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Synesthesia: Does It Have an Effect on Memory?

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Synesthesia: Does It Have an Effect on Memory?

by

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ABSTRACT

Synesthesia is a perceptual phenomenon involving an inducer (a stimulus) and a concurrent (elicited response). For many years, scientists have striven to explain synesthesia and whether or not there are benefits to the people who experience it. In this study, nineteen participants were asked to complete a questionnaire in an attempt to see if their synesthetic experiences gave them advantages in the area of memory. The seven questions were given in a multiple-choice or text entry format, and the questionnaire was approved by The University of Southern Mississippi's IRB before being sent out in an electronic format. The majority of the participants reported that their synesthesia did have an effect on their memory; however, they did not believe the effect to be advantageous. Those who felt their synesthesia was an advantage largely reported that their memory recall was improved because of their synesthetic abilities. Because the majority of the participants do not feel their memory is positively impacted, the results of the study do not support the researcher's hypothesis that synesthesia improves memory abilities. More research will need to be done in the future in order to make more conclusive results using a larger experimental population. Research into the advantages of synesthesia is ongoing.

Keywords: *synesthesia, inducer, concurrent, memory, advantage*

DEDICATION

I would like to thank my family for believing in my ability to see this project through and supporting me throughout my college career. This thesis is dedicated to them.

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TABLE OF CONTENTS

<u>ABSTRACT</u>	iv
<u>DEDICATION</u>	v
<u>ACKNOWLEDGMENTS</u>	vi
<u>CHAPTER I: INTRODUCTION</u>	1
<u>CHAPTER II: LITERATURE REVIEW</u>	4
<u>Why Does it Happen?</u>	4
<u>Possible Genetic Link</u>	6
<u>Why Has the Gene Been Conserved?</u>	7
<u>Are There Advantages to Having Synesthesia?</u>	7
<u>Synesthesia Increases Memory Abilities</u>	8
<u>Synesthesia Does Not Increase Memory Abilities</u>	11
<u>CHAPTER III: MATERIALS AND METHODS</u>	13
<u>CHAPTER IV: RESULTS</u>	14
<u>CHAPTER V: DISCUSSION</u>	16
<u>CHAPTER VI: CONCLUSION</u>	18
<u>Limitations of this Study</u>	18
<u>Further Areas of Study</u>	19
<u>APPENDIX A: Survey Questionnaire</u>	20
<u>APPENDIX B: Survey Email</u>	21

<u>APPENDIX C: IRB Approval Letter</u>	22
<u>REFERENCES</u>	23

LIST OF ILLUSTRATIONS

[Figure 1. What Type of Synesthesia Do You Have?](#)..... 14

[Figure 2. Does Synesthesia Increase Your Memory Abilities in Any Way?](#)..... 15

CHAPTER I: INTRODUCTION

Synesthesia is a perceptual phenomenon researchers have long struggled to define. Brang and Ramachandran (2011) describe it as an “experience [naturally occurring in 2-4% of the population] in which stimuli presented through one modality will spontaneously evoke sensations in an unrelated modality” (p. 1). In short, a stimulus often called an inducer, evokes the experience of a concurrent.

For example, one [individual] describes the sound of her baby crying as having an unpleasant yellow color. In her synesthesia, sounds (the inducers) were experienced as having colors (the concurrents) in addition to the customary auditory attributes. (Grossenbacher & Lovelace, 2001, p. 36)

This inducer-concurrent phenomenon can happen in many different ways; for some, the inducer is sound while the concurrent is color. For others, the inducer may be color, and the concurrent is a number.

The interesting thing about these inducer-concurrent reactions is that they are stable over time, involuntary, and automatic (Brang & Ramachandran, 2011). These unchanging characteristics mean that these associations do not change over time and do not require the person to think about what concurrent the inducer will produce. For example, if a particular synesthete (person with synesthesia) sees the color red as the inducer, and the associated concurrent is the number four, red will always be the inducer for the number four every time it is presented and without the person applying any conscious thought to the association. Another interesting aspect of synesthesia is that “for most individuals, synesthesia is unidirectional: if sounds induce the experience of colors, colors typically do not induce the experience of sounds” (Grossenbacher & Lovelace,

2001, p. 36). This statement implies that for most synesthetes, a concurrent cannot invoke the experience of an inducer.

According to research done by Grossenbacher and Lovelace (2001), synesthetes “typically experience synesthesia on a daily basis, beginning in early childhood” (p. 36). Synesthetic experiences are an integral part of the synesthetes’ lives, they do not usually notice anything as out of the ordinary. In fact, individuals with synesthesia are usually surprised when they first learn that other people do not have the same synesthetic experiences (Grossenbacher & Lovelace, 2001). Though this phenomenon is naturally occurring in most cases and begins in early childhood, synesthesia can also “occur in response to drugs, sensory deprivation, or brain damage” (Brang & Ramachandran, 2011, p. 1). This study only focused on naturally occurring cases of synesthesia.

For many years, researchers have investigated whether there are advantages to having synesthesia. In fact, “subjectively, synesthetes report these experiences are largely positive and engender facilitative benefits for creative aspects of their lives” (Brang & Ramachandran, 2011, p. 3). This statement seems to be upheld by a number of great artists who allegedly have or had synesthesia, including Billy Joel and Vincent van Gogh. However, one of the most explored advantages of synesthesia is the condition’s effect on memory. According to Brang and Ramachandran (2011), “synesthetes as a group also have demonstrated improved memories relative to controls, particularly for items related to their synesthetic experience” (p. 3). Indeed, there is a documented case of a savant named Daniel Tammet who used his synesthesia to memorize pi up to 22,541 digits. There have also been other studies that seem to back up claims that synesthesia has a

positive effect on memory. As discussed later in this paper, these are the studies that are used as the basis of the experiment conducted in this research.

In this experiment, a survey was used to ask synesthetes about the nature of the subjective advantages they get from having synesthesia. The questions included only pertained to memory; however, there was space for participants to include any other advantages they felt came from experiencing the phenomenon. The results were then used to attempt to evaluate the hypothesis: does having synesthesia have a positive effect on memory. The results of the experimentation are documented under the Results and Discussion in Chapters IV and V.

CHAPTER II: LITERATURE REVIEW

Why Does it Happen?

The reason why synesthetic phenomena occur is currently unknown. However, there are some existing theories to explain the experience. For example, “Ramachandran and Hubbard proposed that synesthesia results from an excess of neural connections between associated modalities, possibly due to decreased neural pruning between regions that are interconnected in the fetus” (Brang & Ramachandran, 2011, p. 1). Essentially, this theory suggests that neural lines are crossed during the development of the fetal brain, resulting in mixed sensory experiences, also known as synesthesia. In congruence with this theory, several studies have found anatomical differences in the brains of synesthetes when compared to non-synesthete controls.

Another proposed theory to explain why synesthesia occurs cites structural differences of the brain in individuals with synesthesia. According to Hubbard and Ramachandran (2005), “based on the fact that the visual word form area lies adjacent to the color processing region..., we have proposed that grapheme-color synesthesia may arise from direct cross-activation between these adjacent brain regions” (p. 513). This structural theory suggests that synesthesia is the result of cross activation that is similar to that found in phantom limb patients. This unique cross activation between brain regions in synesthetes results in an involuntary, reproducible, and systematic perceptual experience also known as the concurrent (Hubbard & Ramachandran, 2005).

Many of the studies done on the structural differences of the brains of synesthetes focus solely on those with grapheme-color synesthesia. These studies found that structural neuroimaging “demonstrated increased connectivity and right-lateralized

fractional anisotropy in grapheme-color synesthetes” and “stronger functional connectivity in synesthetes between sensory integration regions in the parietal lobe and primary sensory regions” (Zamm et al., 2013, p. 359). While these results seem to show strong evidence for differences in the brains of synesthetes, these results cannot be generalized to those with different types of synesthesia. A significant reason for this is that, in grapheme-color synesthesia “inducer and concurrent processing regions may be anatomically adjacent” (Zamm et al., 2013, p. 359). While the adjacency of the inducer and concurrent regions of the brain may have no bearing on the synesthetic experience, this possibility cannot be ruled out until further research is done. Therefore, more research is needed on the brain structures of those with other types of synesthesia in order to support the theory of altered brain structure in all synesthetes.

Yet another theory states that synesthesia can occur in one of three different ways. The first way synesthesia arises is developmental synesthesia, in which “these people routinely experience one or more forms of synesthetic perception/conception beginning in early childhood” (Grossenbacher & Lovelace, 2001, p. 37). Grossenbacher and Lovelace (2001) postulate that synesthesia has a genetic component and can be passed down to offspring from their parents. In this type of synesthesia, children are born with the condition and grow up experiencing the associated phenomena. The second way an individual can develop synesthesia is due to a brain injury or sensory deafferentation later in life (Grossenbacher & Lovelace, 2001). However, this type of synesthesia is extremely rare. The last proposed way of developing synesthesia is through the ingestion of hallucinogenic drugs. These individuals may “experience pharmacological synesthesia

during the drugged state,” but do not experience synesthesia at any other time (Grossenbacher & Lovelace, 2001, p. 37).

Possible Genetic Link

While the exact genetic basis for synesthesia remains unknown, the condition does seem to run in families. Most early researchers proposed that synesthesia is an X-linked dominant trait passed down from parents to offspring. However, more recent “research on synesthesia suggests the phenomenon is heterogeneous and polygenic” (Brang & Ramachandran, 2011, p. 1). Therefore, it is exceedingly difficult to identify exactly which genes are involved in passing down synesthesia. Additionally, research shows that “the specific form of synesthesia an individual expresses can vary within families, suggesting the genetic undertones impose a predisposition to synesthesia but not its expression” (Brang & Ramachandran, 2011, p. 2). This muddies the waters further, as it implies that a parent with one type of synesthesia can somehow pass down the genes of synesthesia without passing down the exact same type of synesthetic expression. Even with more advanced research, the exact genes and factors for transmission are a mystery to scientists. Another main reason the genetic basis of synesthesia is so hard to pin down is that “60 different forms of synesthesia have been documented... and one could easily assume that each type of synesthesia is caused by a unique gene or set of genes” (Brang & Ramachandran, 2011, p. 2). This diversity makes the task of generalizing the genetic basis of synesthesia almost impossible for researchers. Further research will be needed on the topic in order to shed light on the genes associated with the transmission of synesthesia among families. However, because of the extensiveness of synesthesia, these

studies will have to include large sample sizes of individuals with varying types of the condition.

Why Has the Gene Been Conserved?

There are many reasons why the genes associated with synesthesia may have been conserved over time. The first reason is that there may be unknown advantages to having synesthesia (Brang & Ramachandran, 2011). Synesthetic experiences may also be the byproduct of some other useful trait. In fact, “recently, research has confirmed numerous cognitive and perceptual benefits that are associated with synesthesia, any of which could be argued to produce a stronger basis for selection” (Brang & Ramachandran, 2011, p. 3). If having synesthesia does in fact come with its own advantages, it would be beneficial for the gene(s) associated with the phenomenon to be conserved. The second reason why the genes may have been conserved is simply that “they did not incur a great enough cost to be purged by selection and could be an example of an evolutionary spandrel” (Brang & Ramachandran, 2011, p. 3). Essentially, because synesthesia does not necessarily have much of an effect on evolutionary adaptation, there has not been a need to get rid of the predisposition to perceptual experiences.

Are There Advantages to Having Synesthesia?

Due to the conservation of the synesthesia gene(s) over the years, researchers have long debated whether there are advantages to having these inducer-concurrent experiences. Many researchers suggest that there is a link between synesthesia and creativity or artistic ability. Indeed, “studies have... confirmed the increased incidence of synesthesia among artists and, relative to controls, synesthetes report spending more time engaged in creative activities” (Brang & Ramachandran, 2011, p. 3). However, it is

extremely hard to prove a link between synesthesia and creativity. It has also been suggested that synesthetes have enhanced sensory processing compared to those who do not have the same perceptual experiences. According to Brang and Ramachandran (2011), “grapheme-color synesthetes show enhanced detection of colors on a perceptually low-level visual test of parvocellular processing” (p. 3). Number-color synesthetes also tend to be more sensitive at discriminating very similar colors. It is unknown, however, if these unique color abilities are the result of increased processing of color information in synesthetes, or if these differences are simply due to synesthetes’ “excessive experience with colors” (Brang & Ramachandran, 2011, p. 3).

Other advantages to having synesthesia may exist. For example, “synesthetic experiences may serve as cognitive and perceptual anchors to aid in the detection, processing, and retention of critical stimuli in the world” (Brang & Ramachandran, 2011, p. 3). According to some research studies, it may be possible for synesthetic experiences to aid in the memory and retrieval process of important information. Furthermore, “in addition to facilitating processes in individual sensory modalities, synesthetes also show increased communication between the senses unrelated to their synesthetic experiences, suggesting that benefits from synesthesia generalize to other modalities as well” (Brang & Ramachandran, 2011, p. 3). This increased communication between the senses may result in enhanced sensory processing and integration when compared to non-synesthetes.

Synesthesia Increases Memory Abilities

As mentioned before, some previous studies have found evidence to support a link between improved episodic and working memory and synesthesia. In 2018, an experiment was conducted that researched memory abilities in 22 grapheme-color

synesthetes compared to non-synesthetes (Rothen et al., 2018). Each synesthete participant was asked to take an internet-based test of consistency to confirm that they did have true synesthesia before completing the study. This consistency test is considered “the gold standard to diagnose synesthesia,” and involves “selecting colors from a large palette on several occasions and measuring consistency of the colors selected” (Rothen et al., 2018, p. 5). After this step was completed, both synesthete and non-synesthete participants were presented with eight different black uppercase letters, one marked with a red asterisk as a target cue. All individuals were asked to “verbally report the letter at the position indicated by the red asterisk” (Rothen et al., 2018, p. 2). After all data were collected and analyzed by the researchers, the results showed that there may be a relationship between synesthesia and memory. Data showed that synesthetes that were more consistent in their answers on the consistency screening test showed better performance in the sensory memory task given to them during the actual experiment (Rothen et al., 2018). Rothen and his colleagues (2018) concluded the study by stating that “sensory memory performance can be enhanced in synesthesia when perceptual awareness of the target is high” (p. 5).

Another study, done at The University of Rochester in 2016, also seems to support the theory that synesthesia improves memory abilities. In this experiment, researchers compared 14 synesthetes’ and a 15-person control group’s ability to learn color-shape pairings (Bankieris & Aslin, 2016). Each participant was presented with nine discriminable snowflake shapes presented in nine different colors, and they learned these snowflake-color pairings across three in-lab sessions. After learning the color pairings, participants were asked to touch “the color square to paint the snowflake its learned

color” and submit their answer when they felt they had picked the correct color (Bankieris & Aslin, 2016, p. 5). Two weeks after this test, the participants were contacted and asked to return to the lab. During this visit, they were asked to recall the snowflake-color associations they had previously been tested on. The results of these two tests support “the hypothesis that synesthetes have a superior ability to learn and retain shape-color associations” (Bankieris & Aslin, 2016, p. 9). The synesthetes in this study were able to learn the initial snowflake-color pairings within a shorter period than controls, and the delayed retest of the snowflake-color associations showed that synesthetes’ long term memory was stronger when compared to the control group (Bankieris & Aslin, 2016). Another study, performed at The University of Bern, had results pointing toward a memory advantage in synesthetes. The study consisted of 97 synesthetes and 97 control participants who were presented with three separate tests. In the first test, participants were presented with a list of words on the screen, each word appearing one at a time (Lunke & Meier, 2018). Each participant was asked to click on a color palette of 13 colors to select the color they felt best went with each word. During the second test, participants listened to short pieces of music for ten seconds each and rated how much they liked the piece on a seven-point scale (Lunke & Meier, 2018). Participants were also asked immediately after hearing the piece of music if they were familiar with the piece. In the third test, participants “were presented with coloured patterns for 3 seconds each and they were asked to rate how much they liked each pattern on a seven-point Likert scale” (Lunke & Meier, 2018, p. 7). After a span of sixty minutes, the memory phase began by presenting the participants with lists of words and informing them that some of the words shown had been shown in the previous word test and some were new words.

The participants were asked to determine whether the word was old or new (Lunke & Meier, 2018). For the music recognition test, the synesthete and control groups were played pieces of music for ten seconds, each after being informed that some of these pieces of music had been played in the previous test and some of the pieces of music were new. Their task was to determine whether the music was old or new (Lunke & Meier, 2018). For the color recognition test, participants were presented with colored patterns in a randomized order, again, after being informed that some patterns had been shown previously and some were new. Participants were then asked to determine if the pattern was new or old (Lunke & Meier, 2018). The data collected during the first stages of the experiment and the data collected after the sixty minutes were then compared with each other. The results of this study indicate that “across types of stimuli, synesthetes show higher recognition memory than the respective control groups” (Lunke & Meier, 2018, p. 13). The researchers suggest that the advantage is a small one, but an advantage, nonetheless. The results of this study, therefore, seem to support the theory that synesthetes have improved memory abilities when compared to non-synesthetes.

Synesthesia Does Not Increase Memory Abilities

While some studies have shown a promising link between synesthesia and memory, some have also shown evidence contradicting the theory that synesthetes have improved memory abilities. For example, in a 2015 study at Ball State University, a case study was performed on a female participant, M.P., with grapheme-color synesthesia (Robinson, 2015). To verify that the subject had synesthesia, she was given a sensory map test prior to participating in the experiment. After her synesthesia was confirmed, the synesthete participant, along with a fifteen-person, non-synesthete control group, was

presented lists of words in varied colors. The participants were asked to remember as many words as possible, and after the lists had been presented the computer screen used went blank for the duration of a minute. At this time, participants were asked to write down as many of the words as they could remember. Researchers hypothesized that M.P. would have an easier time remembering the words presented in colors congruent with her synesthesia compared to control participants (Robinson, 2015). The results of this experiment were inconclusive, and therefore unable to support the researcher's hypothesis. Robinson suggests that the lack of conclusive results was largely due to M.P. only recently being diagnosed with synesthesia. He goes on to explain that others with synesthesia may be more aware of the condition and more able to use it to their advantage. Robinson (2015) concludes, "perhaps they have developed tricks, similar to mnemonic devices, to aid their memory that M.P. may not utilize" (p. 86). Unfortunately, the results of this experiment, no matter the reason, do not seem to support the theory that synesthetes have improved memory abilities.

CHAPTER III: MATERIALS AND METHODS

In this experiment, 19 synesthete participants were asked to complete a questionnaire in order to gauge their opinions of if their synesthesia has an effect on their memory. The questionnaire was reviewed and approved by The University of Southern Mississippi's Institutional Review Board (IRB 20-260) before the survey was administered. The questionnaire, consisting of six questions in total, was made using Qualtrics software and was sent out to the entire student body of The University of Southern Mississippi. Only people with synesthesia were asked to complete the survey, and in return for the thorough completion of the questionnaire, participants were awarded a \$15 Amazon gift card. Each participant was required to fill out a consent form before beginning the survey, confirming that they understood the purpose of the study and wanted to participate.

To begin, the first question of the questionnaire asked participants which type of synesthesia they have, simply to get an idea of the study's population. A few common types of synesthesia were listed in a select which form applies format. A text box was included to allow participants to manually enter which type of synesthesia they have if their type was not already listed. Then, in a yes or no format, participants were asked if synesthesia has an effect on their memory and if synesthesia seems to increase their memory abilities in any way, respectively. If the participants answered yes to either of these questions, a text box was given to allow them to elaborate on their answers and experiences. To conclude the survey, participants were asked if they believed that their synesthesia offered them any general advantages. This question was followed by a text box to allow participants to elaborate on their answer.

CHAPTER IV: RESULTS

In response to the first question, what type of synesthesia do you have? there was a large array of answers. As shown by Figure 1, six of the participants stated that they have color-number synesthesia, three participants said that they have color-sound synesthesia, three participants said they have color-taste synesthesia, and four participants said they have sound-smell synesthesia. The sound taste, touch taste, and other choices were each chosen by one participant. The participant who chose other explained that they have both color-number and color-sound synesthesias.

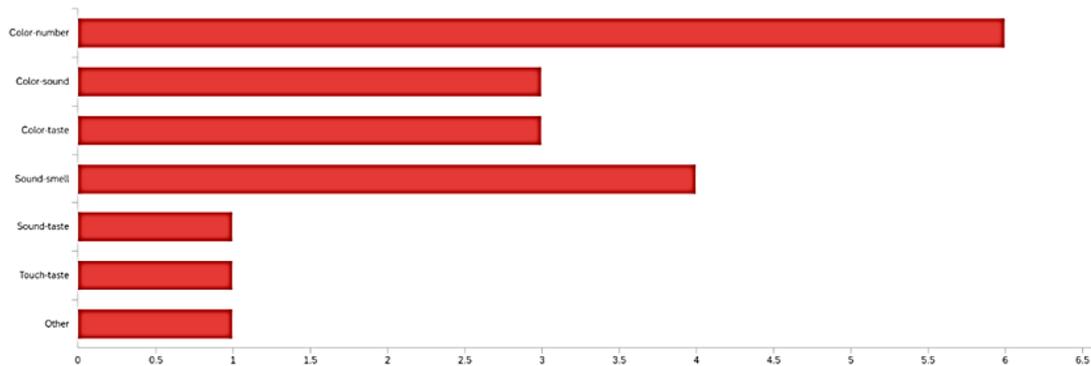


Figure 1. What Type of Synesthesia Do You Have?

The next question on the questionnaire was does synesthesia seem to have an effect on your memory? Twelve of the 19 participants chose the yes choice when answering this question while the other seven chose no. However, when asked the more specific question of does synesthesia increase your memory abilities in any way? the majority of the participants chose the negative option, as shown in Figure 2. The participants who answered with the affirmative option were then asked to further explain their answers. One participant wrote, “I associate things together in my mind. It works the same way as people using... mnemonics to memorize things, I use color association.”

Another participant wrote, “It [synesthesia] helps me further recall smaller details in situations when I hear something and associate it with a smell.”

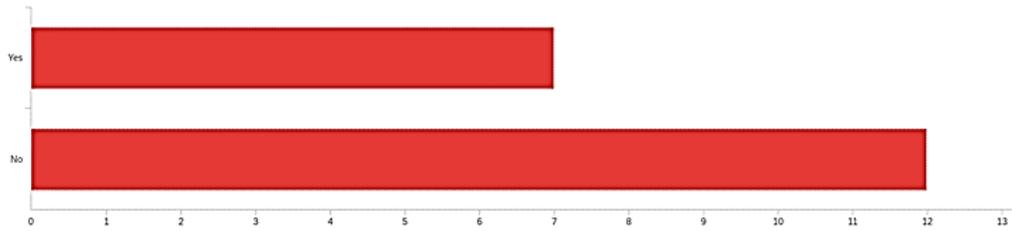


Figure 2. Does Synesthesia Increase Your Memory Abilities in Any Way?

The penultimate question on the questionnaire was does your synesthesia offer an advantage in any way? Twelve of the 19 participants chose the negative answer option in response to this question. The seven participants that answered affirmatively were then asked to explain their answers further. One participant wrote, “I feel it [synesthesia] helps my brain compartmentalize topics and [I am] more able to store information for easy and ready access.” Two of the participants simply wrote that their synesthesia helps them with memory recall in general.

CHAPTER V: DISCUSSION

In all, there were six types of synesthesia reported in this study. These types included color-number, color-sound, color-taste, sound-smell, sound-taste, and touch-taste. Of all the participants, there was only one that reported having more than one type of synesthesia. Overall, there seemed to be a disconnect between the concept of synesthesia having an effect on memory and synesthesia increasing memory abilities. While the participants largely stated that synesthesia did have an effect on their memories, the majority also indicated that synesthesia did not increase their memory abilities in any way. If these participants' synesthesias do not increase their memory abilities, then the way in which their memory is affected by synesthesia is unknown.

However, the seven participants that answered that synesthesia does increase their memory abilities mainly cited improved memory recall. One participant even stated that their synesthetic associations worked for them as mnemonics do for other people without synesthesia. This concept mirrors one of the conclusions drawn from the 2015 study of M.P. by Robinson at Ball State University. As discussed earlier, the researcher wondered if M.P.'s lack of superior memory recall compared to controls was due to M.P.'s synesthesia being a new discovery. If that were the case, perhaps the reason M.P. did not outperform controls was because she had not had time to make certain memory associations with her synesthesia, similar to that of non-synesthetes using mnemonic devices (Robinson, 2015). The idea that synesthetes can use their synesthesia similarly to the way mnemonic devices are used is not a new one. This concept continues to be a highly suggested reason that synesthetes have shown improved memory abilities in the past.

When asked the next question “does your synesthesia offer an advantage in any way?”, again, the majority of the participants chose the negative option. However, the individuals that chose the answer indicating there is an advantage to having synesthesia mainly wrote that memory recall was the most significant advantage. Increased memory recall abilities in synesthetes are also not a new concept. Similarly, the previously discussed study performed at The University of Bern, Lunke and Meier (2018) found that compared to controls, synesthetes had better memory recall abilities. The 2016 study performed by researchers at The University of Rochester involving color-shape pairings also seems to hint at the possibility that synesthetes have better memory recall abilities than non-synesthetes (Bankieris & Aslin, 2016). However, much more research will have to be done on the subject in order to definitively conclude whether or not synesthetes have better memory recall abilities.

CHAPTER VI: CONCLUSION

Unfortunately, the results of the study do not seem to support the hypothesis that synesthetes have memory advantages compared to those without synesthesia. This conclusion is based on the fact that the majority of the participants in the survey responded negatively when asked if their synesthesia offered them this advantage. However, there may be some reasons as to why these results were found.

Limitations of this Study

All participants in this study were rewarded with a \$15 Amazon gift card after they completed the survey. It was clearly stated at the beginning of the survey that only students with synesthesia should answer the questionnaire. However, it is almost certain that there were non-synesthete participants who randomly answered the questions on the survey to obtain the gift card reward. Unfortunately, it is therefore impossible to know if the answers to this survey were completely accurate, as this project was based on the honor system.

Another limitation of this study is that the participant population only included nineteen students from The University of Southern Mississippi. Not only was the sample size small, but it also included only college-aged individuals. Because the sample size was so small, the results of the study are not generalizable to a larger population. Also, because this study only examined individuals from one age group, it is possible that the participants of the study simply have not learned how to use their synesthesia to their advantage yet.

Further Areas of Study

In the future, research should be focused on if the improved memory abilities of certain synesthetes could possibly be teachable to other synesthetes. If the memory techniques used in these synesthetes can be learned, perhaps it would be possible to also teach these memory techniques to the general population. Perhaps these techniques could assist students in studying for tests, musicians in memorizing their music, or even individuals in memorizing items on a grocery list. A lot more research would need to be done on the topic in order to get to this point, but if it is possible, it could be a breakthrough.

More research must also be done on how or if synesthesia is inherited. Where synesthesia originates, what exactly the phenomenon is, and if it has a genetic link are all questions that have yet to be answered. There may also be other advantages to having synesthesia (such as in the field of creativity) that have not yet been discovered. Finding explanations will require larger sample sizes than those used in this study and more precise screening of synesthetic participants.

APPENDIX A: SURVEY QUESTIONNAIRE

1. Name (to contact for gift card)
2. The University of Southern Mississippi email (to contact for gift card)
3. What type of synesthesia do you have?
 - a. Color-number
 - b. Color-sound
 - c. Color-taste
 - d. Sound-smell
 - e. Sound-taste
 - f. Touch-taste
 - g. Other [enter here]
4. Does synesthesia seem to have any effect on your memory?
 - a. Yes
 - b. No
5. Does synesthesia increase your memory abilities in any way?
 - a. Yes
 - b. No
6. If yes, please explain:
7. Does your synesthesia offer an advantage to you in any way?
 - a. Yes
 - b. No
8. If yes, please explain:

APPENDIX B: SURVEY EMAIL

Synesthete participants needed for the following survey: “Synesthesia: Does it Have an Effect on Memory”. If you have synesthesia, please click on the survey link below! The first 115 participants will receive a \$15 Amazon gift card for their participation. PLEASE ONLY COMPLETE THE SURVEY IF YOU HAVE A FORM OF SYNESTHESIA!

https://usmep.co1.qualtrics.com/jfe/form/SV_4NoE13CSzDVRX5b

Hello Everyone! My name is Elizabeth Evans, and I am a senior nursing student at the University of Southern Mississippi. The survey included in this email is for my Honors Thesis. The only requirement for completing the survey is that the participant has some form of synesthesia. The first 115 participants will then receive a \$15 Amazon gift card for participating in the survey. The survey should take about 5-10 minutes to complete and will ask exploratory questions about your synesthetic experience and their relationship with memory.

Synesthesia is a perceptual phenomenon in which a stimulus elicits a spontaneous sensation in an unrelated modality. There are many forms of synesthesia, and the majority of cases are different. For example, when a synesthete hears music, they may also simultaneously see a color. Another individual may see a color and simultaneously assign it a number. There are many different forms synesthesia can take.

Previous studies have determined that there may be a link between synesthesia and memory. However, much more research is needed to definitively prove this connection. The purpose of this research is to gain some insight into how synesthesia may have an effect on memory. If there is a link between the two, the findings may be revolutionary in the field, allowing other studies to build on this research. Our objectives include: 1) Determine if synesthesia does have an effect on memory. If so, perhaps synesthesia can be taught to improve memory in situations involving dementia-related memory loss. 2) Give a basis for future synesthesia and memory research. Hopefully, in the future, researchers will be able to build on research such as mine to make breakthroughs involving the study of memory.

This survey is completely voluntary, and all information will be kept strictly confidential. After the participants receive their \$15 gift cards, their personal information will promptly be destroyed. This study has been approved by the USM IRB (IRB 20-260). Thank you so much for taking the time to complete this survey and assist me in completing my Honors Thesis. Please contact me at [REDACTED] with any questions or concerns.

All the best,
-Elizabeth Evans

APPENDIX C: IRB APPROVAL LETTER

Office of
Research Integrity



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NOTICE OF INSTITUTIONAL REVIEW BOARD ACTION

The project below has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services regulations (45 CFR Part 46), and University Policy to ensure:

- The risks to subjects are minimized and reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered involving risks to subjects must be reported immediately. Problems should be reported to ORI via the Incident template on Cayuse IRB.
- The period of approval is twelve months. An application for renewal must be submitted for projects exceeding twelve months.
- Face-to-Face data collection may not commence until USM's IRB modifies the directive to halt non-essential (no direct benefit to participants) research.

PROTOCOL NUMBER: IRB-20-260

PROJECT TITLE: Synesthesia: Does It Have an Effect on Memory?

SCHOOL/PROGRAM: School of LANP, Leadership & Advanced Nursing

RESEARCHER(S): Elizabeth Evans, Marti Jordan

IRB COMMITTEE ACTION: Approved

CATEGORY: Expedited

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

PERIOD OF APPROVAL: August 12, 2020

A handwritten signature in cursive script that reads "Donald Sacco".

Donald Sacco, Ph.D.
Institutional Review Board Chairperson

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