prevent hippocampal atrophy by slowing brain degradation. It also aids in the development of new connections, the repair of failing brain cells, and the protection of healthy brain cells. Furthermore, aerobic activity is required to efficiently create a molecule known as BDNF (Firth et al., 2018; Sparta Science. 2019 & Gabriel., 2010). People who exercise consistently and are physically healthy, according to Fotuhi (2015), have a large hippocampus, implying that exercise is the most significant way to develop new hippocampal neurons. The hippocampus's new brain cells, neurons, are vital for learning, preserving long-term memories, and regulating emotions. As a result, everyone must engage in regular endurance exercises to have high memory retention.

According to Diley (2019), acute, high-intensity exercise can increase real episodic memory. On the other hand, exercise should be more modest to prevent exhausting people and making them less attentive while studying (Denworth., 2018). As a result, it is demonstrated that aerobic exercise has an immediate effect on memory retention. This research suggests introducing aerobic exercise into study sessions and lectures may improve students' academic performance (*Neumann., 2014)*. In addition, the Suwabe et al. (2018) study found that modest or light exercise increases brain connection, which is crucial for memory development and storage. Also, based on the new findings of a neurological study, ten minutes of moderate aerobic activity can rapidly change how specific brain areas communicate and collaborate, resulting in better memory function (Reynolds., 2018 & University of California Irvine. 2018).

One of the moderate aerobic exercises that greatly help an individual's memory performance is brisk walking. In the study of Colmenares et al. (2011), the individuals who conducted the walking exercise improved their memory. They also say that regular exercise causes the heart rate to increase, which can enhance oxygen and blood flow, which improves students' memory performance. This is backed by Salas et al. (2011) study, wherein, based on their findings, individuals can obtain a memory advantage from a 10-minute walk before studying. Also, another study by Drolette and Hillman (2020) discovered that single bouts of walking are more effective for improving memory performance. Furthermore, experts say that exercising three times a week is highly beneficial to busy people since it improves their general health and, most importantly, saves time *(EFM, 2017)*. In addition, Yang., (2019) stated that physical activity three days per week is suitable for resistance training and bone strengthening.

Several studies have found that students who engage in aerobic exercise immensely gain cognitive performance *(Carlos et al., 2013)*. It also immediately impacted memory retention, which affected recall *(Neumann, 2014)*. Spielman et al. (2016) showed in their study that the benefits provided by exercise enhance overall brain health, which helps to prevent neuron loss. It is also suggested in Liu & Nussock., (2018) study that exercise plays a vital role in neuron creation. Neurogenesis, or the formation of new neurons, aids in improving learning ability and maintaining memory sharpness. As a result, regular exercise is critical to enhancing neurogenesis while keeping the brain attentive. In addition, the timing of the exercise concerning the memory task may affect this occurrence (Labban & Etnier., 2013). According to Dongen et al. (2016), they were conducting aerobic activity 4 hours after learning new ideas can considerably boost memory recall. Exercise helps to enhance hippocampal pattern similarity during retrieval. As a result, exercise can potentially be a memory intervention in the educational context.

Furthermore, Roig et al. (2016) believe that when cardiovascular exercise is recommended to increase memory, exercise time is crucial. In their study, they presented that cardiovascular exercise is a crucial suggestion in enhancing memory in various populations and that this intervention can be used in school settings to improve motor and retention skills and cognitive function in older people experiencing cognitive decline. Furthermore, Hacker et al. (2020) discovered that fifteen minutes of aerobic exercise was sufficient to produce favorable effects. They concluded that the processing speed of visual recognition memory and attention remained unchanged.

Moreover, attention is one of the characteristics that influence recall. Attention must be one of the highest priorities to encode information correctly and effectively. Furthermore, if this phase is combined with performing a task while encoding information, the information will not be encoded properly, resulting in recall failure. This remark is supported by Greene and Benjamin's (2021) study, which discovered that the Divided Attention group performed worse, resulting in deficiencies in memory retrieval compared to the Attention individuals who could do the task successfully. When emotion is involved, attention works better since the individual is more linked to the situation, resulting in serious focus. In research done by Gotoh (2012), the purpose was to find out the use of emotional vocabulary as a key to remembering memory, and the outcome of the study was that listeners were able to recall more expressive words, memorable phrases, and sounds.

In addition, context dependency is one of the elements that influences the recollection of freshly learned knowledge. When the environment is comparable in both the learning and recall stages, this cued recall works efficiently, or an individual will be able to recall more. Seddon (2019) explored the effects of context-dependent memory on students' ability to recall more throughout the examination. According to Sedon's results, pupils assessed in their usual classroom environment and switched to be examined

in a different classroom performed poorly. Furthermore, episodic specificity induction plays a role in unpacking a recently acquired memory, and the interaction of acute exercise and ESI influences episodic memory function (Loprinzi, 2019).

This study assumes moderate aerobic exercise significantly affects first-year Political Science students' memory retention. The reason this research focuses on first-year college students who graduated Senior High School from an online class is that they are the ones who are having a hard time adjusting to face-to-face college classes. According to Schnieders (2021), first-year college students are experiencing difficulties in their coursework. The researcher discovered that students' most common challenges are a lack of motivation, difficulty retaining online information, and difficulty understanding concepts without hands-on experience. Furthermore, the Political Science students fit well to be the main focus of this study, and the researchers aim to figure out the effect of moderate aerobic exercise on students' memory retention. In that case, Political Science, a prelaw course, is particularly suitable for this study due to its high cognitive ability demand. It introduces legendary stresses in legal education, and the law profession may take a substantial toll on cognitive capacity. One of the skills that every lawyer and law student must acquire is memorizing, and law students must not only memorize but also ensure that the knowledge is firmly ingrained in their minds. (Hilbay, 2015).

3. Objectives of the Study

The primary goal of this study was to assess the impact of moderate aerobic exercise on the memory retention of first-year Political Science college students at the University of Cebu-Main Campus during the academic year 2022-2023. This research focused on examining the students' memory retention both before and after three days of exposure to moderate aerobic exercise, intending to determine whether there was a noteworthy difference in memory retention before and after engaging in such exercise.

4. Research Methodology

This section presents the research design, environment, respondents, instrument, procedures, data collection, and analysis.

4.1 Research Design

This study used the quantitative method; thus, it used a Quasi-Experimental Pre-test and Post-test design. The researchers used a Quasi-experimental design, which was divided into two main categories: pre-test and post-test. This research design was implemented since it was consistent with the study's goal to evaluate if the intervention affects the respondents. This quasi-experiment is an experimental situation in which the researchers assigned, but not randomly (Creswell). Creswell also states that the pre-test measures some attributes and characteristics that assessed respondents before receiving the treatment. He also explains that the post-test provides measures of some attributes and characteristics that assessed the respondents after the treatment. Researchers used this research design to determine the effect of a particular treatment on the respondents before and after the manipulation.

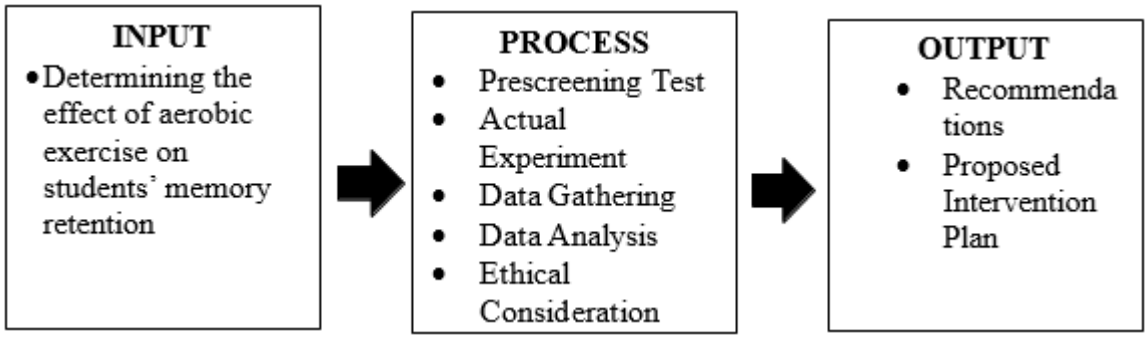

Figure 1: Flow of the Study

4.2 Research Environment

This study was conducted face-to-face, strictly adhering to safety protocols mandated by the government and the school. This section of the research paper focuses on the environment of the selected participants, notably the University of Cebu, a private, non-sectarian, coeducational educational institution in Cebu City, Philippines. We were founded in 1964 by Atty. Augusto W. Go, the university offers various educational levels, including preschool, grade school, junior high school, undergraduate degrees, and post-graduate degrees across its five campuses in Metro Cebu. The study primarily centered on the UC-Main campus, located on Sanciangko Street in Cebu City, which provided a metro-accessible educational environment with diverse courses housed within different departments. Specifically, this research paper concentrated on the College of Arts and Sciences department within UC-Main, which offers programs such as AB English Language, AB Literature, AB Political Science, AB Psychology, and BPA (Performing

Arts), with varying numbers of students in each program. The College of Arts and Sciences comprises a faculty of full-time and part-time teachers, with a total student population of 989 and a combined teaching staff of 79.

4.3 Research Respondents

The study focused on first-year students in the Bachelor of Arts program majoring in Political Science at the University of Cebu-Main Campus during the academic year 2022-2023. To select the participants, the researchers employed a method known as simple random sampling, which provided an equal chance for all potential subjects. The initial dataset contained a total of sixty-eight (68) first-year students. For sample size determination, the researchers utilized Cochran's Formula, considering a 95% confidence level, a 5% margin of error, a 50% population proportion, and a known population size of 68. Given the relatively small population size, Cochran's equation and a population correction were applied to calculate the final sample size, resulting in 58 participants. These 58 individuals were then chosen using a random number method. Subsequently, participants underwent a prescreening process to confirm that they maintained low to average physical activity levels and were free from any underlying medical conditions. If a participant did not meet these criteria, another name from the randomized list was included until the desired sample size of 58 was achieved.

4.4 Research Instruments

This research used the same assessment tool that Brooks et al. (2015) employed in their study at the Medical Sciences Center, University of Wisconsin-Madison. This instrument was specifically developed to gauge participants' memory retention and comprises a list of fifty-word pairs, challenging participants to commit them to memory within a ten-minute timeframe. Subsequently, participants were tasked with completing each pair by filling in the missing word, with no imposed time constraints.

4.5 Research Procedure

This section presents data collection, analysis, ethical consideration, and trustworthiness of the study that were used for accurate data analysis and interpretation.

4.5.1 Data Gathering

Before undertaking any of this study's procedures, the researchers submitted a letter of approval to the chairperson of the first-year political science college students of the academic year 2022-2023 of the University of Cebu-Main Campus, requesting permission to participate in the experiment.

After the approval was obtained, the researchers met with the chairperson and also the major subject instructors of the 1st year and political science students, and appointments were organized to discuss the experiment's timetable. After the schedule for the prescreening test was set, the experimenters thoroughly described the experiment's procedure to the participants so they could understand the nature and goal of the experiment. Respondents were assured of the confidentiality of the findings and that no private data would be used for other reasons. The respondents were given the informed consent forms and requested to read them carefully and thoroughly. If the respondents agreed to participate, they should fill out the form, which served as proof that they agreed to participate in the experiment. After the respondents filled out the informed consent, the researchers then began administering the prescreening exam, which served as the basis for selecting qualified participants for the experiment. Participants took the International Physical Activity Questionnaire (IPAQ), which was utilized in this study, in order to determine the respondents' physical activity level. Those participants who obtained low and average/moderate scores were qualified to undergo the experiment. In addition, participants were required to answer honestly on the form whether they had any underlying medical condition. If the participants have a medical condition, they are excluded from the study. After obtaining the participants' personal information, the researchers finalized and contacted the participants who passed the prescreening test. Whoever passes the prescreening test will proceed to the actual experiment.

The experiment started after the researchers gathered fifty-eight (58) qualified participants. The experiment was carried out at the University of Cebu Main Campus. The researchers informed the participants that the entire session would be recorded for review and documentation.

The experiment consisted of a pre-test and a post-test. Before the pre-test and post-test, researchers provide a letter to the Dean to request a conducive room. During the pre-test, each participant was provided a list of fifty-word pairs, and participants had ten minutes to memorize those words to the best of their abilities. Researchers collected the participants' papers containing fifty-word pairs when the timer ran out. Then, they were given an answer sheet where they were asked to fill in the missing word in each pair with no time limit. After the pre-test, there was a three-day interval before the post-test. The participants must perform the specific moderate aerobic exercise prescribed by the researchers, a brisk walk for 10 minutes during the three-day interval.

The three-day interval exercise was performed physically and conducted at the University of Cebu Main Campus. Before the participants underwent the exercise, their heart rates were measured using the oximeter. Then, after measuring their heart rates, the participants performed a warm-up exercise, and they will only begin brisk walking when instructed to do so to ensure that they all begin at the same time. The participants then did a 10-minute brisk walk in place. After the 10-minute exercise, their heart rate was measured again. Then, they were asked to do a cool-down exercise, and their heart rates were measured again. After measuring the participants' heart rates, the assigned personnel and researchers fill out their daily heart rate log sheets.

The participants repeated the task mentioned above every day throughout the three days, and the researchers monitored the participants during the entire experiment. When the three-day interval was over, the researchers met with the participants again to administer the post-test, which required them to memorize a list of fifty-word pairs in ten minutes. When the timer ran out, the participants were asked to fill in the missing word in each pair with no time limit.

The memorization was done in a conducive classroom or learning environment under the supervision of the researchers. So, there was strict adherence to the time limit, and instructions were given verbally, so if there was any question from the participants, they were accommodated immediately by the researchers. The researchers provide an answer sheet that contains a pre-test and post-test questionnaire. The researchers collected the participants' responses and checked them automatically after they submitted them. Following the completion of the experiment, the researchers expressed their gratitude to the participants by providing them with a certificate and token of appreciation.

4.5.2 Treatment of the Data

The study's collected data underwent analysis using the Paired Samples t-test, a statistical method designed to compare the means of paired measurements from the same subjects or related units. These paired measurements could represent various scenarios, including measurements taken at different time points. The test aimed to determine if the mean difference between these paired observations significantly deviated from zero. Additionally, other statistical measures, such as the weighted mean, mode, and population proportion, were applied. The weighted mean was computed by multiplying event probabilities with corresponding quantitative outcomes and summing the results. The mode identified the most frequently occurring number in the dataset, while the population proportion was calculated by dividing the total population by the items of interest. A qualified statistician conducted all statistical calculations using the trial version of specialized software to ensure accuracy.

5. Results and Discussion

This chapter presents, analyzes, and interprets quantitative data on the results of moderate aerobic exercise on memory retention of the 1st year Political Science college students using Paired Samples T-Test. The presentation of data is in tabular form with corresponding analysis and interpretation and is presented based on the sequence in the problem statement.

There are nine sections presented in this chapter. The first section shows data about the result of the memory retention of the respondents before the three-day exposure to moderate aerobic exercise. The second, third, and fourth section presents the heart rate results of the respondents' three (3) days of brisk walk-in-place exercise. The fifth section presents data regarding the memory retention of the respondents after the three-day exposure to moderate aerobic exercise. The sixth section compares respondents' memory retention before and after exposure to moderate aerobic exercise. The seventh section contains the respondent's memory retention results before and after exposure to moderate aerobic exercise. The eighth section shows the tallied score of the pre-test and post-test and reveals whether the treatment made a significant difference or not. The nine section contains the paired sample test results.

Table 1

Memory Retention Before the Three-day Exposure to Moderate Aerobic Exercise

LAST 4 DIGITS OF ID NUMBER	PRE-TEST SCORE	CODE
2980	26	3
1987	14	2
1313	13	2
3186	12	2
2642	2	1
6266	9	1
523	30	3

7077	4	1
6405	33	4
6667	8	1
5737	11	2
6375	15	2
7763	20	2
9869	17	2
4877	26	3
5477	13	2
9745	12	2
8059	10	1
1787	29	3
1132	11	2
6786	22	3
3987	10	1
1291	26	3
853	9	1
3155	10	1
4735	7	1
1231	12	2
3895	41	5
5183	7	1
s	7	1

LEGEND: *5-Excellent: 41-50, 4-Above average: 31-40, 3-Average: 21-30, 2-Poor: 11-20 and 1-Very poor: 0-10.*

The data contained in Table 1 shows the result of the participants' memory retention before the three-day exposure to moderate aerobic exercise. Based on the table above, 30 participants were able to take the pre-test and obtained a total score of 466.

The table shows the pre-test scores and code (a representation of the level of memory retention) of 30 individuals before a three-day exposure to moderate aerobic exercise. The code ranges from 1 (very poor) to 5 (excellent) based on the pre-test scores. Based on the updated data, the majority of the individuals (20 out of 30) had poor to average memory retention before the exercise program, with pre-test scores ranging from 0 to 30. Only one individual (participant number 3895) had an excellent pre-test score of 41, indicating above-average to excellent memory retention.

Table 2

Three Days Brisk Walk In Place Exercises: Day One (1)

	DAY 1					
LAST 4 DIGITS OF ID NUMBER	OXYGEN LEVEL	RESTING HEART RATE (PRE- EXERCISE)	OXYGEN LEVEL	HEART RATE (AFTER EXERCISE)	OXYGEN LEVEL	HEART RATE (AFTER COOLDOWN)
00523	99	72	97	157	98	111
1987	94	93	105	99	97	97
1313	97	96	97	126	96	96
3186	98	87	97	102	97	95
2642	96	97	100	97	85	
6266	98	61	98	119	99	86

	4					
2980	9	99	99	113	99	98
	9					
7077	9	93	98	101	98	97
	8					
6405	9	89	98	134	95	113
	8					
6667	9	92	97	102	97	93
	6					
5737	9	88	97	130	98	97
	7					
6375	9	88	97	101	97	96
	6					
7763	9	89	96	97	97	88
	7					
9869	9	86	97	98	97	90
	7					
4877	9	93	98	109	98	92
	8					
5477	9	90	96	120	97	100
	6					
9745	9	95	98	114	99	97
	8					
8059	9	94	99	97	97	92
	8					
1787	9	97	99	131	98	104
	9					
1132	9	82	97	107	99	88
	8					
6786	9	91	98	124	98	103
	8					
3987	9	88	94	92	97	77
	9					
1291	9	90	98	115	98	90
	8					
0853	9	105	98	114	97	97
	8					
3155	9	97	96	150	98	97
	7					
4735	9	94	99	97	97	92
	8					
1231	9	67	96	103	96	88
	6					
3895	9	89	96	97	97	88
	7					
5183	9	61	98	119	99	86
	4					
7466	9	93	98	101	98	97
	8					

Table 2 shows the participants' oxygen rate (O2) before, right after the exercise, and after cool down, as well as their heart rate before, right after the exercise, and after cool down. As seen in the fourth column, the student's heart rates are higher as a result of exercising, which is brisk walking in place.

This indicates that the participants had engaged in physical activity that increased their heart rates. While there is a clear difference in heart rate before and after exercise, with the heart rate after exercise clearly higher, the oxygen rate appears to be generally unchanged or only slightly changing.

Table 3

Three Days Brisk Walk In Place Exercises: Day Two (2)

			DAY 2			
LAST 4 DIGITS OF ID NUMBER	OXYGEN LEVEL	RESTING HEART RATE (PRE-EXERCISE)	OXYGEN LEVEL	HEART RATE (AFTER EXERCISE)	OXYGEN LEVEL	HEART RATE (AFTER COOLDOWN)
00523	97	95	96	170	98	110
1987	96	88	98	120	97	97
1313	97	86	97	125	98	95
3186	97	86	97	115	98	93
2642	97	90	97	140	97	96
6266	96	98	97	130	96	103
2980	97	87	97	110	96	100
7077	95	93	97	100	98	89
6405	97	90	97	117	96	96
6667	96	89	98	124	98	102
5737	98	91	97	132	97	113
6375	98	94	98	107	98	95
7763	96	91	97	122	98	97
9869	97	84	96	104	97	86
4877	99	93	96	116	96	14
5477	96	94	98	123	98	102
9745	98	94	98	118	98	96
8059	97	90	97	99	97	83
1787	97	85	92	97	92	88
1132	92	94	97	102	97	94
6786	98	93	98	111	98	93
3987	99	93	99	89	98	62
1291	96	92	96	120	99	105
0853	98	99	98	130	97	94
3155	97	95	97	138	97	105
4735	98	94	99	97	97	92
1231	98	88	97	107	97	93
3895	97	89	96	97	97	88
5183	94	61	98	119	99	86
7466	9	93	98	101	98	97

Table 3 shows the participants' oxygen rate (O2) before, right after the exercise, and after cooling down, as well as their heart rate before, right after the exercise, and after cooling down. As seen in the fourth column, the student's heart rates are higher as a result of exercising, which is brisk walking in place.

The data suggests that the participants performed physical activities that increased their heart rates. Although there was a noticeable disparity in heart rate before and after exercising, with a significant increase in the latter, the oxygen rate remained relatively stable or showed only minor changes.

Table 4

Three Days Brisk Walk-In Place Exercises: Day Three (3)

	DAY 3					
LAST 4 DIGITS OF ID NUMBER	OXYGEN LEVEL	RESTING HEART RATE (PRE-EXERCISE)	OXYGEN LEVEL	HEART RATE (AFTER EXERCISE)	OXYGEN LEVEL	HEART RATE (AFTER COOLDOWN)
00523	96	95	98	150	98	103
1987	98	93	97	124	97	99
1313	96	81	97	101	98	97
3186	95	92	95	105	95	94
2642	97	84	97	98	97	90
6266	98	93	97	108	97	86
2980	97	93	97	119	97	97
7077	98	94	99	125	99	95
6405	99	96	98	128	98	102
6667	98	87	98	107	98	90
5737	95	103	95	127	95	103
6375	95	87	94	110	95	94
7763	96	91	96	113	96	89
9869	97	82	97	109	97	84
4877	97	95	97	125	97	96
5477	98	94	98	111	98	91
9745	97	84	97	122	97	94
8059	96	97	97	110	97	86
1787	96	93	96	121	96	93
1132	96	89	96	119	96	88
6786	99	90	99	106	99	95
3987	95	69	95	88	95	74
1291	96	93	96	118	96	93
0853	97	100	98	136	98	100
3155	97	98	97	168	97	97
4735	98	94	99	97	97	92
1231	97	83	97	98	97	89
3895	97	89	96	97	97	88
5183	94	61	98	119	99	86
7466	98	93	98	101	98	97

Table 4 shows the participants' oxygen rate (O2) before, right after the exercise, and after the cool down, as well as their heart rate before, right after the exercise, and after the cool down. As seen in the fourth column, the student's heart rates are higher as a result of exercising, which is brisk walking in place.

The data suggests that the participants were involved in a physical activity that increased their heart rates. Although there is a noticeable contrast between the heart rate measurements taken before and after exercise, with the post-exercise readings being higher, the oxygen rate has remained constant or changed only marginally.

Table 5

Memory Retention After the Three-day Exposure to Moderate Aerobic Exercise

LAST 4 DIGITS OF ID NUMBER	POST-TEST SCORE	CODE
2980	25	3
1987	13	2
1313	15	2
3186	11	2
2642	5	1
6266	11	2
523	27	3
7077	5	1
6405	32	4
6667	10	1
5737	12	2
6375	17	2
7763	21	3
9869	19	2
4877	23	3
5477	14	2
9745	14	2
8059	11	2
1787	27	3
1132	13	2
6786	23	3
3987	13	2
1291	25	3
853	10	1
3155	12	2
4735	9	1
1231	14	2
3895	40	4
5183	10	1
7466	8	1

LEGEND: *5-Excellent: 41-50, 4-Above average: 31-40, 3-Average: 21-30, 2-Poor: 11-20 and 1-Very poor: 0-10.*

The data in Table 5 shows the result of the respondents' memory retention after the three-day exposure to moderate aerobic exercise. Based on the table above, 30 respondents were able to take the post-test and obtained a total score of 489.

The table shows the post-test scores and code (a representation of the level of memory retention) of 30 individuals after a three-day exposure to moderate aerobic exercise. Based on the post-test scores, the code ranges from 1 (very poor) to 5 (excellent). Based on the data, most individuals (20 out of 30) improved memory retention after three days of moderate aerobic exercise. Participant 3895 had the highest post-test score of 40, indicating excellent memory retention after the exercise program.

Table 6

Memory Retention Before and After Exposure to Moderate Aerobic Exercise

AST 4 DIGITS OF ID NUMBER	PRE-TEST SCORE	CODE	POST-TEST SCORE	CODE
2980	26	3	25	3
1987	14	2	13	2
1313	13	2	15	2
3186	12	2	11	2
2642	2	1	5	1
6266	9	1	11	2
523	30	3	27	3
7077	4	1	5	1
6405	33	4	32	4
6667	8	1	10	1
5737	11	2	12	2
6375	15	2	17	2
7763	20	2	21	3
9869	17	2	19	2
4877	26	3	23	3
5477	13	2	14	2
9745	12	2	14	2
8059	10	1	11	2
1787	29	3	27	3
1132	11	2	13	2
6786	22	3	23	3
3987	10	1	13	2
1291	26	3	25	3
853	9	1	10	1
3155	10	1	12	2
4735	7	1	9	1
1231	12	2	14	2
3895	41	5	40	4
5183	7	1	10	1
7466	7	1	8	1

LEGEND: *5-Excellent: 41-50, 4-Above average: 31-40, 3-Average: 21-30, 2-Poor: 11-20 and 1-Very poor: 0-10.*

Table 6 shows the pre-test and post-test scores of 30 participants exposed to moderate aerobic exercise for three days. The scores are rated on a scale from 0-50, with higher scores indicating better memory retention.

From the table, it can be observed that the average pre-test score was 15.53, while the average post-test score was 16.13. The scores suggest a slight improvement in memory retention after three days of moderate aerobic exercise. A paired-sample t-test was conducted to determine if the difference in pre-test and post-test scores was statistically significant. The results showed that the mean difference in scores was not significant. This indicates that the improvement in memory retention was not significant. It is important to note that individual differences existed in the pre-test and post-test scores, as seen in the table. Some participants

had high pre-test scores, indicating good memory retention before the exercise, while others had low pre-test scores. Similarly, some participants had high post-test scores, indicating improved memory retention after the exercise, while others had low post-test scores.

Moderate aerobic exercise may not significantly affect memory retention in the short term. However, further research is needed to determine if the results hold over a more extended period or with different types of exercise. Furthermore, it's crucial to take into account other variables that could potentially influence memory retention, including factors like age, gender, and overall health.

Table 7

Tallied Score

Scale	Verbal Description	Ranges	EST TALLY SCORES	EST TALLY SCORES
5	Excellent	41-50	1	0
4	Above average	31-40	1	2
3	Average	21-30	6	7
2	Poor	11-20	11	14
1	Very poor	0 -10	11	7

LEGEND: *5-Excellent: 41-50, 4-Above average: 31-40, 3-Average: 21-30, 2-Poor: 11-20 and 1-Very poor: 0-10.*

The result found that some respondents had improvements in memory retention scores after the three-day exposure to moderate aerobic exercise. Table 6 shows that twenty-one (21) participants had increased scores after completing the three-day exercise program, while only nine (9) had decreased scores. These improvements could be explained by activating and reconsolidating memories in the hippocampus, which the exercise facilitated. Exercise may also have promoted the formation of memory traces across different brain regions, contributing to improved memory retention.

However, the study also found that some respondents had decreased memory retention scores after the exercise. These results contradict the predictions of multiple trace theory, which would suggest that repeated activation and reconsolidation of memories should lead to more substantial memory traces and improved retention.

Ebbinghaus's Forgetting Curve Model (1885) also provides insight into memory retention, indicating that memory tends to decline rapidly without proper reinforcement. This model highlights the importance of revisiting information to help retain it longer. This model also suggested that some respondents' decreased memory retention scores could have been due to factors other than exercise, such as stress or lack of sleep. Additionally, the study may have needed to be longer to see consistent improvements in memory retention across all participants.

Table 7 presents the pre-test scores, which show that eleven (11) respondents had inferior scores, eleven (11) had poor scores, six (6) had average scores, one (1) had above-average scores, and only one (1) had excellent scores. In the post-test, seven (7) respondents achieved inferior scores, fourteen (14) had poor scores, seven (7) had average scores, and two (2) had above-average scores.

Post-test scores showed that the number of respondents with inferior scores decreased while the number of respondents with poor scores increased. Additionally, only one point difference existed between average and above-average scores in the pre-test and post-test, resulting in a high score in the post-test. Twenty (21) participants had increased scores after completing the three-day exercise program, while only nine (9) had decreased scores. The post-test scores demonstrated poor memory retention, as reflected in the coding of scores. This suggests no significant difference in memory performance following the exercise program despite the changes in individual scores.

The study's findings, as shown in Table seven (7), align with multiple trace theory insofar as they suggest that moderate aerobic exercise can positively affect memory retention by activating and reconsolidating memories. However, the inconsistencies in the results highlight the complexity of memory processes. In the study of Cowan (2014), it was discovered that cognitive load, task demands, and individual differences impact the complexity of memory. Hence, further study is needed to understand exercise's effects on memory better.

Table 8

Results of Paired Sample T-Test for the Pre-test and Post-test Scores

		Mean	N	Std. Deviation	d. Error Mean	Memory Retention
Pair 1	PreTest	15.5333	30	9.46767	1.72855	Poor
	PostTest	16.1333	30	7.79803	1.42372	Poor

The first table shows that the mean of the pre-test scores, 15.53, is only slightly higher than the post-test scores, 16.13, but only by one point, which is not a significant difference; they are nearly identical with only a point difference. The pre-test scores are widely spread around the mean, whereas the post-test scores are two standard deviations lower, indicating that the post-test scores are clustered closer around the mean than the pre-test scores. Regardless, the results show that both pre-test and post-test scores are more similar than different; both have poor memory retention.

Table 9

Paired Sample Test (Paired Differences)

	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interv of the Difference		t	Df	Sig. (2-tailed)
				Lower	Upper			
PreTest -PostTest	-.60000	2.09433	.38237	-1.38203	.18203	-1.569	29	.127

Decision: Reject H_O when $p - vlaue < \alpha = 0.05$

Table 9 shows that the p-value, 0.127, is greater than the critical value, 0.05. Hence, retain the null hypothesis, signifying that there is no statistically significant distinction in the memory retention of students before and after being subjected to moderate aerobic exercise. This suggests that, according to our findings, moderate aerobic exercise does not affect students' memory retention.

5. Conclusion

This chapter offers an introduction to the study's context, participant characteristics, research design, and the methodology utilized for data collection. It delineates the principal aim of the research: to evaluate the influence of moderate aerobic exercise on the memory retention of first-year Political Science students at the University of Cebu-Main Campus during the academic year 2022-2023. Specifically, the investigation focuses on memory retention levels both before and after a three-day period of moderate aerobic exercise, and it seeks to determine whether a significant difference exists in memory retention pre- and post-exposure to such exercise.

The study was conducted at the University of Cebu Main Campus, Sanciangko Street, Cebu City, Philippines 6000. The study participants were first-year Political Science students enrolled in the school year 2022–2023. The researchers were able to conduct a prescreening together with giving informed consent to the target participants. The researchers gathered 30 qualified participants who underwent the experiment, which consisted of the pre-test, the three-day interval exercise, and the post-test. In gathering the data, the researchers used a quasi-experimental pre-test and post-test design, which is quantitative. The pre-test was conducted in Room 520 at the University of Cebu Main Campus, where the environment was conducive enough for the participants to answer the memory test. The three-day exercise was conducted around the areas of the campus where participants felt comfortable executing the exercise correctly. Lastly, the post-test was also conducted in Room 520, where the giving of certificates of participation took place. The researchers were able to collect the data using statistical tools. Researchers identified the mean difference, mean, standard deviation, sample size, z-value, and p-value.

The study primarily investigates how a three-day exposure to moderate aerobic exercise affects students' memory retention and seeks to determine if a noteworthy difference exists between their memory performance before and after this exercise period. Initial memory retention, determined by pre-test scores from 30 participants, totals 466. Following the three-day moderate aerobic exercise exposure, post-test scores from the same 30 participants resulted in an increased memory retention score of 489. Of these participants, 21 exhibited improved scores, while 9 experienced a decline in memory retention. Despite the score increase observed in the 21 participants, it is worth noting that most of them still achieved relatively low scores. As a result, the analysis concludes that no statistically significant difference exists in students' memory retention before and after their engagement in moderate aerobic exercise.

This study did not find significant evidence that moderate aerobic exercise improves student memory retention. The lack of statistical significance indicates that exercise did not significantly affect memory. However, it is essential to note that most participants (21 out of 30) showed improved memory retention scores despite poor pre-test and post-test scores. This suggests that the relationship between exercise and memory may be more complicated and requires further research. Future studies could explore other factors that may affect the relationship between exercise and memory, such as IQ levels, various learning preferences, food intake, amount of sleep, and stressful life events. Although statistical significance was not achieved, the study's findings represent a significant contribution to the existing body of knowledge in this field., indicating that exercise may have the potential to serve as an intervention for enhancing memory retention among students.

This study's central focus is to investigate moderate aerobic exercise's impact on students' memory retention. The research design comprises a pre-test, a three-day intervention involving a 10-minute brisk walk-in-place exercise, and a post-test, all conducted in a face-to-face setting. The initial population consists of 68 individuals, with the sample size comprising 58 first-year Political Science students from the University of Cebu - Main Campus during the academic year 2022-2023. Data collection was specifically restricted to participants who fulfilled the prerequisites of completing a physical activity questionnaire to gauge their physical activity levels and furnishing information about their medical condition as conditions for their inclusion in the experiment. Consequently, this study did not consider factors such as students' IQ levels, diverse learning preferences, dietary habits, sleep duration, and life stressors, which could impact their memorization abilities. Initially, 58 students were expected to participate. However, following a prescreening test, only 30 respondents met the qualifications, with eight students having medical conditions, nine being absent during the prescreening, and twenty-one having high levels of physical activity.

Based on the findings of the study, the following are recommended. Future researchers may use this as a reference and a review for future studies. Future researchers may build on this research and improve this innovation. Future studies should include in the selection criteria their learning preferences, food consumption, amount of sleep, and stressors or stressful life events, which could have impacted the student's ability to memorize. Future researchers may also assess their respondents after experimenting. Future researchers should increase the number of respondents.

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