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Elation or Tranquility: The Impact of Music and Mood on Memory

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Elation or Tranquility: The Impact of Music and Mood on Memory

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Abstract

In this thesis, I researched how music is intertwined with mood and in what ways it can affect one's memory. A lot of research indicates that mood can affect one's memory (e.g., Lee & Sternthal, 1999). For example, it was found that respondents remember information better when in a positive mood rather than a neutral mood. Yet, other research has found that positive moods can reduce the processing of information (Lee & Sternthal, 1999). Additionally, research shows that having a mood in one setting can encourage the recall of information obtained in that setting when the same mood occurs later on ("the mood congruency effect"; Singer & Salovey, 2002). In this study, I aimed to discover whether 1) different kinds of music would induce different kinds of moods, 2) the mood would influence one's memory, specifically that participants listening to calm or happy music during both studying and testing would have increased memory performance, and 3) one's memory performance would be better when in a more positive mood and listening to happier music. To research this, I designed an experiment in which 80 participants (70 females) studied for and completed a basic, computerized memory test under five different conditions of listening to music at either the learning phase, the learning phase and the testing phase, or neither. During this experiment, participants completed a survey on metacognition, studied a list of 25 word pairings either while listening to music or not (dependent on condition), completed a math distractor task, and took a memory test while listening to music or not (dependent on condition), while also completing multiple mood rating checks throughout. Although we did not see an effect of mood or music on memory, these results do imply that music may be an effective tool in combating feelings of sadness while completing math tasks.

Keywords: memory, mood, music, metacognition

Elation or Tranquility: The Impact of Music and Mood on Memory

Memorization is a key aspect of cognition, used for studying, learning, and retaining information, making it incredibly important to everyday life. People frequently look for ways to maximize and increase their memory performance, and mood and music have been researched as potential memory aids (e.g., Irish et al., 2006). Mood, for one, has been shown to improve memory when the mood state during encoding or learning information is the same as the mood state when recalling the information. This theory was coined the Mood Congruency Effect through Bower's Network Theory of Affect (Bower et al., 1978). His theory further states that material that matches one's mood is more easily retrievable and more easily learned. Additionally, when that material is intense in affect, it is also more efficiently learned (Bower et al., 1978). Further research of mood on memory has only supported Bower's claims. Singer and Salovey (2002) researched his theory extensively by looking at 170 previous studies. Upon their research, the team concluded that the mood congruency effect is both very real and very strong.

In addition to this congruency effect, mood has been found to affect memory even when the mood is only present at one stage of the memory process, for example while encoding and not during recall. Lee and Sternthal (1999) studied this by looking at the effects of a positive mood on memory. Their findings suggest that respondents remember information better when in a positive mood rather than a neutral mood. However, contrary to these findings, several theories have indicated that a positive mood can actually decrease effective memorization. The cognitive capacity view states that a positive mood creates activation of a diverse array of information, limiting the individual's ability to process the additional incoming information (Mackie & Worth, 1989). This suggests that the positive mood brings the brain closer to its max capacity of information that it is able to retain at any given moment. The feelings as information view states that a positive mood signals that the situation is irrelevant and therefore does not require detailed processing (Schwarz, 1990). Relatedly, another study suggests that a positive mood increases the likelihood that false information will be remembered inaccurately and later recalled as being true (Forgas et al., 2005). With so many inconsistencies as to whether a positive mood during encoding actually increases or decreases the ability to later recall the information, our study aims to bring clarity to this debate.

While a lot of research has focused on the effects of mood on memory, there is also a significant amount of research looking at the effects of music on memory. The Mozart Effect is one of the first studies pointing to the concept that music has a positive impact on cognition (Rauscher et al., 1993). The Mozart Effect claims that after listening to Mozart's music for 10 minutes, subjects were significantly better at spatial reasoning tasks than were subjects who had listened to 10 minutes of relaxation instructions. While Rauscher et al. (1993) studied the effects of music on generic cognitive tasks, other work has focused more explicitly on music's ability to elicit better memory performance, especially autobiographical memories. Autobiographical memories, memories of one's personal history, thus naturally incorporate mood. According to Sterenberg et al. (2023), music can evoke autobiographical memories creating a nostalgic mood. This study looked at how a song's familiarity, enjoyment, autobiographical salience, and emotional arousal, as well as the individual's current mood and nostalgia proneness, predicted the music's ability to evoke nostalgia. The study found that the autobiographical salience of the music was the greatest predictor of nostalgia. Furthermore, Krumhansl and Zupnick (2013) investigated music's ability to evoke autobiographical memories and found that music from one's youth is both most readily recognized and evokes the most powerful and specific memories (see also Schulkind et al., 1999). These studies on autobiographical memories and music demonstrate the interwoven relationship that music, memory, and mood all have, by showing how music can resurface such memories, which can bring forth strong emotions.

With much research and interest on autobiographical memory, it is interesting to compare the research completed on music's effect on more short term, episodic memory. Nguyen and Grahn (2017) investigated the effect of music on encoding information while studying, taking into account the mood and arousal level of the music. Nguyen and Grahn (2017) found that recall and recognition memory were best when low arousal music was playing, compared to high arousal music. In the case of recognition memory, memory was best when the music was negative in mood. Overall, they also found that background music did not actually enhance memory compared to silence. This study was particularly interesting, because it resembled the current study's goals to an extent, except it placed the emphasis of mood and arousal on the music and not on the participant. The current study delves further into this investigation by analyzing instead how calm versus happy music can induce a mood, and then seeing how such background music impacts memory.

While this research looked at mood, music, and memory to suggest that arousal level of music influences memory, other work has considered mood, music, and memory to see how emotional expression within music impacted recognition of that music (Aubé et al., 2013). Results showed that emotions expressed in music lead to better memory accuracy. A similar study also looked at how mood within music influenced memory, utilizing major and minor keys to create a mood congruency effect (Houston & Haddock, 2007). The results replicated those of the previous studies, showing that there was both a strong mood congruency effect, as well as that melodies with a positive mood were better recognized (see also Eschrich et al., 2008). These studies focus on the emotional component of the music itself, but neglect the emotional state of the individual listening to the music. The current study takes the step further to look at how mood can impact memory when the mood goes beyond the song to impact the individual.

It is also important to look at the research completed on the relationship between only mood and music, as there are many studies that did not consider memory, but provided critical findings useful for the purpose of our research. The Velten technique, or how researchers can induce moods in a laboratory setting, is one point of interest, as the current study aims to do just that. The Velten technique successfully seemed to induce moods in participants after they had read either 60 statements aimed at inducing elation or 60 statements aimed at inducing depression (Velten Jr., 1968). These findings therefore prompt the question of whether similar moods can be equally induced through not only statements, but through music. The findings of Pignatiello et al. (1986) and Sousou (1997) suggest that music can successfully induce a mood and therefore, is a strong alternative to the Veltan technique when inducing mood in participants (see also Vuoskoski & Eerola, 2012). Such studies allowed us to hypothesize that music would successfully elicit induced moods in the current study.

In addition to utilizing music for laboratory mood induction, further evidence supports the claim that music and mood are closely related by examining how mood is highly influenced by music in everyday life (Jäncke, 2008). For example, Hunter et al. (2011) found that people prefer to listen to music that matches their current mood and Jolij & Meurs (2011) reaffirmed that simply listening to music makes people significantly happier. With endless research on the topic of music and mood, the current study narrows these findings by reincorporating the aspect of memory, bringing more clarity to the field and filling the gaps from previous literature.

Finally, this study not only focuses on analyzing these three variables, but also considers them in the context of metacognition, which is one’s knowledge of their own thinking and cognitive processes (Flavell, 1979). Studies suggest that particular moods may boost metacognitive abilities and emphasize the importance of emotions in cognitive processes (Massoni, 2014). It has also been shown that metacognition may not be a key indicator of memory performance, as Irak and Çapan (2018) found that individuals' confidence in their memory capabilities was negatively correlated to their actual memory performance, suggesting poor metacognition. Metacognition offers an interesting perspective when evaluating memory and provides additional tools for understanding and analyzing the results and relationships between mood, music, and memory.

In the current study, we explore the effect of music on mood and memory in college students. We hypothesized that 1) different kinds of music would induce different kinds of moods, 2) the mood would influence one's memory, specifically that participants listening to calm or happy music during both studying and testing would have increased memory performance, and 3) one's memory performance would be better when in a more positive mood and listening to happier music.

Method

Participants

80 participants (70 females, 9 males, and one nonbinary) participated in this study. The participants ranged in age from 18 to 22, with 8 first-years, 14 sophomores, 23 juniors, and 35 seniors. 70% (56) of participants identified as white or caucasian, 10% (8) as Hispanic or Latino, 10% (8) as Multiracial or Biracial, 7.5% (6) as Asian or Pacific Islander, 1.25% (1) as Black or African American, and 1.25% (1) as Native American or Alaskan American. Additionally, 65% (52) of participants noted that they had some prior musical training while 35% (28) noted that they did not. Participants were recruited through a variety of methods: SONA and the Butler

University psychology department, first hand recruitment via text and email to organizations, such as Butler Ballet and Delta Gamma, and also through word of mouth. See Table 1 for more information regarding participants.

Procedure

The experiment consisted of a pretest/posttest design, in which participants' moods were tested both before and after various tasks and exposure to music. The study began with a pre-experiment survey assessing participants' metacognition. The initial survey contained both The Metacognitive Awareness Inventory (See Appendix A) and the Brief Music in Mood Regulation Scale (B-MMR) (See Appendix B; Saarikallio, 2012). These questions helped gauge how well the participants monitor their own concentration and thinking abilities, how well they regulate their learning, and how much music tends to affect their mood and emotions.

After the initial survey, participants completed an initial mood rating to determine how happy, sad, calm, and tense they were feeling at pretest. Participants then rated their mood, specifically their happiness, sadness, calmness, and tenseness levels separately, to set a baseline of how they were feeling when they began the experiment. These moods were rated on a Likert scale with 0 being "not at all" to 4 being "extremely."

Afterwards, the participants were assigned to one of five conditions (See Table 3), in which they experienced a different condition to both study and take the memory test. The study session allowed each participant to review a list of 25 word pairings (see Appendix C) simultaneously for five minutes on the computer. This test was created by choosing words from a random word generator. Depending on the condition, they may or may not have listened to music during this time.

Next, each participant was then asked to rate their mood a second time, determining how the music, if present, affected their mood. Participants then completed a two-minute long, mindless arithmetic task, consisting of basic first-grade math questions. This acted as a distractor task to neutralize any music induced mood, as well as bring their focus elsewhere before beginning the memory test. After this distractor math task, they were asked to rate their mood one last time, to see if the task was successful in bringing the participants back to a more neutral affect state. Finally, the participants were tested on the word associations. They were shown one half of the word pairs simultaneously and given three minutes to type the words that were previously paired with them. Depending on the condition, some participants heard music during the test, as well.

The study finished with a brief questionnaire to gather the participants general demographic information (e.g., age, race, sex), as well as if they had any prior musical training. Participants were then debriefed on the study and given any compensation promised (i.e. extra credit points if they were enrolled in a psychology course or service hours for Butler Ballet's honorary fraternity).

The music choices were predetermined through a pilot study ($N = 41$), where participants listened to six different song choices and rated how each affected their mood. Participants rated their mood for both happiness and calmness levels on a scale from -3 to 3, with -3 being that the song did the complete opposite of eliciting that mood and 3 being that the song completely elicited the respective mood. This study was completed to ensure that the selected calm song frequently elicited a calm mood state and that the happy song had a high probability of positively affecting one's mood.

The chosen "happy" song, "Jubilant Day (Upbeat Lo-Fi Hip Hop Mix)," was the one that elicited the highest feelings of happiness (*M* = 1.366) but did not strongly elicit feelings of calmness (*M* = -0.146) and the chosen "calm" song, "I need concentration when studying in the library (3 hour lo-fi hip hop mix/lo-fi music for studying)," was the one that elicited the highest feelings of calmness (*M* = 1.780) but did not strongly elicit feelings of happiness (*M* = 0.634). These songs were specifically selected because they would not be recognizable, did not contain lyrics, and could be played on repeat with no clear beginning or end.

Data Analysis

To preface, we began analyzing the data with all participants included, as there were no outliers in the dataset. However, three participants were identified throughout the duration of data collection as having followed the experiment directions for the memory test incorrectly. These participants memorized the words in the wrong order, not understanding that the words were set up in pairs, and instead looked at them as a comprehensive list. For this reason, we excluded these three participants from any analyses regarding memory scores. Their data was still considered when analyzing mood.

Additionally, after exporting the data from Qualtrics, there appeared to be many blank cells throughout the mood ranking responses. Further investigation found that when participants left the sliding bar in the default position, it did not export data. We made the assumption that participants left the bar in this position because they identified most with the mood associated with that position, which is neutral mood with a rank of "2." Prior to analysis, we filled in all blank mood scores with a "2" and proceeded with data analysis.

When running our analyses, some of our tests required us to consider each of the five conditions, whereas other analyses were related to whether music was present. In the latter case, we conducted analyses comparing three conditions instead of five. Our control condition remained Condition 1 and then Conditions 2 and 3 were combined to make the music congruency condition, indicating that the same music was played during both studying and testing. Conditions 4 and 5 were also combined to make the music incongruency condition, indicating that music was played only while studying. Additionally, some of the remaining analyses concerned only the type of music that was present. In this case, our control condition again remained Condition 1 and then Conditions 2 and 4 were combined to create a calm music condition (regardless of congruency) and Conditions 3 and 5 were combined to create a happy music condition (regardless of congruency).

Lastly, we followed the scoring directions on the Metacognition Inventory (Schraw & Dennison, 1994) and the B-MMR (Saarikallio, 2012) to score the survey. For the Metacognition Inventory, every "true" was scored as a 1 and every "false" a 0. For the B-MMR, each question is answered on a 5-point Likert-scale ranging from "Strongly Disagree" to "Strongly Agree." A higher score on the Metacognition Inventory indicated greater metacognition and a higher score on the B-MMR indicated greater mood regulation through music.

Results

Pre-existing differences?

First, we ran a 4 (Mood: happy, calm, sad, and tense) by 5 (Condition: control, calm music while both studying and testing, happy music while both studying and testing, calm music only while studying, happy music only while studying) repeated measures ANOVA to determine whether there was a difference in moods between the 5 conditions prior to beginning the study. In other words, this analysis confirmed that the random assignment worked and participants were in a similar mood state at the beginning of the study. There was a main effect of mood, $F(3, 225)$

= 25.37, $p < .001$, suggesting that participants had varying baseline levels of emotions. Follow-up paired samples t-tests revealed that participants were significantly more happy (M = 2.49, SD = 0.75) than sad (M = 1.16, SD = 1.01) and tense (M = 1.88, SD = 1.17), significantly more calm (M = 2.31, SD = 0.93) than sad, and significantly more tense than sad. However, there was no main effect of condition, $F(4, 75) = 0.21$, $p = .93$, nor was there a Mood by Condition interaction, $F(12, 225) = 1.51$, $p = .12$. Therefore, any differences in participant's mood and/or performance could not be attributed to pre-existing differences between conditions.

We also tested to ensure that between the five conditions participants had similar scores on the Brief Music in Mood Regulation (B-MMR) scale. This tested that there were no pre-existing differences in whether participants believed that music did have an effect in regulating their mood. We ran a one-way ANOVA with Condition as the between subjects variable and no significant difference between conditions on the B-MMR was found, F (4, 72) = .72, $p = .58$, $\eta^2 = .04$. This showed that between conditions, participants had a similar idea of how much music impacts mood.

Did music induce a mood?

In the initial pilot study, the results depicted that mood was impacted by the song choice. Based on those results, we were led to believe that music would have a significant impact on mood within the experiment. When testing for an effect of music on change in mood, however, our results did not replicate those findings. So instead, we investigated whether our participants reported a change in moods after hearing the music associated with their condition. At this point, participants had all listened to music while studying, except those in the control condition. Thus, to compare whether the type of music impacted mood ratings, we grouped together Conditions 2 and 4 (to make a calm condition) and Conditions 3 and 5 (to make a happy condition). We ran separate 2 (Time: before studying, after studying) by 3 (Condition: control, calm music, happy music) repeated measures ANOVAs for each of the four moods (happy, sad, calm, and tense) to determine whether there was a change in mood before and after studying in the music conditions.

For the happiness mood ranking, we ran a 2 (Time: before studying, after studying) by 3 (Condition: control, calm music, happy music) repeated measures ANOVA to determine whether there was a change in happiness before and after studying. There was a main effect of condition, $F = (2, 77) = 3.23$, $p = .045$, $\eta^2 = .06$. To follow up, we ran independent samples t-test to compare average happiness ratings across the three conditions, control, happy, and calm. Results revealed that those in the happy condition ($M = 2.64$, $SD = 0.59$) were significantly happier compared to the control condition ($M = 2.09$, $SD = 0.88$), $t(46) = -2.57$, $p =.01$, $d = -7.79$. The calm ($M = 2.42$, $SD = 0.72$) and happy conditions did not vary from each other, $t\ (62) = -1.23$, $p = .22$, $d = -.31$, nor did the calm and control conditions, $t(46) = -1.38$, $p = 0.17$, $d = 0.42$. No other main effects or interaction effects reached significance (See Figure 1).

For the sadness mood ranking, we ran a 2 (Time: before studying, after studying) by 3 (Condition: control, calm music, happy music) repeated measures ANOVA to determine whether there was a change in sadness before and after studying between the conditions. There was a main effect of time, $F(1, 77) = 5.45$, $p = 0.02$, $\eta^2 = 0.01$, showing that people were less sad after studying ($M = 1.01$, $SD = 0.93$), compared to before studying ($M = 1.18$, $SD = 1.02$). No other main effects or interaction effects reached significance.

For the calmness mood ranking, we ran a 2 (Time: before studying, after studying) by 3 (Condition: control, calm music, happy music) repeated measures ANOVA to determine whether there was a change in calmness before and after studying. There was a main effect of time, $F(1, 77) = 8.04$, $p = 0.01$, $\eta^2 = 0.03$, showing that people were less calm after studying ($M = 2.01$, SD

= 0.91) compared to before studying (*M* = 2.29, *SD* = 0.92). No other main effects or interaction effects reached significance.

And finally, for the tenseness mood ranking, we ran a 2 (Time: before studying, after studying) by 3 (Condition: control, calm music, happy music) repeated measures ANOVA to determine whether there was a change in tenseness before and after studying. There was a main effect of time, $F(1, 77) = 5.80$, $p = 0.02$, $\eta^2 = 0.01$, showing that people were more tense after studying (*M* = 2.10, *SD* = 1.20), compared to before studying (*M* = 1.88, *SD* = 1.16). No other main effects or interaction effects reached significance.

To our surprise, the mood induction was not as salient as we thought and contrary to our pilot study results, music did not successfully prime the participants with a mood of happiness or calmness. However, regardless of the condition and the music that was listened to, participants did become less sad, less calm, and more tense after studying (See Figure 2).

Did music and mood affect memory?

Although initial analyses suggested that the songs did not elicit the moods we intended them to, we still conducted all planned analyses. To test if music has an impact on memory, we conducted a one way ANOVA with condition (control, calm music while both studying and testing, happy music while both studying and testing, calm music only while studying, happy music only while studying) as the between subjects variable and memory as the dependent variable. There was no significant main effect of condition on memory, $F(4, 72) = 0.20$, $p = 0.94$, $\eta^2 = 0.01$ (See Figure 3).

Because we found that music did not significantly elicit a mood, this ANOVA did not test whether or not mood influenced memory. Instead, to test if mood correlated to participant's memory scores, we ran a series of correlations between the pre memory test mood rating (happy, sad, calm, and tense all separately) and the memory scores (collapsed across condition). None of the correlations reached significance (*p's* > .05; See Table 3 and Figure 4).

Did the type of music affect memory?

To test whether music affects memory when broken up into the type of music playing, we combined the conditions. Because Conditions 2 and 4 both included calm music, with the only difference being whether the music was played during memorization and recall, or only at memorization, we combined these conditions. We also combined Conditions 3 and 5, which both involved happy music. Thus, Condition 1 remained our control condition, with no music, Condition 2 is the calm music condition, and Condition 3 is the happy music condition. We then ran a one-way ANOVA to determine if the type of music (calm, happy, or control) impacted memory performance and there was no significant effect of condition, $F(2, 74) = 0.24$, $p = 0.79$, $\eta^2 = 0.01$ (See Figure 5).

Was there a music congruency effect?

Next, we tested if a music congruency effect existed, in which memory scores should be better in the presence of having the same environment for both studying and testing (both containing music or both containing silence; Bower et al., 1978). Now, we combined conditions 2 and 3, since they both involved music being played while both studying at testing, labeling them as Condition 2, and combined conditions 4 and 5, since they both involved music being played only while studying, labeling them as Condition 3. These conditions aimed our focus on only whether there was music congruency or not, and not the type of music being played. Thus, Condition 1 remained our control condition, with no music, Condition 2 is the music congruency condition, with music playing while both studying and testing, and Condition 3 is the music incongruency condition, with music playing only while studying but not while testing. We then ran a one-way ANOVA and there was no significant effect of condition, $F(2,74) = 0.28$, $p = 0.75$, $\eta^2 = 0.01$ (See Figure 6).

Did the math test affect mood?

We then analyzed the results of the math distractor task. This task was put in place to bring participants back to a neutral mood after having studied the word list while listening to music. To see if the math test influenced the participants mood and succeeded in bringing them back to a neutral mood state, we ran a 2 (Time: before math and after math) by 4 (Mood: happy, sad, calm, and tense) repeated measures ANOVA between the mood ratings before and after the math task. There was no significant effect between the levels of happiness, calmness, or tenseness, but there was a significant change in the levels of sadness $F(1,76) = 7.65$, $p = 0.01$, $\eta^2 = 0.09$, showing that sadness increased between the pre-math mood ranking ($M = 1.00$, $SD = 0.92$) and the post-math mood ranking ($M = 1.23$, $SD = 1.06$). This showed that the math task did not neutralize participants' moods, but instead increased sadness.

Did the B-MMR scale score correlate with memory?

Next**,** we tested if participants' score on the Brief Music in Mood Regulation scale affected their memory score. After having tested for pre-existing differences between conditions, we ran a correlation, to see the direct relationship between the B-MMR score and memory score. Again, no significance was found $r = 0.10$, $p = 0.40$.

Did Metacognition correlate with memory?

Finally, to see how participants' metacognition scores from the initial survey related to their final memory scores, we ran a correlation. There was a significant relationship $r = -0.23$, $p = 0.04$. Counter to our predictions, this showed that as participants' metacognition scores increased, their memory scores decreased, signifying that the poorer one's metacognition is, the better their memory is.

Discussion

In the past, research has investigated how music can influence one's mood (Jäncke, 2008), how music may help memory (Irish et al., 2006), and even the impacts of mood on memory (Lee & Sternthal, 1999), but there has been no cohesive study investigating all three factors simultaneously. To fully research the combination of all three variables - music, mood, and memory - we designed this study to investigate the impact of music on mood and, consequently, mood on memory. I hypothesized that 1) different kinds of music would induce different kinds of moods, 2) the mood would influence one's memory, specifically that calm and happy music would increase memory performance to an extent, and 3) one's memory performance would be better when in a more positive mood and listening to more upbeat music. To test this, we randomly assigned 80 participants to one of five conditions. We tested the participants' memory with a recall memory test and instructed them to rank their mood at multiple points throughout the experiment. Calm, happy, or no music was played during either the studying session, or both the studying and testing sessions.

Results in general did not support our hypotheses, as the majority of the data was not significant. To begin, we confirmed that all of the participants began the experiment with rather equal moods and that no condition had participants that were significantly more or less happy, calm, sad, or tense than any of the other conditions. This helped establish a solid baseline and eliminated the possibility of pre-existing mood differences. Similarly, we confirmed that participants held similar beliefs as to whether or not music has an impact on mood by finding that participant scores did not significantly differ on the Brief Mood in Music Regulation scale.

The results of our study depended on the concept that music has the ability to induce a mood (Pignatiello et al., 1986; Sousou,1997), yet in few of the conditions did listening to music impact the individual's mood. For those who listened to different types of music, there was no differential change in calmness, sadness, or tenseness from before listening to music to after. However, those who listened to happy music were significantly happier than those who were in the calm music condition or the control condition. Thus some, but not all, of the music elicited the moods we hoped it would. Ignoring conditions and only looking at the impact of studying on mood, there was a significant change in mood across all conditions for sadness, tenseness, and calmness. After studying, participants ranked their mood as being overall less sad, less calm, and more tense. This result suggests that even if music does not induce mood, studying does, and reasonably so. After studying, feelings of sadness decreased, but stress levels increased as calm levels decreased and tension levels increased. Because anxiety increased and tension levels rose, it is possible that there was less room for other emotions to occur. With only the happy song seeming to successfully elicit a happy mood, it is interesting that rankings of calmness were opposite of the predicted direction. Perhaps the reason that the calm song was not successful in eliciting a calm mood is because the factor of studying overpowered the strength of the song's mood induction. Yet in this case, although studying would have negated any calming effects that the music had, calm scores should have still decreased post studying. Thus, the calm condition still should have had higher levels of calmness than those in conditions who did not have the benefit of calming music at all. Because there was no difference between conditions, we can assume that the calm music either needed to be played longer to induce a mood or was simply not as strong in inducing a mood as was the happy music.

Without the basis of music impacting mood, we could no longer assume that a significant difference in memory scores between conditions was elicited from a change in mood. Instead, any memory difference would be attributed purely to the condition, or the type of music listened to. Despite this, there was no difference between each condition and the memory scores. To further investigate if memory was influenced by mood, we then looked at the relationship between the memory score and the mood ranking from right before the memory test for each mood separately. Again, there was no relationship between any of the moods tested and the resulting memory scores, showing that memory score did not fluctuate based on the state of one's mood in the current study.

Even though there was no difference between each condition and the memory scores, we decided to further explore our data by grouping the conditions together based on the type of music playing to see if perhaps the type of music, calm or happy, impacted memory. Again, there was no difference in memory scores between participants who listened to happy music, participants who listened to calm music, or even participants who listened to no music.

One of our goals in this study was to replicate findings of a mood congruency effect (Bower et al., 1978). The mood congruency effect explains the psychological finding that when people are in a certain mood when experiencing and encoding an event, they remember the information and event better when in the same mood while attempting to recall the event and information (Bower et al., 1978). We predicted that when music induced a mood, that mood would create a mood congruency effect, leading those who listened to happy or calm music while studying to have a better memory score when listening again to happy or calm music, respectively, while testing. Because music did not successfully induce a mood in our study, we can not make this assumption from our data; however, we can instead ask if there was a "music congruency effect," in which those who listen to the same music at both the encoding and recall stages have better memory performance than those who listen to the music at only the encoding stage. To test this new hypothesis, we looked at the difference between those who listened to music at both studying and testing and compared their performance to those who only listened to music while studying and to those in the control who experienced no music. There was no significant difference, and therefore, no "music congruency effect."

Because some participants who heard music while studying would not hear music during testing, we included a math distractor task between the studying portion and the testing portion to bring participants back to a neutral mood state. This ensured that in the case of no music playing while testing, they would not still be in the same mood that had been induced from the previous music while studying. Because our results showed that music did not induce a mood, the point of the distractor task became insignificant; however, we still tested to see if there was any change in mood before and after completing the math task. By looking at the mood rankings from immediately before and after the math task, we found that there was no difference in happiness, calmness, or tenseness scores, but sadness did change. Participants became significantly sadder after completion of the math task, leading to the belief that math increases feelings of sadness. Alternatively, it is possible that the effects on mood were short-lasting and simply wore off by the end of the math task. Given that post math sadness scores (M = 1.234) were very close to the baseline sadness scores (M = 1.175), this possibility seems very feasible.

Finally, we analyzed the results of the survey to see if participants' beliefs on metacognition or on how music regulates mood influence their memory. There was no relationship between memory and how one views the regulation ability of music on mood, but there was a significant negative relationship between metacognition scores and memory.

Participants' metacognition scores decreased as their memory scores increased, displaying that the worse one's metacognition abilities are, the better their memory performance is. Even though these findings were counter to our predictions, they are in line with past work (Irak & Çapan, 2018). As metacognition is the process of thinking about thinking (Flavell, 1979), perhaps people who believe they are better at thinking about thinking, have worse memory scores, because they think they know more than they do, whereas people who believe they are bad at thinking about thinking, have better memory scores because they actually know more than they think they do. This relates to the concept that the more intelligent one is, the less intelligent they feel because they recognize how much in the world there is left to know, whereas those who are less intelligent, believe they are smarter than they are, because they are ignorant to how little they truly do know. In simple terms, the results showed people tend to be bad at metacognition.

Overall, although many of our hypotheses were not confirmed and much of the data led to non-significant results, we did find that the happy music did induce a happy mood, studying effects mood, math makes people sad, and people are bad at metacognition.

Limitations

Multiple aspects of our study faced limits, hindering our results. The first issue we encountered during data analysis was that our music did not induce a mood as saliently as we predicted. When we initially chose the songs for the study, instead of simply looking at their mean mood scores, we should have run a one sample t-test to see if the mean score was significantly different from zero. This would have ensured that the songs actually did significantly change people's moods. In future research, it would be best to ensure the music's ability to induce a mood prior to beginning experimentation. Additionally, the selected songs were "happy" and "calm," yet those are not opposite emotions. When replicating the study, using "energetic" and "calm" music choices may be a better decision, as the results would be more contrasting and would better represent the opposing music choices that people select from when studying (Schimmack & Rainer, 2002).

As for the memory test, although similar varieties of this test have shown to be efficient in past research (Buck et al., 2021), we found limitations with it. To begin, our data displayed a large amount of variability and the test did not account for pre-existing differences. Memory varies greatly among individuals and where some may begin the test with a very good memory, others may not be as fortunate. Memory can also be influenced by the state of mind an individual is in when they begin the test (Miles & Hardman, 1998). It is impossible to know how distracted some of the participants may have been or what events in their day may have been inhibiting their ability to concentrate. For example, one participant mentioned that they had just come from the gym and sauna, and felt that they were in a daze, unable to concentrate or follow directions correctly. These existing differences may have overpowered any potential effects. Furthermore, the word list used for the memory test only allowed for either full credit or no credit for each question, but did not account for situations where participants showed partial memory. There were many instances in which a participant listed a similar word, entered the plural or past tense form of a word, spelled the word incorrectly, or even entered the correct word, but with the wrong paired word, and did not get any points even though they were on the right page. Additionally, some of the words were emotionally valenced and given the impact of mood in the study, this could have influenced the results. In future research, perhaps using a different memory test, or scoring the test to account for more specific memory variations, will lead to more accurate results.

Finally, the demographics of our study were very uneven and our sample was not diverse. We recruited from primarily the psychology and dance departments of Butler University, leading to an unrepresentative sample of the general population. Our sample was also predominantly Caucasian females. Having such a niche population, white female dancers, make up the majority of our participants, leads to results that are not applicable to the general public. Replicating this study with a larger, more representative sample may yield significant results, and would allow our results to be more generalizable. Additionally, with the majority of our sample being dance majors, most participants had prior musical training and experience. It would be interesting to analyze how much musical training participants have to determine if exposure to music could have impacted one's response to listening to music. Perhaps having such a strong musical background limited the effectiveness of the music because of overexposure, and replicating this study with individuals who are not as intune to music could yield to more drastic effects.

Implications

Our study analyzed the effects of music and mood on memory and despite the setbacks that we faced, much of our research can be applied to further studies and help progress people's understanding of music, mood, and memory. For example, if future research shows that studying does in fact impact mood, students can utilize this knowledge to become aware of their emotions and manage them accordingly. By further finding that studying also affects mood, individuals can become cognizant of their emotions while encoding information. Future research could build off of these findings by investigating how monitoring one's own mood may prevent the negative emotional effects of studying, or investigating other ways to mitigate the negative consequences that studying elicits. Awareness of the effects of studying is the first step in creating change. We also found that math makes people sadder, suggesting that individuals could listen to music while or after doing math problems to hopefully improve their mood and reduce such sadness. Similar to the effects of studying, bringing awareness to this impact allows people to learn how to adapt and evolve. Finally, our results indicated that participants had poor metacognition. It would be interesting to further investigate these results and see if people in general tend to be inefficient at metacognition or if there are specific elements of memory that elicit such results.

In conclusion, this study investigated the impact of mood and music on memory and the relation to metacognition. We found that studying makes individuals more stressed, math makes people sadder, happy music has the ability to elicit a happy mood, and people have poor metacognition in relation to memory. Although past research on the mood congruency effect could not be replicated and many of our hypotheses were not fully supported, these results provide essential groundwork to the natural intersection of music, mood, and memory and pave the way for further findings in this realm of literature.

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Table 1

	Condition 1	Condition 2	Condition 3	Condition 4	Condition 5
N	16	16	14	16	15
Happy Baseline (SD)	2.25 (0.93)	2.06 (0.68)	2.86 (0.36)	2.69 (0.70)	2.67 (0.72)
Sad Baseline (SD)	1.13 (1.03)	1.38 (1.20)	1.21 (0.89)	0.94 (1.00)	1.13 (0.99)
Calm Baseline (SD)	2.38 (0.89)	2.13 (1.03)	2.57 (0.76)	2.31 (1.08)	2.20 (0.86)
Tense Baseline (SD)	2.00 (1.10)	2.19 (1.17)	1.29 (1.33)	1.75 (1.13)	2.13 (1.06)
Metacognition (SD)	37.38 (7.15)	36.94 (7.20)	39.79 (7.48)	41.63 (5.92)	41.67 (4.75)
BMMR (SD)	3.89 (0.52)	4.22 (0.62)	3.91 (0.79)	4.03 (0.55)	4.06 (0.65)

Note. Participant pretest measures by condition.

Table 2

	Study Condition	**Test Condition**
Condition 1	No Music	No Music
Condition 2	Calm Music	Calm Music
Condition 3	Happy Music	Happy Music
Condition 4	Calm Music	No Music
Condition 5	Happy Music	No Music

Note. Participants were randomly assigned to one of these five conditions.

Table 3

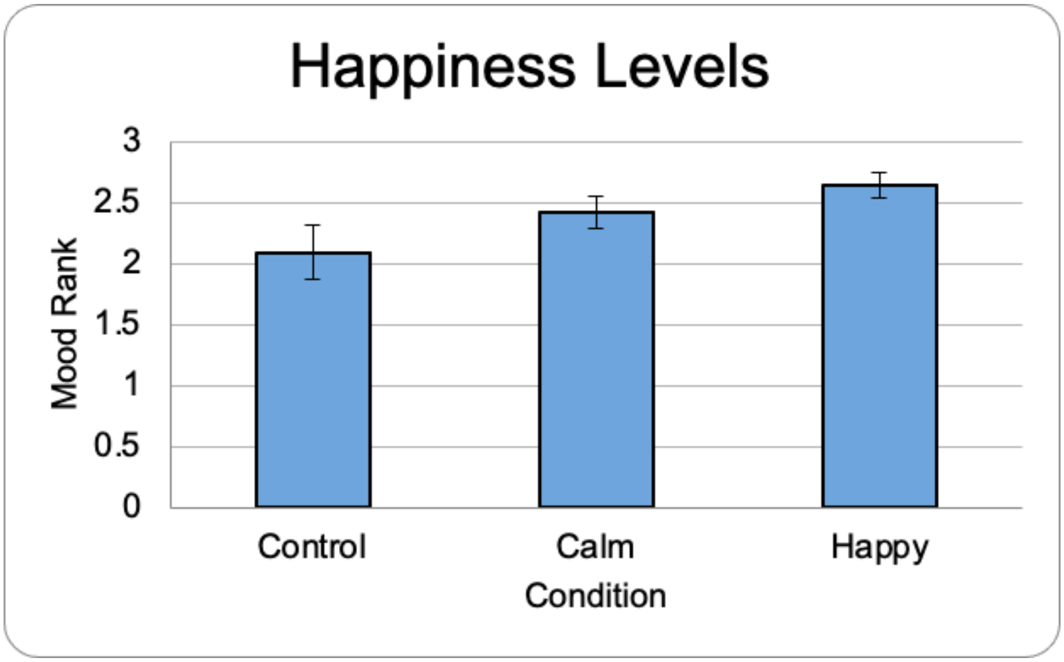
Correlation ▼

Pearson's Correlations ▼

Variable		Post Math - Happy	Post Math - Sad	Post Math - Calm	Post Math- Tense	Mem Score
1. Post Math - Happy	Pearson's r	—				
	p-value	—				
2. Post Math - Sad	Pearson's r	−0.393	—			
	p-value	< .001	—			
3. Post Math - Calm	Pearson's r	0.535	−0.082	—		
	p-value	< .001	0.480	—		
4. Post Math- Tense	Pearson's r	−0.386	0.266	−0.548	—	
	p-value	< .001	0.019	< .001	—	
5. Mem Score	Pearson's r	−0.068	−0.016	−0.114	0.039	—
	p-value	0.556	0.888	0.324	0.737	—

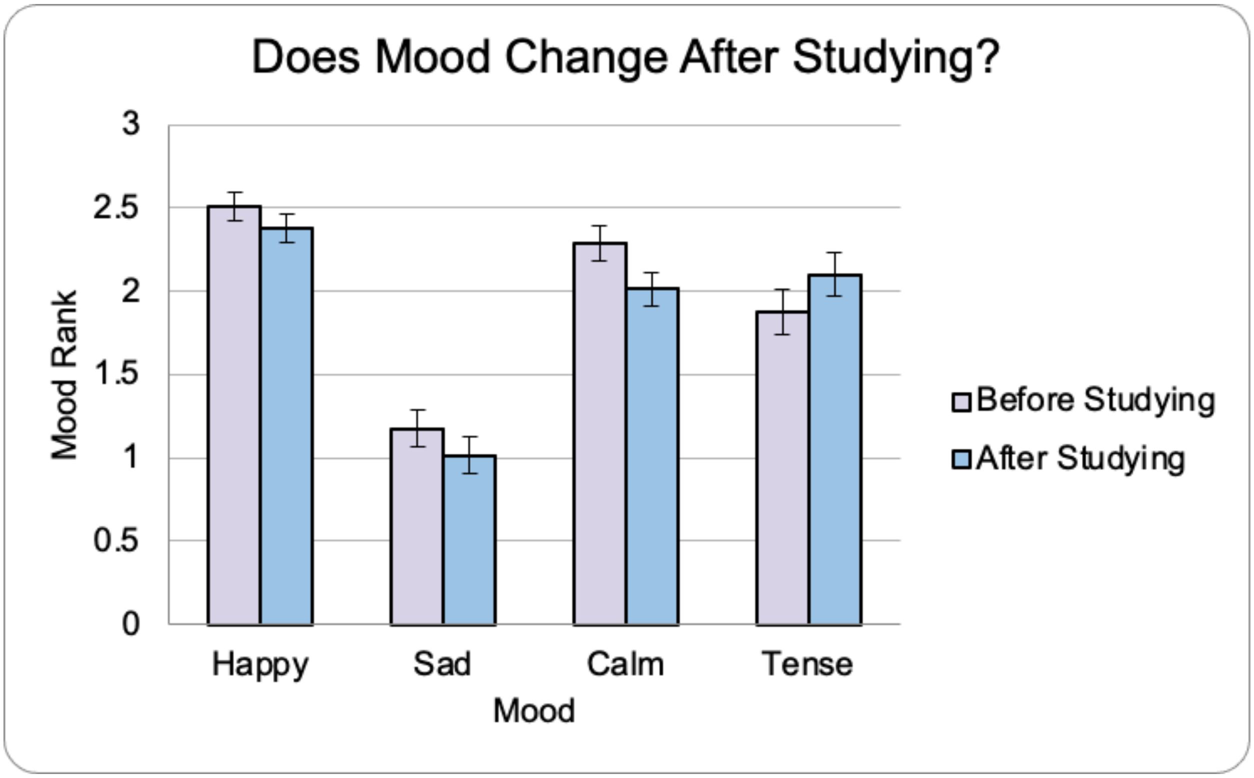
Note. After the math test, participants were significantly sadder.

Figure 1



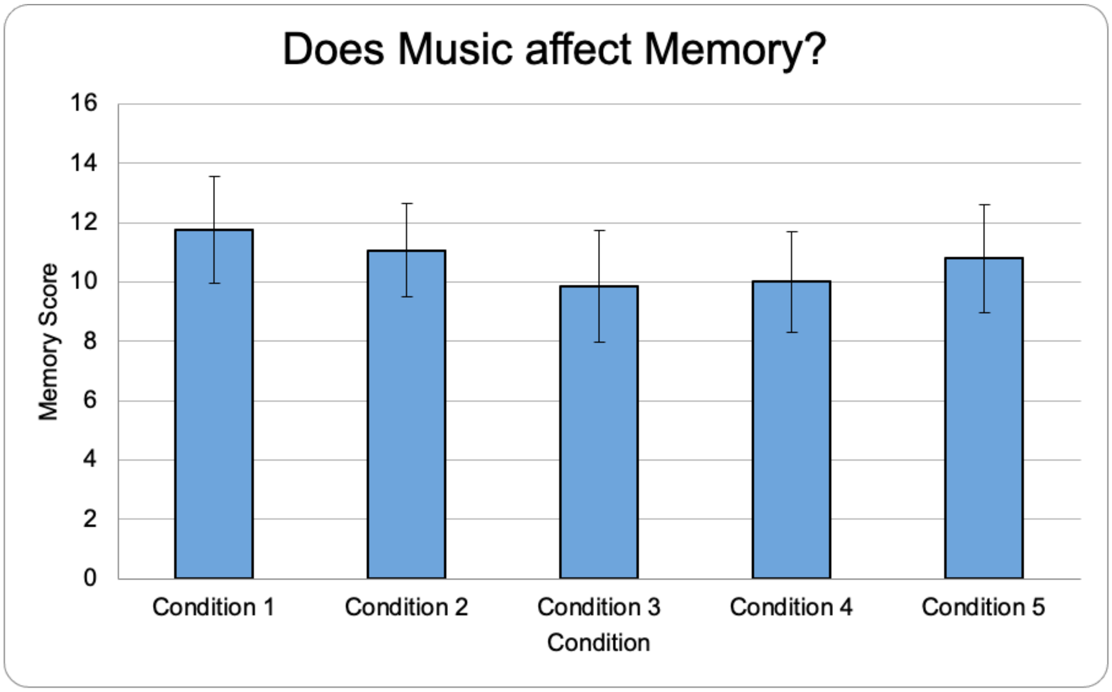
Note. Those in the happy song condition were significantly happier than those in the control condition.

Figure 2



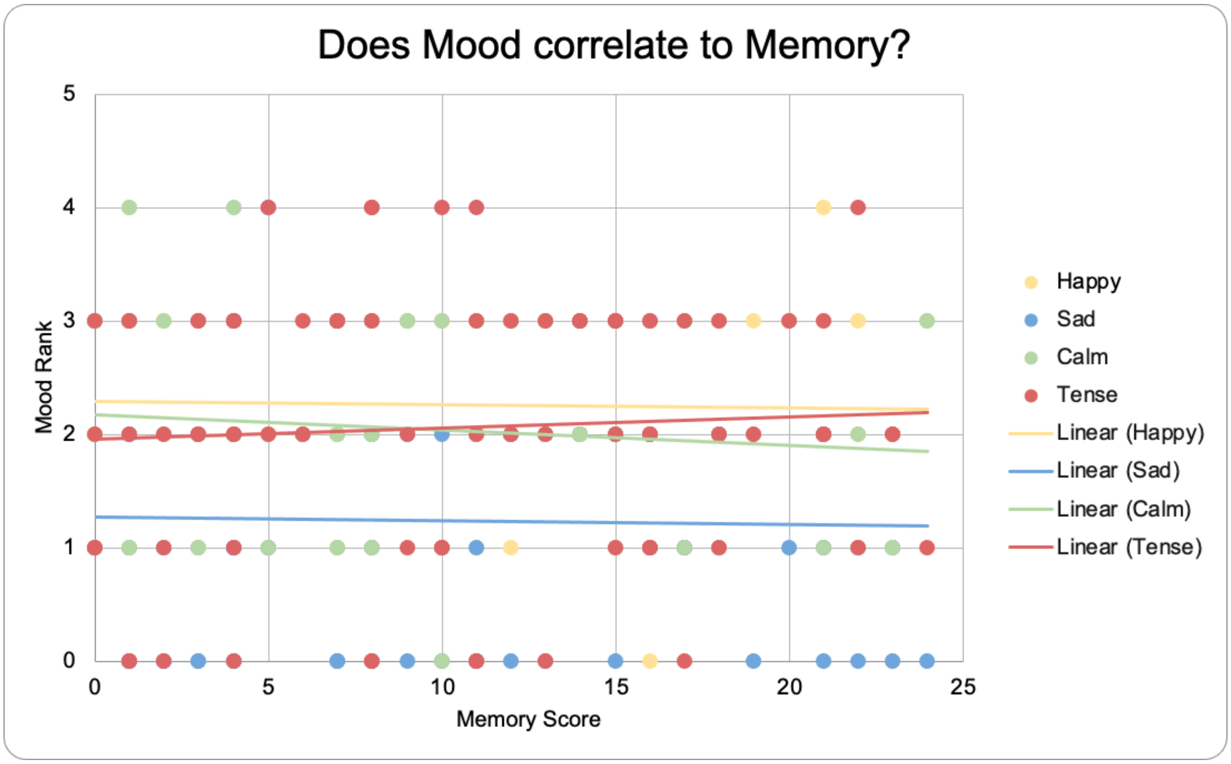
Note. Participants were significantly less sad, less calm, and more tense after studying (regardless of Condition).

Figure 3



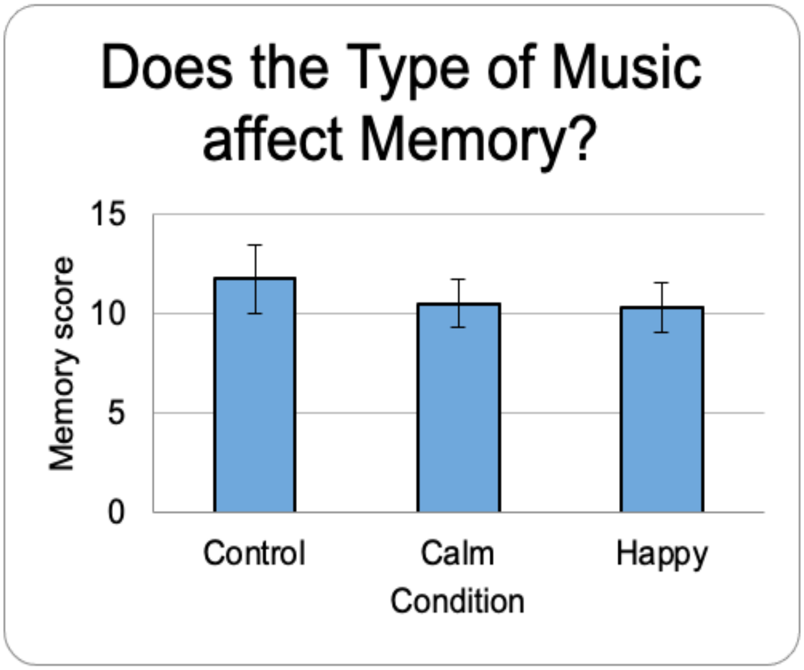
Note. Condition had no significant impact on memory performance.

Figure 4



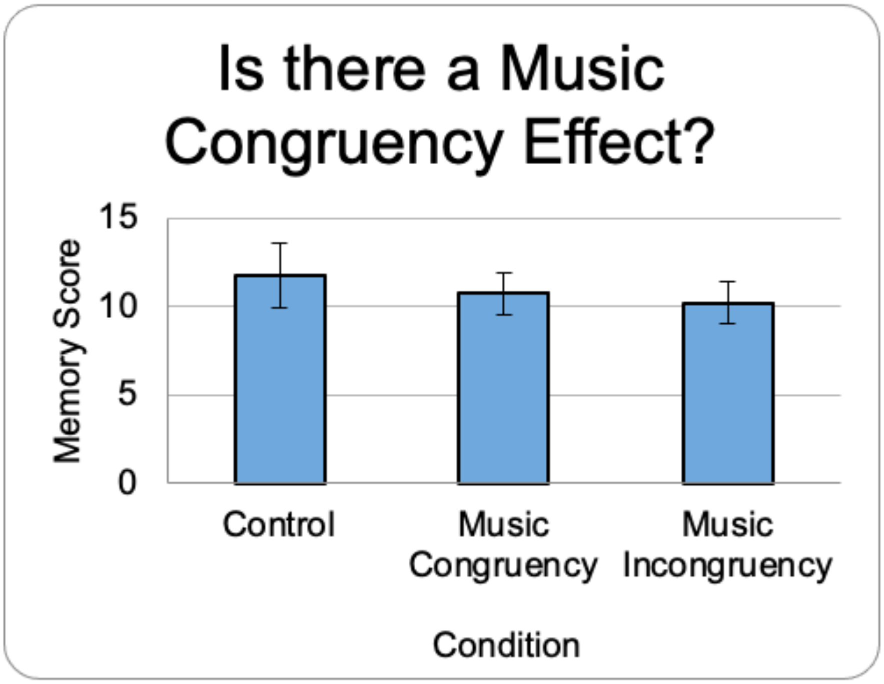
Note. No mood showed any significant correlation to memory performance.

Figure 5



Note. The type of music participants listened to did not have a significant impact on memory performance.

Figure 6



Note. No music congruency effect was found.

Appendix A
Metacognitive Awareness Inventory

	True	False
1. I ask myself periodically if I am meeting my goals.		
2. I consider several alternatives to a problem before I answer.		
3. I try to use strategies that have worked in the past.		
4. I pace myself while learning in order to have enough time.		
5. I understand my intellectual strengths and weaknesses.		
6. I think about what I really need to learn before I begin a task.		
7. I know how well I did once I finish a test.		
8. I set specific goals before I begin a task.		
9. I slow down when I encounter important information.		
10. I know what kind of information is most important to learn.		
11. I ask myself if I have considered all options when solving a problem.		
12. I am good at organizing information.		
13. I consciously focus my attention on important information.		
14. I have a specific purpose for each strategy I use.		
15. I learn best when I know something about the topic.		
16. I know what the teacher expects me to learn.		
17. I am good at remembering information.		
18. I use different learning strategies depending on the situation.		
19. I ask myself if there was an easier way to do things after I finish a task.		
20. I have control over how well I learn.		
21. I periodically review to help me understand important relationships.		
22. I ask myself questions about the material before I begin.		
23. I think of several ways to solve a problem and choose the best one.		
24. I summarize what I’ve learned after I finish.		
25. I ask others for help when I don’t understand something.		

26. I can motivate myself to learn when I need to.		
27. I am aware of what strategies I use when I study.		
28. I find myself analyzing the usefulness of strategies while I study.		
29. I use my intellectual strengths to compensate for my weaknesses.		
30. I focus on the meaning and significance of new information.		
31. I create my own examples to make information more meaningful.		
32. I am a good judge of how well I understand something.		
33. I find myself using helpful learning strategies automatically.		
34. I find myself pausing regularly to check my comprehension.		
35. I know when each strategy I use will be most effective.		
36. I ask myself how well I accomplish my goals once I'm finished.		
37. I draw pictures or diagrams to help me understand while learning.		
38. I ask myself if I have considered all options after I solve a problem.		
39. I try to translate new information into my own words.		
40. I change strategies when I fail to understand.		
41. I use the organizational structure of the text to help me learn.		
42. I read instructions carefully before I begin a task.		
43. I ask myself if what I'm reading is related to what I already know.		
44. I reevaluate my assumptions when I get confused.		
45. I organize my time to best accomplish my goals.		
46. I learn more when I am interested in the topic.		
47. I try to break studying down into smaller steps.		
48. I focus on overall meaning rather than specifics.		
49. I ask myself questions about how well I am doing while I am learning something new.		
50. I ask myself if I learned as much as I could have once I finish a task.		
51. I stop and go back over new information that is not clear.		
52. I stop and reread when I get confused.		

Appendix B
The Brief Music in Mood Regulation Scale (B-MMR)

Entertainment: happy mood maintenance

1. I usually put background music on to make the atmosphere more pleasant
2. When I'm busy around the house and no one else is around, I like to have some music on the background
3. I listen to music to make cleaning and doing other housework more pleasant

Revival: relaxation and new energy

1. I listen to music to perk up after a rough day
2. When I'm exhausted, I listen to music to perk up
3. When I'm tired out, I rest by listening to music

Strong Sensation: intense emotion induction

1. Music has offered me magnificent experiences
2. I want to feel the music in my whole body
3. I feel fantastic putting my soul fully into the music

Diversion: distraction from worries and stress

1. For me, music is a way to forget about my worries
2. When stressful thoughts keep going round and round in my head, I start to listen to music to get them off my mind
3. When I feel bad, I try to get myself in a better mood by engaging in some nice, music-related activity

Discharge: release and venting of negative emotion

1. When I'm really angry, I feel like listening to some angry music
2. When everything feels bad, it helps me to listen to music that expresses my bad feelings
3. When I'm angry with someone, I listen to music that expresses my anger

Mental Work: contemplation and reappraisal of emotional experience

1. Music helps me to understand different feelings in myself
2. Music has helped me to work through hard experiences
3. When I'm distressed by something, music helps me to clarify my feelings

Solace: emotional validation and support when feeling down

1. When everything feels bad, music understands and comforts me
2. When I'm feeling sad, listening to music comforts me
3. I listen to music to find solace when worries overwhelm me

Appendix C
Word Association List

1. blast	budge
2. news	stake
3. old	gossip
4. breakfast	growth
5. due	grip
6. lost	bloody
7. soar	laundry
8. tape	cupboard
9. stable	soak
10. crowd	endure
11. adjust	score
12. torture	abstract
13. stand	cat
14. panic	virtue
15. morale	throne
16. snuggle	store
17. forge	plaster
18. figure	gutter
19. organ	wisecrack
20. entry	sustain
21. feather	witch
22. smart	proclaim
23. snap	order
24. prosper	failure
25. sculpture	powder