“Meme, myself, and I:” Self-directed effects in meme-centered pedagogy

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Neuroscience, the study of the brain and nervous system, has been steadily growing as a field of study in undergraduate establishments over the past four decades (Ramos et al., 2011). Neuroscience has a complex vocabulary that is new to most students, which in some students may cause some anxiety (Birkett & Shelton, 2011). To counteract this anxiety, some educators have begun to use alternative assignments. Researchers have found that interactive and cooperative learning settings can decrease science anxiety (Okebukola, 1986). Interactive learning has also been shown to increase engagement in the material (Mendez-Reguera & Lopez Cabrera, 2020). If interactive learning can decrease anxiety while increasing engagement, it stands to reason that interaction with other forms of media can possibly do the same. Memes are a contemporary form of media that are increasingly popular in younger generations (Beach & Dredger, 2017). In this study, researchers investigate the effect of using self-designed memes to increase engagement and retention of neuroscience information.

Memes can be defined as an image with a caption, usually intended to be humorous or make a commentary (Procházka, 2014). Procházka (2014) claims that internet memes are a new form of literacy, and they are not the only researcher to claim this. Knobel (2006) notes that memes can be highly adaptable, which lends to their ability to mutate and continue to grow throughout the years, much like a language. Vickery (2014) also notes the versatile nature of memes seen in the Confession Bear meme and the various user confessions that spawned from it, ranging from superficial confessions to serious confessions that were in direct contrast with the image. Memes have also been used as a tool to unify and connect people, particularly the younger generations (Beach & Dredger, 2017). Because of the versatility of memes, many educators and researchers have begun to look at their value within the classroom.

Menedez-Reguera and Lopez (2020) used memes as a method to engage students beyond their regular assignments. Students were given the optional assignment of designing their own meme and uploading it to a discussion board. The assignment was made optional so that there was no pressure on the students to create a meme, but researchers received 64 original memes from 45 students. It can be inferred from the overwhelming responses that students were willing to complete the assignment. Furthermore, feedback received from the assignment demonstrated that students found the meme creation an enjoyable and engaging assignment. Mendez-Reguera and Lopez Cabrera (2020) demonstrate through qualitative means that the creation of memes can be an engaging activity for students to complete while also demonstrating the importance of connecting with younger generations in a way that is meaningful to them (i.e. through memes).

Memes have also been examined in relation to the learning of mathematics (Bini et al., 2020). Researchers examined mathematics memes from various internet forums and created a formula for a successful math meme. The formula consists of a meme base (or an image) and a mathematics idea as the text. Memes were found to be a way for people to connect and share humorous content about a shared interest. Furthermore, Bini and colleagues (2020) suggest that memes can be used as a tool for education, particularly as a way to humorously connect the lessons to the students.

Instagram, a popular social media platform for sharing memes, has also been examined in its ability to facilitate the learning of anatomy (Douglas et al., 2019). Douglas and colleagues (2019) surveyed various Instagram accounts associated with anatomy for educational content and found that the platform can be an efficient way of spreading information. Researchers also noted that while learning solely through 2D images may lead to an inflated sense of one's knowledge, incorporating meaningful images (such as memes) into the classroom may be an efficient way to

engage the younger generation, though they suggest much more research needs to be done on the effectiveness of social media platforms in the classroom.

Similar to Procházka's (2014) theory that memes are a new form of literacy, some researchers have been using memes as a method of teaching language. Purnama (2017) used memes to help facilitate learning to students learning English as a second language. Students were put into groups and tasked with creating a meme that related to their current lesson (the elderly). They were then to post the meme on an Instagram account where it could be viewed by other groups as well as the public. Students were then evaluated for their attitudes about social media, memes, and the assignment. Researchers found that by working together to create a meme, students were more engaged and more relaxed (Purnama, 2017).

Han (2019) also studied the effects of meme usage, but in English speakers learning Chinese. Students learning Chinese used a group messaging app from which memes were collected and analyzed for content and relation to the culture; students were interviewed about their experiences with memes as well. Students often reported that using the memes allowed them to feel closer to the language allowing them to express their knowledge. Students also explained that creating and using the Chinese memes helped them feel more creative, engaged, and connected with the culture.

Purnama (2017) and Han (2019) demonstrate the qualitative functionality of memes. Not only do the memes allow younger students to feel more engaged and creative in their studies, it also allows them to learn and engage in a field of study with unfamiliar vocabulary. It stands to reason that if students can use memes as a way to learn the complex vocabulary of another language and engage in their studies, students can also utilize the same techniques when learning the unfamiliar vocabulary associated with neuroscience. Neuroscience may also seem dry to

some students, so by introducing an entertaining and engaging assignment, students may be more inclined to participate and engage in their learning.

In another study, teachers used memes as a means to encourage critical thinking skills in a political science setting (Wells, 2018). Students were given a choice of two still images and told to create a meme about politics, along with a short essay defending their position. Wells (2018) argues that the memes allow students to critically think about the information they are learning by creatively adjusting it to be in meme format. Furthermore, students reported in a post-activity survey that they felt the assignment helped them think critically as well as demonstrate their knowledge. Again, Wells (2018) qualitatively demonstrates the engaging use of memes as a tool within the classroom.

Brown (2020) studied the effect of using social media (a platform where memes are often shared) as a method of learning in a pharmacology program. Instead of writing a final paper, groups of students were tasked with creating two memes related to what they had learned throughout the semester. Students reported that the found the assignment engaging and challenging, with some groups submitting more memes than required. Furthermore, the memes that groups submitted mostly focused on topics that had been mentioned multiple times throughout the semester, suggesting that memes are a way for students to express their knowledge and solidify what they already know. Brown (2020) qualitatively demonstrates that memes are an effective way to engage students, even in science courses.

Underwood and Kararo (2020) studied the effectiveness of memes in helping students prepare for a chemistry final. Students worked in groups at white boards around the classroom and wrote chemistry related captions for images that were provided to create a meme. Groups would rotate around the room, reading other groups memes and adding their own suggestions.

Students reported that this activity was engaging and enjoyable; they found it a positive way to study before the final. Underwood and Kararo (2020) demonstrate again the qualitative effectiveness of using memes to solidify student's previous knowledge in a scientific setting.

Finally, Riser (2020) demonstrated the effectiveness of memes in a psychology classroom. Students were either assigned a short essay or a meme project. Students with the meme project had to identify important topics from their lifespan development class and create memes reflecting those topics. Students were graded on their work, and were also given a feedback survey. While grades did not differ significantly between the two groups, students that received the meme assignments wrote that they felt a greater sense of purpose when compared to the students that had to write a short essay. Riser (2020) also suggests that memes are a valuable way to encourage group discussion and engagement when in science-based classes.

Research from Brown (2020), Underwood and Kararo (2020), and Riser (2020) demonstrate, qualitatively, that memes are useful tools to use in scientific learning settings. Students are able to engage in a difficult course in a way that is familiar to them and allows them to solidify the knowledge they have on the subject. By engaging students with memes, students also reported a more positive outlook on the assignment. While there is a plethora of qualitative research on the effectiveness of memes in the classroom, there is a lack of research on the quantitative impact memes can have in the classroom.

Furthermore, research at Florida Southern College from D'Allessandro and colleagues (2021) showed that neuroscience targeted memes can significantly increase the retention of neuroscience information in short- and long-term scenarios. Participants in this study were in one of four conditions: neuroscience meme with neuroscience caption, neuroscience meme with unrelated caption, unrelated meme with neuroscience caption, or unrelated meme with unrelated

caption. Overall, the participants in the condition with the neuroscience meme and neuroscience caption had the best retention of neuroscience information short- and long-term. However, the participants in the unrelated image, neuroscience caption condition had better memory retention than the participants in the neuroscience image, unrelated caption condition. This could suggest that participants in the former condition had better retention because they were making their own connections between the caption and the meme. This left researchers with the question: would self-created memes be a better memory aid for neuroscience information when compared to pre-made memes?

The current study fills multiple gaps in research. First and foremost, the current study will collect quantitative, as well as qualitative research, on the benefits of using mems in the classroom. So far, most of the studies involving memes in education have been qualitative, so this study provides a look into the quantitative effect of memes on information retention in participants. Moreover, this study evaluates the effect of using memes in neuroscience education. While there has been research on the effectiveness of memes in science settings, this research would fill the gap left by research in neuroscience. Finally, this study attempts to fill the gap left from D'Allessandro and colleagues (2021) study, answering if self-created memes are better memory aids than pre-made memes.

Based on previous research, there are a few hypotheses that the researcher would like to mention. Firstly, it is hypothesized that students who create their own captions for the memes will perform better on both post-tests due to their higher level of engagement (Brown, 2020; Riser, 2020). Furthermore, the researchers hypothesize that students that create their own captions will rate the activity more positively on the feedback survey, again due to the higher level of engagement (Brown, 2020; Riser, 2020).

Design

Method

The current study examines the effect of creating memes versus receiving memes on the learning of neuroscience content. Specifically, this study uses memes to facilitate the learning of the function of various neurotransmitters. This study is a 2x2x3x3 mixed design format. The first variable (2) is a between-subjects variable in which the participants received a pre-made caption or created a caption for an image. The second variable (2) is also a between-subjects variable, in which participants either received a linked image or an unlinked image. This linkage was determined based on the captions' relevancy to the image. The third variable (3) is a within-subjects variable evaluating the length of information retention in participants through a pre-test, short-term post-test, and long-term post-test. Finally, the last variable (3) is also a within-subjects variable, with the measure being the level of relatedness of the question in the tests to the information participants were presented (directly related, indirectly related, unrelated).

Participants

The current study had 105 participants, which were all sampled from introductory psychology courses at a small private school in Southeastern United States. The average age of participants was 18.91 years. The participants were sampled from all four years of undergraduate education, and there were 20 majors represented, with psychology majors being the majority. Participants self-reported gender, with 74% of participants being female, 22% being male, and 4% being nonbinary. They also self-reported their race, with 64% being White, 12% being Hispanic, 11% Mixed, 7% Black, and 5% Asian.

Materials and Procedures

Informed Consent. (see Appendix A). Participants were first exposed to an informed consent detailing the nature of the study and providing resources in the case that they may need them.

Neurotransmitter Passage. (see Appendix B). Participants were then exposed to a short lecture consisting of 14 short paragraphs describing various neurochemicals and their affects. The 14 neurochemicals selected were chosen to limit previous knowledge of the participants, as most of the neurochemicals mentioned are not extensively covered in either neuroscience course at the college.

Pre-test. (see Appendix C). Participants would then be prompted to take their first test of neuroscience knowledge. The pre-test consisted of 42 questions, with three questions pertaining to each neurochemical mentioned in the neurotransmitter passage. The questions for the neurochemicals were grouped together, with each three questions pertaining to one neurochemical. The group of three questions was also ordered based on relevancy, with the questions being directly related, indirectly related, and unrelated.

Meme Exposure. (see Appendix D). Participants were sorted into one of four conditions, with meme caption and meme linkage varied. This led to four conditions: pre-made caption and linked image, pre-made caption and unlinked image, self-made caption and linked image, and self-made caption and unlinked image. There were 14 images the participants would see, one for each neurochemical that had been mentioned in the neurotransmitter passage.

Meme Prompt. (see Appendix E). Beneath each image would also the corresponding paragraph from the neurotransmitter passage, so that the participants in the self-made caption conditions would have a reference point for their captions.

Short-Term Post-Test. (see Appendix F). The short-term post-test would occur immediately after the meme exposure. This post-test contained the same 42 questions from the pre-test, with the order of the question groups switched around.

Attitudinal Survey. (see Appendix G). Participants would then be exposed to an attitudinal survey measuring their level of engagement with the ancillary material in the study. This survey was six questions long, with each question being graded on a 5-point Likert scale. The Likert scale ranged from Strongly Disagree to Strongly Agree.

Demographics. (see Appendix H). Participants ended the first part of the study by completing a demographics survey. This included open-ended questions about their age, class status, major, GPA, race, and gender.

Long-Term Post-Test Emails. (see Appendix I). Two weeks after completing the first part of the study, participants would be emailed with a code to access part two of the survey that contained this long-term post-test. If the participants did not complete it by the end of the week they were emailed, they would be sent a reminder email.

Long-Term Post-Test. (see Appendix J). This post-test is considered to be part two of the study. It contains the same 42 questions as the pre-test and short-term post-test, but the question groups have again been shuffled.

Scripts. (see Appendix K). Messages and prompts were provided throughout the survey monkey for participants to read. This includes prompts from before each activity as well as a debriefing message that was shown.

Procedure

Part One. After participants opted to sign-up for one of the four open links for the study on SONA, the college's research study hub, participants would be given a link to part one of the

study. Having four separate links for the participants to choose from provided randomization into the four conditions. The link would take them to a survey monkey that had all the study materials within it. This study began with participants filling out the informed consent sheet (see Appendix A). They would then be shown a link to a google doc that contained the neurotransmitter passage (see Appendix B). When the participant had finished reading the passage, they were able to click back to the survey and complete the pre-test (see Appendix C). After completing the pre-test, participants would be exposed to one of the four meme conditions (see Appendix D). Participants were allowed to look at the memes as long or as short as they felt was necessary. Participants would then go to the next page of the survey, which contained the short-term post-test (see Appendix F). After completing the short-term post-test, participants would fill out a six-question attitudinal survey about their level of engagement with the ancillary material (see Appendix G). Finally, participants would fill out open-ended questions on a demographic survey (see Appendix H). Participants would then see a screen saying they had finished the survey with a short debriefing message (see Appendix K). Overall, this part of the study took under an hour and participants received two research credits for completing the study.

Part Two. Participants would be emailed two weeks after they completed part one of the study (see Appendix I). The email contained a passcode to the second part of the study on SONA. If participants did not complete part two a week after receiving their first email, they would be sent a reminder email. Part two contained the long-term post-test (see Appendix J). Participants would then be debriefed (see Appendix K) and rewarded one research credit. This part of the study took under 30 minutes.

Results

Retention of Neuroscience Information

Multiple four-way ANOVAs were run to determine the effect of meme exposure on retention of neuroscience information. The first ANOVA was run with meme exposure as the grouping variable and overall correct answers on pre-test, short-term post-test, and long-term post-test as the between-subject factors. No significant results were found between overall retention of neuroscience information and meme exposure. Another three ANOVAs were run with meme exposure as the grouping variable and correct answers within question relatedness (direct, indirect, unrelated) as the between-subject factors. One ANOVA was run for pre-test, one for short-term post-test, and one for long-term post-test. No significance was found between retention for question type and meme exposure.

Multiple one-way ANOVAs were also run to determine the retention of neuroscience information collapsed across meme exposure conditions. The first ANOVA used overall pre-test correct and overall short-term post-test correct as the between-subject grouping variables, with results collapsed across conditions. This ANOVA reported a significance of $p = 0.095$. The next ANOVA run used overall short-term post-test correct and overall long-term post-test correct as the between-subjects grouping variables with results collapsed across conditions. This ANOVA reported a significance level of $p = 0.021$. Finally, a one-way ANOVA was run with overall pre-test correct and overall long-term post-test correct as the between-subject grouping variables collapsed across all conditions. This ANOVA reported a significance level of $p = 0.422$.

Multiple four-way ANOVA was then run to determine the effect of question type on retention of neuroscience information collapsed across condition. The first four-way ANOVA was run with correct direct questions, correct indirect questions, and correct unrelated questions for the short-term post-test as the between-subject grouping variables collapsed across

conditions. A significance level of $p < 0.05$ was found for all three conditions. Finally, a four-way ANOVA was run with correct direct questions, correct indirect questions, and correct unrelated questions for the long-term post-test as the between-subject grouping variables collapsed across conditions. A significance level of $p < 0.05$ was found for all conditions.

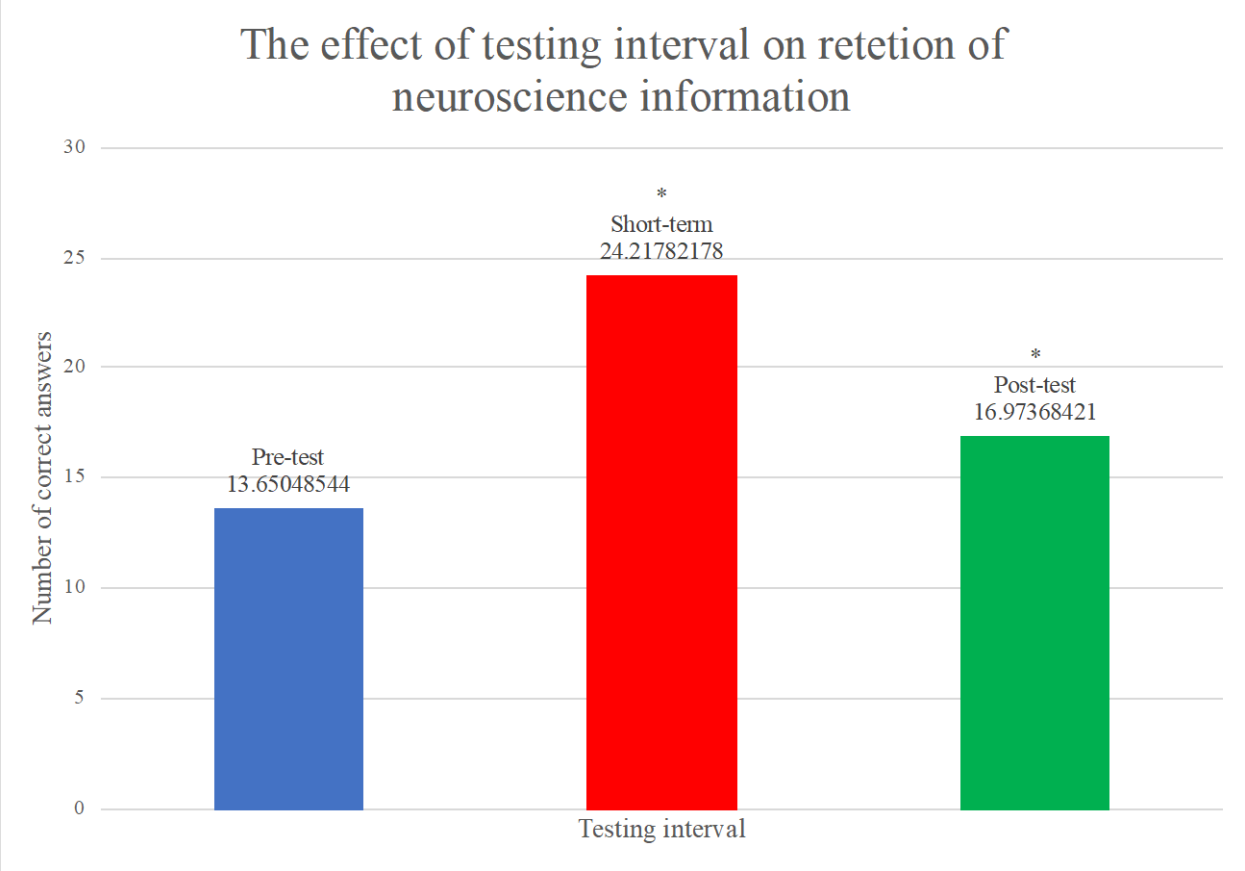

Figure 1. The effect of testing interval on retention of neuroscience information

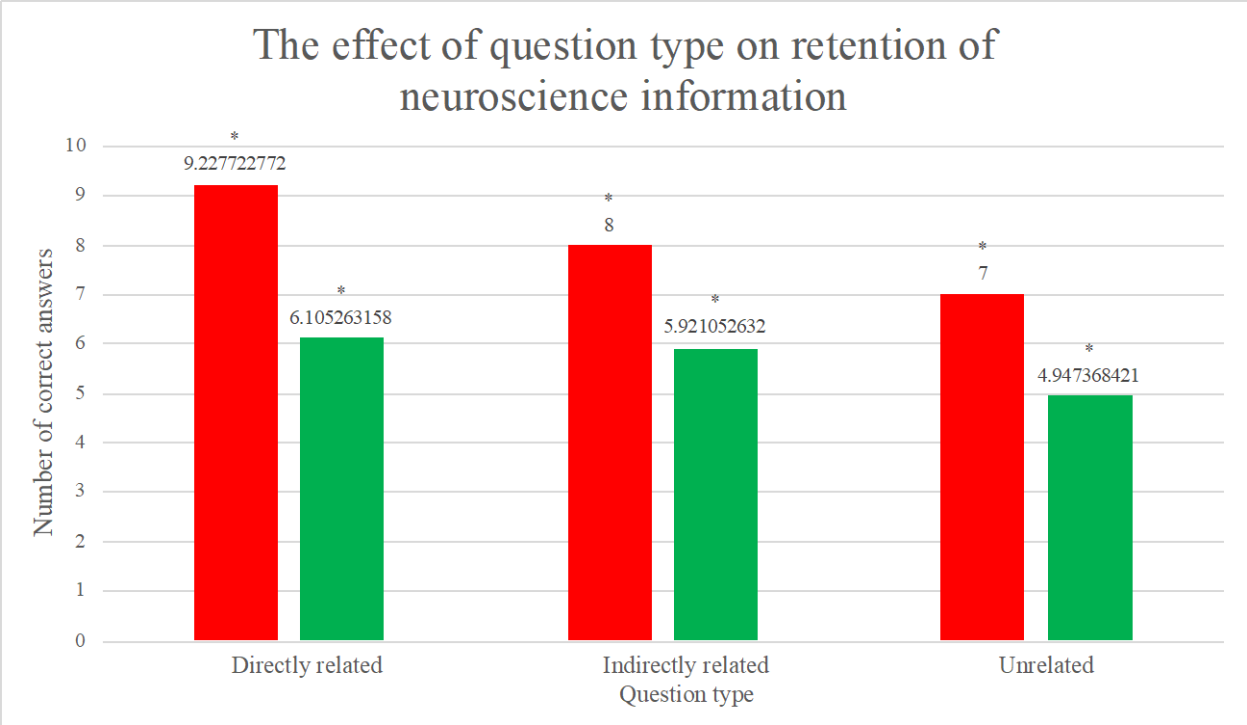

Figure 2. The effect of question type on retention of neuroscience information in short-term and long-term post-tests. Red bars indicate the short-term post-test condition while green bars indicate the long-term post-test condition.

Engagement

Multiple four-way ANOVAs were run to compare the level of engagement across the different meme exposures. There were 6 questions included in the engagement survey, and a four-way ANOVA was run for each with meme exposure as the between-subjects grouping variable and level of engagement (on a Likert scale of 1= Strongly Disagree to 2= Strongly Agree) as the dependent variable. If significance was found for a question, a pairwise comparison was then run to determine which groups experienced significance.

Significance was found for three of the six questions. The first question was "I consider the ancillary material engaging for my understanding of the content." Participants in the pre-made caption linked image and pre-made caption unlinked image condition reported

significantly higher levels of engagement when compared to the self-made caption unlinked image condition. This ANOVA had a significance level of $p < 0.01$. The second question was "I feel that the ancillary material is helpful in better understanding the previous lecture's content." Participants in the pre-made caption linked image condition reported significantly higher levels of engagement when compared to self-made caption unlinked image condition. This ANOVA has a significance level of $p < 0.05$. The last question that showed significance was "I believe that more ancillary material like this should be available in my psychology classes." Participants in the pre-made caption linked image condition reported significantly higher levels of engagement than participants in either the self-made caption image linked condition or the self-made caption image unlinked condition. This ANOVA had a significance level of $p < 0.01$.

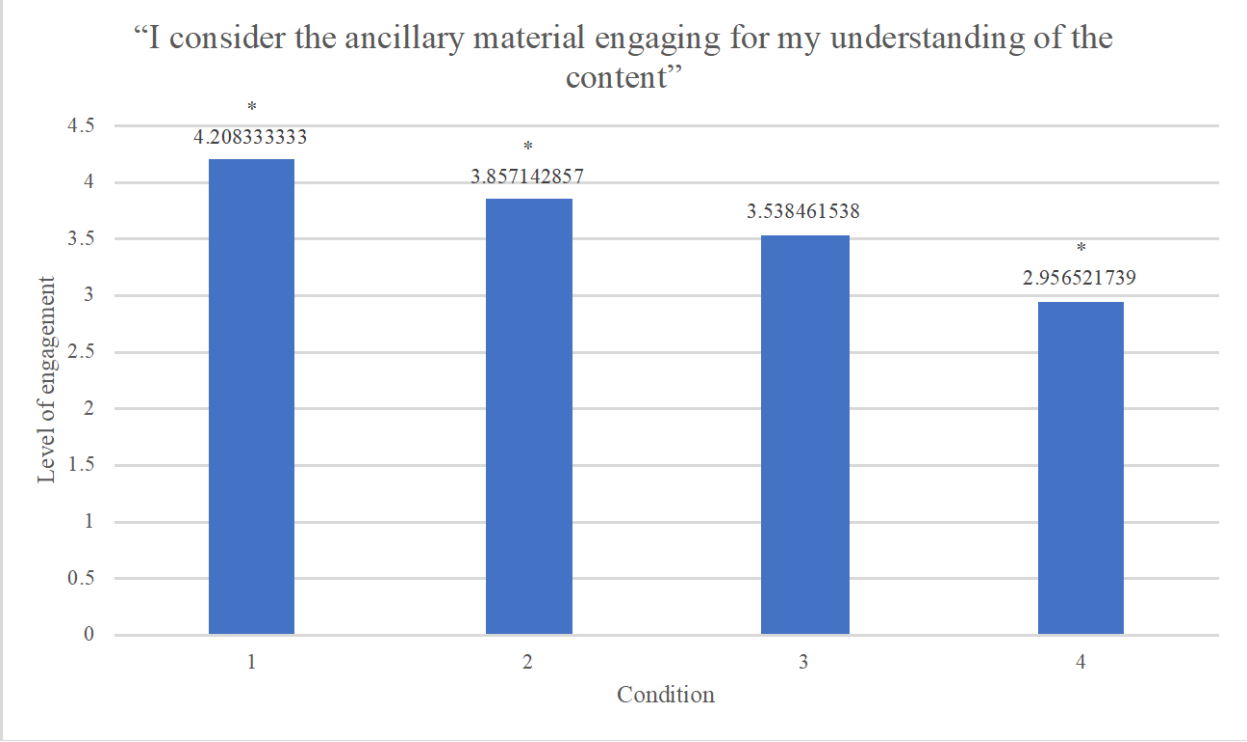

Figure 3. Effect of meme exposure on level of engagement, question one. Condition one is pre-made caption image linked. Condition two is pre-made caption image unlinked. Condition three is self-made caption image linked. Condition four is self-made caption image unlinked.

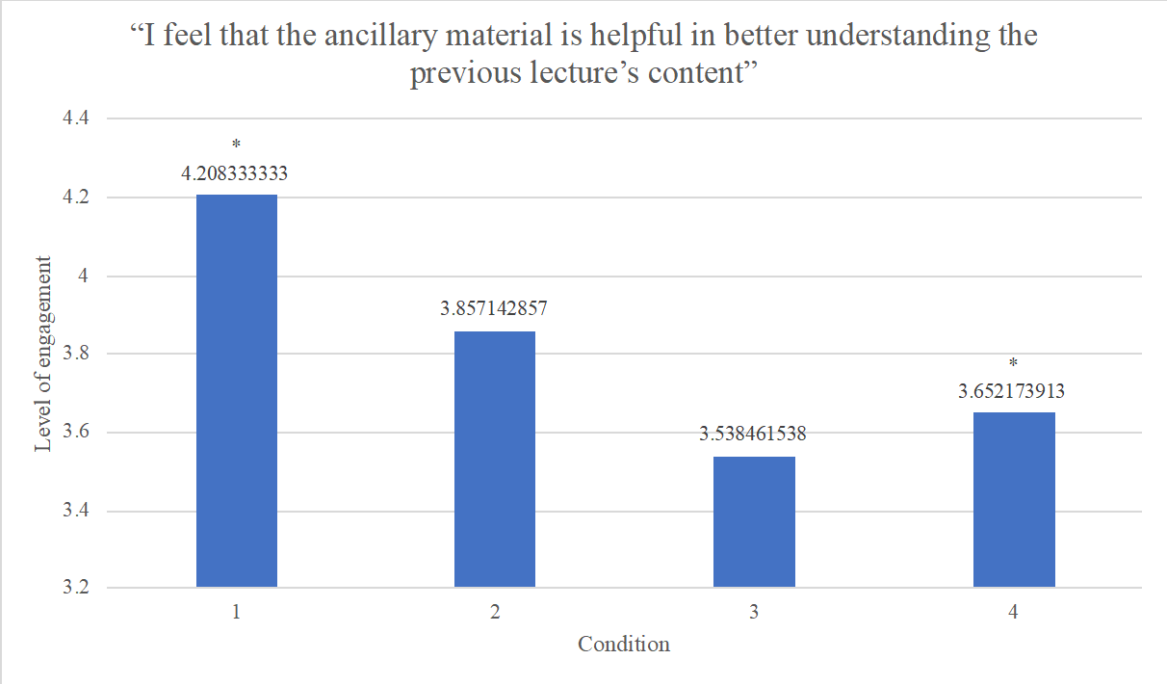

Figure 4. Effect of meme exposure on level of engagement, question two. Conditions are the same as the conditions mentioned in Figure 3.

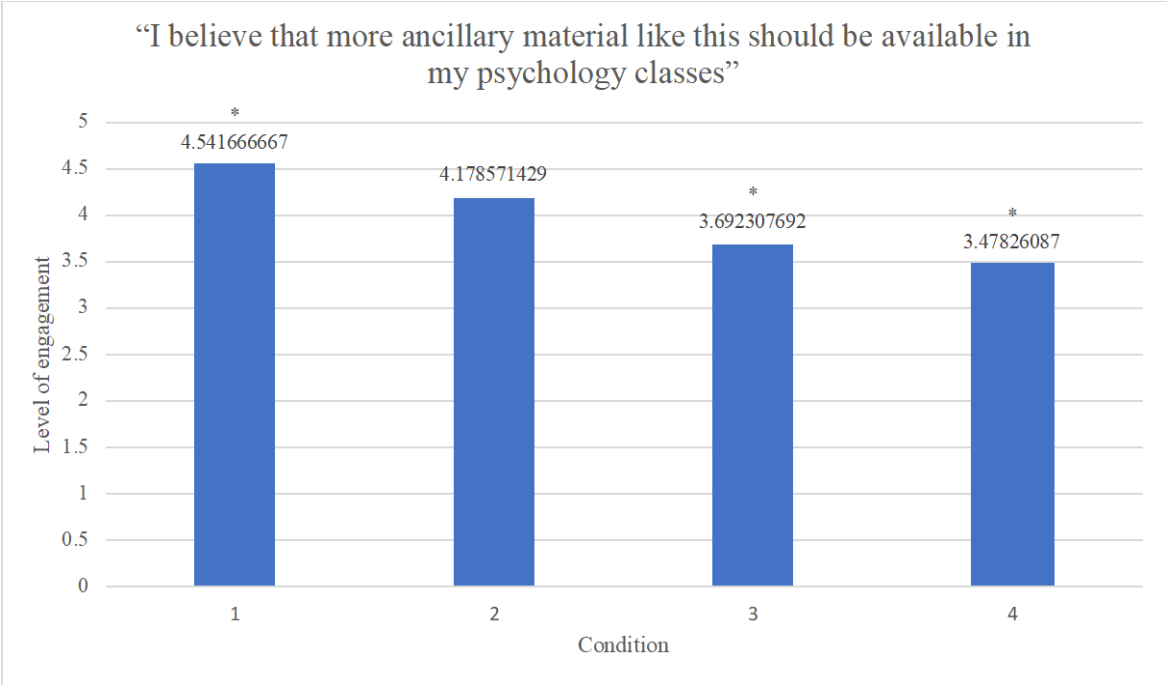

Figure 5. Effect of meme exposure on level of engagement, question three. Conditions are the same as the conditions mentioned in Figure 3.

Discussion

The purpose of this study was to evaluate the effect of self-create memes versus pre-made memes on the retention of neuroscience information. Participants were sampled from introductory psychology courses at a small private school in the Southeastern United States and were put into one of four conditions: pre-made caption linked image, pre-made caption unlinked image, self-made caption linked image, or self-made caption unlinked image. Participants retention of the neuroscience was measured through a pre-test, short-term post-test, and long-term post-test. None of the researcher's hypotheses were supported. Overall, there was no difference between meme exposure conditions and the retention of neuroscience information. Furthermore, participants in the pre-made caption conditions reported significantly higher levels of engagement when compared to the self-made caption conditions for three of the six engagement questions.

While there was no difference between meme exposure condition and retention of neuroscience information, there was a difference in retention of information when collapsed across conditions. As seen in Figure 1, there is a significant increase of recall in information from the pre-test to the short-term post-test, and a significant decrease in recall from the short-term post-test to the long-term post-test. This is consistent with previous literature on memory recall over time (Murre & Dros, 2015). Furthermore, as seen in Figure 2, there was a significant difference between the recall of directly related, indirectly related, and unrelated questions in both the short-term post-test and long-term post-test. This suggests that participants more readily recall directly related information as opposed to indirectly or unrelated information.

While there was no significant difference between meme exposure conditions, there was a significant increase in memory recall when collapsed across conditions from the pre-test to

short-term post-test. This suggests that receiving memes as an ancillary material, whether it is a pre-made meme or a self-made meme, helps to facilitate the learning of neuroscience information. This suggests that memes can be effectively incorporated into lesson plans to facilitate learning in the classroom and beyond.

Furthermore, the level of engagement significantly differed from the researcher's hypotheses. As seen in Figures 3, 4, and 5, participants in the pre-made caption conditions often reported significantly higher levels of engagement when compared to participants in the self-made caption conditions. Researchers believe that this occurred because participants in the pre-made caption condition were more comfortable receiving information for a subject they were new to as compared to the self-made caption who had to create a caption for a subject they weren't yet comfortable with. Furthermore, this was a virtual, unmonitored survey that was under an hour long, and participants in the self-made caption condition had to spend more time creating their memes. This may have led to participants in the self-made caption conditions to feel a higher level of burn-out or frustration, and thus a lower level of engagement. Researchers suggest that if memes are going to be incorporated into the classroom as a learning tool that they are either pre-made for students or that the students are more familiar with the topic before creating their memes.

Overall, there are many limitations to this study. Because this study took place at a small private college, there were not enough participants in each condition to achieve full confidence and significance. If there had been more participants, it would be possible to see significant differences in retention between the meme exposure conditions. Furthermore, the participant pool is from a small private school in the Southeastern United States, with a majority of participants being White, female, psychology majors. This may have led to bias in the results.

Furthermore, because this study was conducted online, participants may have had diverted attention while completing the study. Furthermore, because the participants had to click an external link to view the neurotransmitter passage, it is possible that some of them may have gone between the survey monkey screen and the neurotransmitter passage screen to look for answers while completing the short-term post-test. Moreover, when the study first began, there were some issues with the survey monkey in which about 20 out of 105 participants did not see the entire neurotransmitter passage which may have led to bias in the results.

In the future, there are many directions this study could take. The researchers recommend that to find more accurate results, this study should be run in person with a greater number of participants to assure a higher confidence in the results. Furthermore, researchers believe it would be beneficial to run a similar study in a classroom setting, with professors either assigning students a written assignment or a meme assignment and determining how the assignment affects recall of the information. However, as mentioned before, to ensure higher engagement participants should be more comfortable with the subject they are learning. Moreover, because memes can be considered a new literacy (Procházka, 2014), it is suggested that participants are given primers for how to create their own scientific based memes.

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Appendix A

Informed Consent

https://docs.google.com/document/d/1Def8lMH1kDIA98VX9Pz1sGX3ur4_gXRa/edit?usp=sharing&ouid=102941643255941425170&rtpof=true&sd=true

Appendix B

Neurotransmitter Passage

https://docs.google.com/document/d/1eVy9vHC-YMYNMUUpsJ3EF9OHYcEMjs48/edit?usp=sharing&ouid=102941643255941425170&rtpof=true&sd=true

Appendix C

Pre-Test

https://docs.google.com/document/d/1dRVwYeP_VLUGOyUusvf8fwMlIHsLiOs9/edit?usp=sharing&ouid=102941643255941425170&rtpof=true&sd=true

Appendix D

Meme Exposure

Pre-Made Caption Linked Image.

https://docs.google.com/document/d/19BJueWbd7mcnT8o3_XeER8AIOTKnpWpqANOpcCvhGss/edit?usp=sharing

Pre-Made Caption Unlinked Image.

https://docs.google.com/document/d/1lgLv_50qkzfOaQlDNtwtEx7SOZMSY97_ScwgCBvGHy4/edit?usp=sharing

Self-Made Caption Linked Image.

https://docs.google.com/document/d/1b8VoWOd8FfZ7JeG6bGK8U6jd2acApgvNylbjFGr6cz0/edit?usp=sharing

Self- Made Caption Unlinked Image.

https://docs.google.com/document/d/1RsWIWnZVdRW4OzXPSdTotyeut_Z7FztUTBaN1HjCa5I/edit?usp=sharing

Appendix E

Meme Prompt

https://docs.google.com/document/d/1RYxP03jrp0nD597454LXNIwZjXip73MT76-oDrCP5LI/edit?usp=sharing

Appendix F

Short-Term Post-Test

https://docs.google.com/document/d/1NcjneAL4fIXGAW6_SFhSG30LBjUleVgFHuwE2BnvUhM/edit?usp=sharing

Appendix G

Attitudinal Survey

https://docs.google.com/document/d/12xN0SnWxfg_YJsT00IzePD_mZE4W6Nun/edit?usp=sharing&ouid=102941643255941425170&rtpof=true&sd=true

Appendix H

Demographics

https://docs.google.com/document/d/190FMyR_oVhj1kkdo9kHAPjmb6rIS-LoF/edit?usp=sharing&ouid=102941643255941425170&rtpof=true&sd=true

Appendix I

Long-Term Post-Test Emails

https://docs.google.com/document/d/1tqLPYFlhbSjrYBYgc53zY4-A6hvu0fqsVWm8PXS3IXk/edit?usp=sharing

Appendix J

Long-Term Post-Test

https://docs.google.com/document/d/1vH9TAwpTw-NRKANLXvVwyrgr2BXDKpDVOuCl2wlJODU/edit?usp=sharing

Appendix K

Scripts

https://docs.google.com/document/d/1NuKw3mrPzsW3Lii2v3GND8EBi7ue3mh5sEKb2Me4ehY/edit?usp=sharing