Emotion as a Mediator Between Music Exposure and Task Performance

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In Partial Fulfillment of the Requirements for the Degree of
MASTER OF ARTS

In
The Psychology Department
State University of New York
New Paltz, New York 12561

May 2016
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Submitted in partial fulfillment of the requirements for the Master of Arts degree in Psychology
at the State university of New York at New Paltz.
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Abstract

Research has shown that music can have significant effects on individuals’ emotional state, and that those emotional states can then have noteworthy effects on their performance in certain types of tasks. Specifically, the focus of recent research has been on individuals’ performance on detail-oriented tasks following mood induction through music. The present study aimed to expand on this previous research and incorporate Fredrickson’s broaden-and-build theory by measuring both creative task performance and detail-oriented task performance. As in previous studies, it was hypothesized that slow, minor key music would induce participants into a sad mood, thus enhancing their performance on a detail-oriented task. In addition to previous research, and in line with the broaden-and-build theory, it was also hypothesized that upbeat, major key music would induce a happy mood, thus enhancing creative task performance. Lastly, it was hypothesized that emotion would serve as the mediator between exposure to music and task performance. Results did not support the projected hypotheses; however further exploratory analyses provide insight for future directions.
Emotion as a Mediator between Music Listening and Task Performance

Music has been shown to have a profound effect on both the human mind and body. For example, it is not uncommon for an individual to listen to certain pieces of music and get the chills, a physical response to what they are hearing (Nusbaum et al., 2014). Music has also been used in intervention programs to help individuals express and recall life experiences that cannot easily be put into words (Duffey & Haberstroh, 2013), and group songwriting and performing has been shown to be an effective therapy experience to positively affect emotions and improve well-being (Baker & Ballantyne, 2012). Thoma, Ryf, Mohiyeddini, Ehlert, and Nater (2012) found that individuals choose to listen to music that is congruent with their current mood in everyday situations, suggesting that people may use music as an emotional regulation tool.

Research examining the relationship between music and emotions has focused mainly on happiness and sadness. Topics in this literature range from the brain correlates of music-evoked emotions (Koelsch, 2015) to the effectiveness of intervention programs to help mentally ill patients (Gebhardy, Kunkel & Von Georgi, 2014). Several studies have focused on demonstrating that certain types of music not only sound ‘happy’ or ‘sad’, but are effective at actually inducing those emotions in individuals (Friedman & Taylor, 2013; Vuoskoski & Eerola, 2012; Schnall, Jaswal & Rowe, 2008). Empathy has been shown to be an important trait in individuals’ susceptibility to sad mood induction through music (Vuoskoski & Eerola, 2012).

This potential effect of music upon emotional state raises the possibility that exposure to music might indirectly affect performance on cognitive tasks. Individuals induced into experiencing a certain emotion have shown changes in thought and action depending on the emotion that was induced. For example, a happy mood hinders performance on certain detail-oriented tasks (Storbeck & Clore, 2005; Schnall et al., 2008). The present study examined
music’s ability to induce mood, and test the effect of mood on task performance in a more comprehensive manner than previous research has done. Music is a prevalent part of today’s culture, and as such, understanding the relationship between what we hear and how we respond is an important concept to address. In many cases, we can choose to listen to music while at work, in the car, or while participating in our favorite activities. Think of an artist listening to their favorite band to get in the mood to paint, or a gym enthusiast putting on their favorite playlist to get ready for a workout. Music is also present in areas where we might not be initially aware of it. For example, there is typically music playing at shopping malls and grocery stores, in elevators, TV commercials, and much more. Even in work settings, there is often music present in some way, such as the radio playing in an office building, hold music on a company’s phone, or music playing in a lobby.

If music can affect our performance on certain cognitive tasks, then it is even more important to address this relationship since music is pervasive in today’s society. Everyday tasks such as shopping for creative gift ideas, coming up with a budget plan, or a variety of other academic or work tasks may be affected by the music we hear. As described in the following sections, individuals are consistent in the way they identify music as happy or sad, and music with ‘happy’ or ‘sad’ properties can induce congruent emotions in listeners. The emotions induced by this music may then play an important role in performance on different types of tasks.

Music and Experienced Emotions

It is first important to understand what features of music we associate with the emotions of sadness and happiness. Krumstahl (1997) measured college students’ emotional reactions to a variety of classical music and found that there was a consistent set of qualities that participants
used to identify music as happy or sad. Happy music was associated with major harmonies and faster tempos, while sad music was associated with minor harmonies and slower tempos. This finding has been replicated by Chamorro-Premuzic, Fagaon and Furnham (2010). In general, major keys and minor keys are a significant factor in the emotional perception of music, although potential differences among the specific keys within those two categories have not been extensively explored.

Friedman and Taylor (2013) explored the perceived differences of musical compositions created by humans and those created by computer programs. They found that the perceived origin of the music (created by a human versus created by a computer) did not alter participants' affective responses to the music. However, individuals were able to distinguish between 'happy' and 'sad' sounding excerpts, and happy music was rated by participants as significantly more arousing, enjoyable, interesting, likeable, and led to greater feelings of happiness, as compared to sad music (Friedman & Taylor, 2013).

Further research has shown that not only do we perceive emotional content in music, but that music can also induce those emotions in us as well. Specifically, researchers have focused on music’s ability to induce happiness and sadness in adults (Stoebeck & Clore, 2005; Vuoskoski & Eerola, 2012) and in children (Schnall et al., 2008). Schnall et al. (2008) used 12.5 minute loops of two orchestral pieces of music to induce happiness and sadness in children. Following exposure to the music children were asked to choose one of five faces, which ranged from depicting a pronounced frown to a strong smile, to represent how they felt. Results confirmed that children induced into a sad mood chose faces that matched the music they were exposed to. Overall, previous research has clearly demonstrated that people consistently classify what type of emotion different music sounds like, and that music can effectively induce the
emotion it sounds like.

**Emotion and Task Performance**

Research has also shown that individual’s current emotional state can impede or enhance their performance on certain types of tasks (Schnall et al., 2008; Storbeck & Clore, 2005). Schnall et al. (2008) explored situations in which happiness may not be beneficial to task performance, particularly in childhood. In their first experiment, music was used to induce happiness or sadness. Results indicated that being in a positive mood hindered a child’s ability to perform well on detail-oriented tasks, when compared to children induced into a sad mood. Positive emotion has also been shown to have similar detrimental effects in adults, hindering their performance on a detail-oriented false memory task (Storbeck & Clore, 2005). Adults who were induced to a happy mood were more likely to falsely indicate that a list contained the word ‘sleep,’ when in fact the list had only included items related to sleep, not the word ‘sleep’ itself. Researchers posited that perhaps happy individuals are thinking in a broader sense, recalling the gist of the list, while sad individuals are thinking in a more detailed manner, recalling the specific words included in the list.

Other research on emotion and task performance has shown that music can also be beneficial in the workplace. Lesiuk (2005) found that computer developers who listened to music more while at work experienced higher state positive affect, which in turn increased work performance. Researchers posited that this is because computer programming is a creative task, and such activities may be enhanced by positive affect (Lesiuk, 2005). Note that in this study, unlike the previously described research, the emotional content of the music was not specifically studied or manipulated. In addition, although researchers stated that computer programming is a creative task, it can also be argued that attention to detail is necessary to complete programming
taks. While Lesiuk demonstrated that listening to music had an effect on task performance, the
details of the pathway to the reported outcome need to be further studied and clarified.

Fredrickson's (2001) broaden-and-build theory can be used to help explain how
emotional state may impact performance on various kinds of tasks. The theory focuses on the
capability of emotions to have far-reaching effects on our cognition, health and ability to adapt.
Specifically, according to the theory, positive emotions expand thought and encourage
exploration, both of which are key aspects of creativity. Fredrickson addresses how multiple
aspects of positive emotions broaden our minds. For example, joy encourages playing and
pushing limits to be creative, and pride creates the urge to share news and achievements with
others, broadening other individuals’ knowledge and helping to envision future goals. Negative
emotions, on the other hand, lead to a narrowing of thought, and lead to more target-focused
behavior. Contrary to positive emotions, negative emotions carry direct and immediate benefits,
focusing on addressing in-the-moment needs for survival (Fredrickson, 2001).

In a test of the broadening component of the theory, Fredrickson and Branigan (2005)
used film clips to induce amusement, contentment, neutrality, anger or anxiety in participants
and then measured their scope of attention using a global-local visual processing task in which
participants were presented with a stimulus triad with a standard figure on top and two
comparison figures below it. Each figure consisted of a single shape stacked in a triad or a
square. Participants were told to choose which comparison figure best matched the standard
figure, such that they would have to choose either a figure that matched in terms of the shapes
that made up the figure, or the shape of the figure as a whole. Choosing the figure as a whole is
associated with a global, broadened scope of attention, while choosing based on the individual
shapes making up the figure is associated with a local, detailed scope of attention. Results
supported the broaden-and-build theory such that, compared to individuals in a neutral state, individuals induced into positive emotions through had broadened scopes of attention and individuals induced into negative emotions had narrowed scopes of attention.

The previously mentioned studies support the prediction of the broaden-and-build theory, such that being happy seems to hinder performance in detail-oriented tasks (Storbeck & Clore, 2005; Schnall et al. 2008). Continuing with this theory, we would expect that happiness would then enhance performance on creative tasks, which requires broader, global level thinking. Initial research has supported the idea that positive affect can help in creative problem solving and fluency tasks (Isen, Johnson, Mertz & Robinson, 1985; Phillips, Bull, Adam & Fraser, 2002). Isen et al. (1985) found that individuals induced into a positive mood came up with more unusual words during a word association test, suggesting that positive affect facilitates creative problem solving. Further, individuals induced into a positive mood have also shown effects in executive functioning, such that positive emotion impairs performance on the switching condition of a Stroop test, but enhances performance on a creative uses test of fluency (Phillips et al., 2002).

Based on these results, the present study will aim to establish music’s ability to affect task performance through its effects upon emotional state. As described above, previous research has shown that music is a reliable tool for inducing happy and sad emotions, and that these emotions can be either beneficial or detrimental to performance, depending on the nature of the task. Tasks in the present study will be chosen for the level of creativity versus detail involved, and will therefore provide a more direct test of the claim that happiness can be detrimental to performance on detail-oriented tasks. Similar to the Fredrickson and Branigan (2005), for the present study I define a detail-oriented task as one that measures participants’ local processing
skills, while a creative task is one that measures participants' ability to think outside the norm, especially in terms of originality.

Further, although there is significant research identifying emotion as the link between music and task performance, previous research has not utilized mediation analyses to directly identify emotion as the mediator, which the present study will address as well. Finally, the present study will employ the PANAS-X (Watson & Clark, 1999), which provides subcategories within affect scores. The sadness subcategory will be used to provide a more precise operational definition of sadness that excludes other negative emotions such as anger or frustration. The joviality subcategory will represent a more accurate operational definition of happiness, eliminating other positive emotions such as confidence or attentiveness. It is hypothesized that upbeat, major key music will induce jovial affect, and slow, minor key music will induce sad affect. An increase in jovial affect is expected to then have a beneficial effect on participants' performance on a creative task, while an increase in sad affect is expected to have a beneficial effect on detail-oriented task performance. Finally, it is hypothesized that emotion will serve as the mediator between music and task performance as described above (see Figures 1 and 2).

*Hypothesis 1a: Slow, minor key music will cause a significant increase in sad affect scores between baseline scores and post-music exposure scores.

*1b: Upbeat, major key music will cause a significant increase in jovial affect scores between baseline scores and post-music exposure scores.*

*Hypothesis 2a: Higher sad affect scores post-music exposure will be associated with higher scores on a detail-oriented task.*
2b: Higher jovial affect scores post-music exposure will be associated with higher scores on a creative task.

Hypothesis 3a: Sad affect will mediate the positive relationship between exposure to slow, minor key music and performance on the detail-oriented task.

3b: Jovial affect will mediate the positive relationship between exposure to upbeat, major key music and performance on the creative task.

Method

Participants

The present study consisted of 52 (12 male, 39 female, 1 transgender) undergraduate students recruited from the SUNY New Paltz Psychology Department subject pool. Students ranged in age from 18 to 38 ($M = 22, SD = 4.19$) and received 4 subject pool credits in exchange for their participation.

Materials

Materials for the present study included eight classical music excerpts, an online survey, an environmental representation activity, a creative task (Task A), a detail-oriented task (Task B), and a small sound system. Music used to induce happy and sad moods fit the criteria found by Krumstahl (1997), such that upbeat, major key music was expected to induce a happy mood, while slow, minor key music was expected to induce a sad mood. The musical excerpts used to induce a sad mood can be seen in Appendix D and those used to induce a happy mood can be seen in Appendix E. All pieces were flute and piano duets in C Major or A Minor, and music selections in each section were matched to have similar tempos and time signatures.

The survey consisted of a compilation of measures related to the main aim of the study. Participants first completed an environmental representation activity at the start of each survey to
ensure adequate time to be affected by the background music prior to beginning the rest of the survey. Task A was a creative task, namely the Guilford’s Alternate Uses test (Guilford, Christensen, Merrifield & Wilson 1978), where participants were given a list of common items and asked to create a list of up to six unconventional uses for each object. Task B was a detail-oriented task, specifically a six letter cancellation test. Cancellation tests are commonly used to assess participants’ ability to visually locate and identify specific target items (Pradhan & Nagendra, 2008), and have been used in multiple forms, using number strings (Halligan, Wilson & Cockburn, 1990), stars (Lowery, Ragland, Gur, Gur & Moberg, 2004) symbols (Lauer, Gorzewski, Gerlinghoff, Backmund & Zihl, 1999) or letters (Pradhan & Nagendra, 2008). The present study used a letter cancellation task, as it has been shown that they are more sensitive and accurate than some other cancellation tasks (Halligan, Wilson & Cockburn, 1990).

Measures

**Demographics.** Information on age, gender, preferred music genre and musical ability was collected to provide a general background for each participant (see Appendix A).

**The Positive and Negative Affect Schedule – Expanded Form.** The PANAS-X (Watson & Clark, 1999) is a 60-item scale, measuring general negative affect (10 items), general positive affect (10 items), fear (6 items), hostility (6 items), guilt (6 items), sadness (5 items), joviality (8 items), self-assurance (6 items), attentiveness (4 attentiveness), shyness (4 items), fatigue (4 items), serenity (3 items) and surprise (3 items). Each item is rated on a 5-point Likert scale from 1 *(very slightly or not at all)* to 5 *(extremely)*. Reliability for both general positive affect and general negative affect schedule is high, with Cronbach’s alphas between .86 and .90 for positive affect, and between .84 and .87 for negative affect, similar to the original PANAS-X measure (Watson & Clark, 1999). The added sub-categories showed high convergent
correlations, between .85 and .91, with the relevant subscales of the Profile of Moods States (POMS; McNair, Lorr & Droppelman, 1971). It also has less highly correlated subcategories, demonstrating discriminant validity, such that subgroups were distinctly different from one another (Watson & Clark, 1999).

**Awareness and Familiarity of Music.** Awareness of music was measured with three questions, “Were you aware of the music playing in the background during this experiment?” with answer choices of Yes or No. This was followed up by an open-ended question: “What emotion does this music sound like?” Familiarity was measured with a single question, “To what extent you recognize the music that was being played?” with answer choices of 1 (I’ve heard it before), 2 (It sounds vaguely familiar) or 3 (I’ve never heard it before). See Appendix B.

**Guilford’s Alternate Uses test.** Creativity was measured using Guilford’s Alternative Uses test (Guilford et al., 1978). This measure presents participants with a list of well-known objects, along with the primary use of that object, and instructs them to list up to six other uncommon uses for each object in the time allowed. Four minutes are allotted for each of two sections, with each section listing 3 objects. The 6 items are each scored as acceptable, earning 1 point, or unacceptable, earning no point, based on scorer judgment, using a few general rules as guidelines. First, a use must be feasible to be considered acceptable. For example, using a hula hoop as a ring for your finger would be unacceptable. An acceptable use must also be different than the given primary use of the option, and not just a modification it. For example, an unacceptable answer would be stating that an alternate use for a pen is to draw with, when the given primary use was to write with. Finally, vague answers, such as stating an item can be used to reach something or to create something, are considered unacceptable. Total points across both sections make up the participants overall score. For example, participants may be presented with
the word brick (used for building). Expected answers could include: to hit someone on the head, a paperweight, a doorstop, to save water in a toilet tank, to build a house, and/or to throw through a window.

**Six Letter Cancellation Task.** Attention to detail was measured using a six letter cancellation task, created by the author in line with the description in Pradhan and Nagendra (2008). The task consisted of a worksheet containing letters of the alphabet arranged randomly in 22 rows and 14 columns. Participants were given 6 target letters and asked to cancel out as many as they could in 1 minute and 30 seconds. Both the total number of correct and incorrect cancellations were scored, and then incorrect cancellations were deducted from total cancellations to calculate net scores. The present study administered a compilation of 6 worksheets for a total task time of 9 minutes. Total task score is an average of net scores from each worksheet. Test-retest reliability of this measure has been shown to be strong in previous research \( (r = 0.78) \). See Appendix C.

**Design and Procedure**

Informed consent was obtained prior to individuals' participation in this study. Once signed up, participants were randomly assigned to one of two conditions: slow, minor key background music \( (n = 25) \) or upbeat, major key background music \( (n = 27) \). Upon arrival, all participants completed the PANAS-X prior to entering the lab where the survey was set up. This was to record a baseline measure of affect for all participants. Music was playing at 60 decibels in the lab before participants entered to begin the survey, and continued to play on a loop until the participants finished the experiment. On average, participants were exposed to approximately 2.5 loops of the music. Upon entering the lab, participants began with an environmental representation activity similar to that used by Martin, Ward, Achee and Wyer (1993). This
activity did not measure performance, but rather distracted participants while they gained exposure to the background music prior to beginning tasks A and B. Martin et al. (1993) asked participants to draw a map of their college campus as a 1-minute distractor task. While previous research stopped participants after 1 minute, the current study instructed participants to spend 10 minutes on this task to ensure adequate exposure to the music. Participants were first instructed to draw a map of SUNY New Paltz, and then a map of the neighborhood they grew up in as a child to the best of their ability within the 10-minute timeframe. The task did not act as a measure, and as such how much time participants spent on each map was not monitored.

Instructions indicated that participants should focus on accuracy over speed in order to ensure the task lasted for 10 minutes. This task was piloted, ensuring that it lasted up to 10 minutes and did not act as a stressor in any way.

Following the environmental representation task, participants took the PANAS-X again, and then both Task A and Task B, which were counterbalanced across participants to deter order effects. Finally, participants completed a post-task survey, which collected information on awareness and familiarity of background music along with basic demographics. An email is being sent out to debrief all participants. The entire procedure from informed consent to completing the final questionnaire took approximately 45 minutes per participant.

**Results**

A breakdown of descriptive statistics by condition can found in Table 1. Additionally, general descriptive information and inter-correlations can be seen in Table 2. In Hypotheses 1a and 1b, I posited that participants exposed to slow, minor key music would experience a significant increase in sad affect and those exposed to upbeat, major key music would experience a significant increase in jovial effect, respectively. I conducted a pair of 2 (time) x 2 (music condition) split-plot ANOVAs, one for each type of affect to examine these hypotheses. No
significant main effects or interactions were found within sad affect before and after music exposure, contrary to Hypothesis 1a. Contrary to Hypothesis 1b, an initial split-plot ANOVA only indicated a significant main effect of time, $F(1, 50) = 11.80, p < .001$, such that jovial affect after music exposure ($M = 2.59, SD = 0.88$) was significantly lower than jovial affect prior to music exposure ($M = 2.95, SD = 0.90$) across both music conditions. A significant interaction between jovial affect and music condition was not supported. Therefore, music did not influence affect as hypothesized.

According to Hypotheses 2a and 2b, higher sad or jovial affect after music exposure would be positively associated with performance on the detail-oriented task and creative task, respectively. Correlations between Time 2 affect and task performance did not support either hypothesis (see Table 2). Instead, there was a significant correlation in the opposite direction between sad affect ($M = 1.30, SD = .42$) and performance on the detail-oriented task ($M = 36.46, SD = 6.84$), $r = -.39, p < .01$, such that higher sad affect scores as Time 2 were associated with lower scores on the detail-oriented task. Additional correlational findings can be seen in Table 2.

Lastly, Hypotheses 3a and 3b predicted mediation models, such that sad affect would mediate the positive relationship between exposure to slow, minor key music and detail-oriented task performance, and jovial affect would mediate the relationship between exposure to upbeat, major key music and performance on creative task performance. Regression analyses along with 95% bias-corrected confidence intervals generated from a set of 10,000 bootstrap samples were used to test these possible models (Hayes, 2013). Lack of support for earlier hypotheses as mentioned above would seem to discount the presence of a mediator, but Hayes notes that, contrary to past practice in mediation analysis, significant relationships between the three variables are not absolutely required for a mediation effect to be present. Nevertheless, results
did not reveal significant mediation for jovial affect, \( ab = 0.51, \text{BC CI } [-0.70, 0.32] \), or for sad affect, \( ab = 0.00, \text{BC CI } [-1.22, 1.81] \). Sad affect was found to be a significant predictor of detail-oriented task performance, \( b = -6.17, SE = 2.11, p < .01 \), confirming findings from the correlational analyses noted above. However, music did not significantly predict affect, and the mediation model as a whole was not significant. Results testing the jovial affect model found no significant predictors, and the mediation model was also not significant (see Figures 3 and 4).

Because none of the hypothesized relationships were found, I engaged in further exploratory analyses to try to make sense of the data. I began by exploring participants’ perceived emotional content of the background music. Approximately 90.4% of participants perceived the music as sounding either happy, sad, or calm, and as such, these three categories were used to create a new variable called perceived emotional content (See Tables 3 and 4). The purpose of this new variable was to explore the possibility that perceived emotional content of the music may be more important than features such as tempo and key in producing emotion and influencing performance.

Previous analyses were rerun, using perceived emotional content in place of participants’ actual music condition. Split-plot ANOVAs showed similar findings, as there was a significant main effect of jovial affect \( F(1, 44) = 8.34, p < .01 \), such that jovial affect after music exposure \( (M = 2.63, SD = 0.89) \) was significantly lower than jovial affect prior to music exposure \( (M = 2.94, SD = 0.93) \), regardless of perceived emotional content of the music. A significant interaction between jovial affect and music condition was not found. Again, no significant results were found for sad affect.

Because a substantial proportion of participants described the music as calm rather than happy or sad, I explored the impact of music exposure on serene affect. These results provided
some new insight. There was a significant main effect of time $F(1, 44) = 6.80, p < .05$, $\eta^2_{\text{partial}} = .13$, such that serene affect after music exposure ($M = 3.49, SD = 0.89$) was significantly higher than serene affect prior to music exposure ($M = 3.08, SD = 0.91$) regardless of perceived emotional content. This main effect was qualified by a significant interaction between serene affect and the calm perceived emotional content group, $F(2, 44) = 6.28, p < .01$, such that serene affect significantly increased more strongly for participants who reported the music they were exposed to as calming, as compared to other participants (See Figure 5). Finally, new models testing serene affect as a mediator of both detail-oriented and creative task performance showed only that perceived calm music was a predictor of serene affect, $b = .64, SE = .28, p < .05$. No significant indirect effects were found for the detail-oriented task, $ab = 0.02$, BC CI [-1.71, 0.08] or the creative task, $ab = 0.06$, BC CI [-0.43, 1.13].

**Discussion**

The aim of the present study was to identify possible mediation models linking music exposure to task performance through music’s effect upon affect. It was hypothesized that slow, minor key music would induce a sad affect, which would in turn enhance performance on a detail-oriented task, and that upbeat, major key music would induce a jovial affect, which would in turn enhance performance on a creative task. It was therefore suspected that affect, or emotion, would act as the mediator between each type of music and participants’ performance on subsequent tasks. Analyses did not support any of the projected hypotheses, however.

**Limitations and Explorations**

There are a few possible explanations as to why results did not support the current hypotheses, the first being that the small sample size used in this study comprised entirely of psychology undergraduate students. Further, initial analyses, acting as a manipulation check,
showed that the music used did not effectively manipulate mood as intended. Previous research using music as an induction tool primarily used orchestral music (Storbeck & Clore, 2005; Schnall et al., 2008), whereas in the present study, I used flute and piano duets. Krumstahl (1997) found that individuals typically associate happy music with major harmonies and faster tempos and sad music with minor harmonies and slower tempos. As such, it was expected that any music fitting these criteria would suffice to induce happy and sad affect. The purpose of using flute and piano duets was to ensure music in each condition would be as similar as possible, creating differences only in key and tempo. Alternatively, the complexity and varying instrumentation in full orchestral music seemed nearly impossible to match, leaving more possible confounds to manipulate affect. It is possible that simplifying the music made it less salient to participants, and thus less effective in mood induction.

Correlation analyses were used to identify any relationships between current affect and performance on the detail-oriented and creative tasks separately. Contrary to the hypotheses, the only significant relationship that existed was between sad affect and detail-oriented task performance. Further, this relationship was in the opposite direction than was hypothesized, such that higher reports of sad affect were associated with lower scores on the detail-oriented task. Although this task was piloted to ensure it did not prompt any undue stress, perhaps a significant portion of participants found the combination of tasks too tiring, thus having a negative impact on their scores. Alternatively, perhaps students who were feeling sadder, specifically, were more susceptible to be stressed by the cumulative nature of the task. It was also expected that higher jovial affect would be associated with better performance on the creative task. While the association was in the hypothesized direction, it was not significant. The lack of power due to the small sample size likely prevented me from establishing what was a relatively small effect ($r =$}
.09, \( p > .05 \)). Finally, mediation analyses were run to address the hypothesized mediation models as a whole. The sad affect model confirmed the negative relationship between sad affect and detail-oriented task performance, while the jovial affect model showed no significant predictors whatsoever.

Although the proposed hypotheses were not supported, exploratory analyses did provide some enlightening findings. At the end of the study, participants were asked various questions regarding the background music, including an open-ended question allowing them to freely state what they thought the music sounded like. Upon reviewing participants’ answers to this question, approximately 90% of responses were able to be definitively sorted into three significant categories: Sad, Happy, and Calm. As such, perceived emotional content was created as a new variable using these self-selected groups. Initial analyses were rerun to include the serenity subcategory of the PANAS-X to look at calmness, and new analyses were run using perceived emotional content in place of actual music condition. These analyses showed similar main effects and correlations to previous analyses, but included new significant results regarding serenity. First, serenity significantly increased between time 1 and time 2 as a whole across all conditions. Additionally, a significant interaction was found, such that serenity significantly increased in participants who perceived the music as sounding calm.

Taking these new findings into consideration with the music induction phase of the study, we can see a new possible explanation for the failed manipulation. Nearly a third, 28.8\%, of all participants perceived the music as sounding calming, which is a significant deviation from the expected 50/50 split of happy vs. sad to match the actual music condition. We can speculate that perhaps the instrumentation of a flute and piano provides more of a calming sense than anything else, overriding the underlying key and tempo.
Future Research Directions

Although the hypotheses presented by the current study were not supported, the findings, or lack thereof, suggest several directions for future research. First, the failed music manipulation questions previous literature that uses orchestral music for mood induction. The inability for simplistic duets following the typical happy and sad sounding rules may imply one of two things: Krumstahl’s (1997) findings that that we primarily use key and tempo to determine happy versus sad music may not be descriptive enough, or the previous literature is tapping into something other than the key and tempo of the music to induce mood. For example, perhaps instrumentation overpowers key and tempo, such that the tone of a flute is calming in its own sense or perhaps a trumpet might sound jubilant, regardless of key. Orchestral music uses a combination of many instruments, likely disguising their solo tones, instead creating a whole new complex tone. In addition to providing a more complex tone, the complexity of the music as a whole, in terms of notes, tempo, different moving parts, and so on is increased as well.

If orchestration is an underappreciated predictor of emotional impact, this has implications for practice. Individuals and business are commonly known to utilize music for mood induction, whether to get energized to exercise, or make to shoppers happier and more likely to purchase merchandise. Some agencies might even use what we typically classify as elevator music in an attempt to alter peoples’ mood. If the above speculation regarding tone and complexity of music is in fact true, elevator music, which is typically non-orchestral and more simplistic, may be an ineffective tool.

Although previous research has hinted at a positive relationship between sad affect and detail-oriented task performance (Storbeck & Clore, 2011; Schnall et al., 2008), the present findings call such a relationship into question. These previous studies have used more simplistic
manipulation checks, such as a single 7-point scale from ‘very unhappy’ to ‘very happy’ (Storbeck & Clore, 2011) or a range of five schematic faces from a pronounced frown to a strong smile (Schnall et al., 2008). Therefore, these studies may not have been measuring happiness (joviality) and sadness precisely, whereas the present study directly measured these particular kinds of affect. With the close relationship between sadness and depression, existing research regarding depression and task performance can provide useful insight into these discrepant findings. In a review of relevant literature, Austin, Mitchell and Goodwin (2001) found evidence of executive impairment in individuals with depression. More recently, Hershenberg et al. (2016) found that individuals who were depressed exhibited significantly lower motivation to exert effort on a task in which a monetary reward was offered. Taken together with the significant negative relationship between sadness and task performance found in the current study, research suggests that sad affect may not benefit task performance and may actually hinder it. As such, future research should address these competing hypotheses.

Alternatively, perhaps the features of the musical selection are less important than an individual’s perception of its emotional content. While there appears to be a decent consensus on what sounds happy versus sad, the present study found clear evidence that different people can judge the same piece of music as embodying different emotions. The interaction between perceived calm music and feelings of serenity provides tentative preliminary evidence that perception may outweigh the music’s mechanics. Future research should address this concept in a larger sample to see if it still holds true and carries over to other perceived emotions.

Finally, future research should address if and where other emotions fit into Fredrickson’s (2001) broaden-and-build theory. Correlations implied that increased serenity was associated with increased joviality and positive affect in general. However, it was not significantly related
to creative task performance, as was expected with joviality. If the present sample was larger, and the association between jovial affect and creative task performance was significant, it would be expected that serenity may also be associated with a better creative performance.

Overall, the current study was unable to support the hypotheses about the impact of music upon task performance as a function of changes in emotional state. However, it has provided evidence to both challenge previous research and inform future research. Identifying the true mechanisms that influence how we perceive music can have significant benefits to both businesses and individuals wishing to utilize it for mood and performance enhancement. Breaking down general positive and negative affect into more specific emotions might pave the way to help us identify how other less discussed emotions may impact performance on a broader array of tasks.
Appendix A: Demographics

Please answer the following questions as honestly as possible:

1) Please indicate your age: ________________

2) Please indicate your gender
   ___ Male
   ___ Female
   ___ Transgender
   ___ Prefer not to say

3) What genres of music do you prefer? (Rank top 3, with 1 being the genre you prefer the most)
   ___ Classical
   ___ Country
   ___ Pop
   ___ Rock
   ___ R&B
   ___ Hip Hop
   ___ Jazz
   ___ Folk
   ___ Electronic
   Other: ________________

4) Which of the following describes your music experiences (Check all that apply)
   ___ Took private music lessons as a child
   ___ Currently take private music lessons
   ___ Participated in a musical group in school (for 5 years or more)
   ___ Currently participate in a music ensemble
   ___ I actively search for new music to listen to
Appendix B: Awareness and Familiarity of Music

Please answer the following questions regarding the music playing during this experiment.

1) Were you aware of the music playing in the background during this experiment?
   ___ Yes
   ___ No

   If yes, please answer the following questions:

2) What emotion does this music sound like?

3) To what extent did you recognize the music that was being played?
   ___ I've heard it before
   ___ It sounds vaguely familiar
   ___ I've never heard it before
Appendix C: Six-Letter Cancellation Test

**Six-Letter Cancellation Test (1)**

**Target Letters:** A T M S I E

**Directions:** Review the below text and cross off as many of the target letters referenced above as you can in 90 seconds.

J R O G E W T O T T H K D M
I O F B Z I W K K C P Q J X
A U T P X O B K B F N Z P K
D J L S S J O E E V Q O K V
G J Q B S D D V W F K W W O
I L N A M C M C J M R S O D
N O C Q X I D M O Q P W R F
U X W G B H T R X V D Y W K
L D N I W E I Z N G O U K N
F E H B W Q F P C A I E B B
T T L W J T P G D P A G H F
B L Z R W D W H X A I P Q I
G H L P X F T B S J C C G M
R P J B S K F R N A A M G Q
C N M H J Z W E E A V K F D
I Y Z K X M N K L I Y F R H
Z W W W R I U N U L O C D N
S L J L B T E Q E V U O D N
I M G R C R K M N U X I Z L
D L U N R O T I O L C P X G
C R K N I J D Z D G D Z E B
C Y N E T E B T G H R D L Q
Six-Letter Cancellation Test (2)

Target Letters: R X C Z S N

Directions: Review the below text and cross off as many of the target letters referenced above as you can in 90 seconds.

H F L H F S J B S S X S H D
G O O O A Y O V J U H J S J
H G S Q J V T I P F W L Y C
G R P R D D V M Z S X J I T
L M M Y E I G H Q U K Y M W
E D D W I U A H B M F T I W
P U A E I C A N L T Q C A K
I G Z O N K M U L V F A R M
K N G S D I H Y K G N W U G
V E O T V L Y O X E R O G H
U A L U B L S S H F B C H P
T S P B G G I S N L O M K U
C N V P U M O E K N B T X S
W D L U Q Y A W B P E M O B
O Q X U R L G H Z E E B M T
S Q F R J J Y A I S W M D
S C G C N T H Z A Z O U L U
C Q X B N R C D O A I G M J
U W J W K E G B X E X B W E
C R P N I U V Q L Z U S N B
Y V A R L O K C E H K Z T Y
I U D F N L Q V L X J Y P P
Six-Letter Cancellation Test (3)

Target Letters: E W G C F Z

Directions: Review the below text and cross off as many of the target letters referenced above as you can in 90 seconds.

O I P Z M I Z O D D S C W D
V W F D W Z Z J K E D Y J Q
M O U I Q K L H H E V B E W
J F W P M P J Q R J W Y B U
K L P U V W I J E X V V V Y
K D G M H R J K B M L G A D
M X H H I O W V J R R M V I
N P W K C C I J G D B O Q R
N U U J K O Y O T X Q Z U K
L B X C U M X M W G V M F J
M K T C O J U X L Y S C F H
D I B N O Z M H K D N Z M X
M U F C J L A Y B F I S O Z
L W P O C N Q Q K R P D B S
G B W R S W B P I R E H Q D
T L J X S E K R D R S G A E
O V X R S R L H A V J C Y H
X V Y Q J Z C J P W N N P R
D J Q J A Y M P I G K Z K R
W Y R I Z Y O J Z A Z B U R
D A A B U Q Y G Y P Z F G P
Q C E O P X R R S B Y X A S
Six-Letter Cancellation Test (4)

Target Letters: T B H I Y K

Directions: Review the below text and cross off as many of the target letters referenced above as you can in 90 seconds.

A B H A L B N I O Y E B P I
W I C Y J P M B G E L K Y G
I U A B S O T N B R X D J X
H Y S S K K B W F B U R Z Z
P T A Q W C B Y E K V K J V
Q N P M R T B P G K U U R G
K P U K B C U V B Q N K Q G
Y F W J C X A W I H M H V H
G K G V G F B R B M S M P E
A K V L I O J W O Z E Y K C
C J R A M R C O H L Q K B G
G T W V K U Z S I X Y X V W
G Q S W L O E C P M A F S A
K A A C P T P D X H A H O V
Y W U H N P V T I Z Q X T O
S S X S D B H I C N X X H N
G M U J W P X X O I A Q T W
C J I V F D J K K Q D I M Z
O H Y Q E U L Q V U X I K U
V I U Q R Y B Y Q A A D R L
B D V Z W N C I V H H U X E
B Z M F J J E Y B A J S H H
Six-Letter Cancellation Test (5)

Target Letters: E K U L W F

Directions: Review the below text and cross off as many of the target letters referenced above as you can in 90 seconds.

```
F G U T V Z Z F N W Z E A I
Y J H V K S S W G I Y N P P
T Q R J B B J N K F N K F
O A Z X C T H R T N S T N D
Z S Y R A X J K P R I S K B
Y J L D O P G X X A O Q G H
K P V P R M Z F B Z B Z A B
V T K N U S N D I Z T T S S
D S C T S M W M Q W B O C J
W O W T H B Z Y F O N R A F
D Q A Y V L F A O V M U X O
F U F J L R G W W P D E Q I
P D Y R S L C I E Q M M T U
I F S N L P H R E H X N G T
O C L C M U J T M L I H W O
T E N I B P J E Y I I R Z A
W T P N Y Y C G U P X E Z X
Q I Y G R K T S Q H I O N F
C N E E A Y L Z U Q J A B R
E A F P Y B C P T A A Q Z J
F Y K U U K J W O K X L H R
A T K M K M V H S M C K X H
```
Six-Letter Cancellation Test (6)

Target Letters: G P K A T M

Directions: Review the below text and cross off as many of the target letters referenced above as you can in 90 seconds.

V U A L T W E L A D F H V T
W G W R Y E T Z J S B C O I
X O W U A M E V E V X I O X
M A Q P S I E X J A E Z B N
F J Y Y W O R R V W G F D X
J E G T Y R J D Z W Z G Q V
L M M J Z N R O R Q F T I D
E V K N W H P C W F T A F C
W B S H S W B C D Z F N V S
J B N B Q C W P Q V P E S Z
S K T Y S A L W L X I K S T
A H H Z C T S C M R F Z R I
I C Y Q O F C W M T V J W X
Q E F N S W U W T H G I Y G
B E N G O V H O X B B I N L
X J L U A B N G O H N F J S
L J U H M U Z G R L D U V H
I J B A J H X N O K R V Y G
Y W M B Z J J E C O V X S W
V K J X R Q G I W N E S I T
O B A W F E E P W M A D G G
O H M R S S V Z L L I B Y H
Appendix D: Slow/Minor Music Selections

Sonatina, *Andantino Sognando*, by E. Burton, 60bpm, 2:26

Adagio from *Sonata No. 1 in A minor* by J.J. Quantz, 69bpm, 3:05

Allegretto from *Symphony No. 7 in A major*, by L. van Beethoven, 72bpm, 3:00

Flow, *My Tears*, by J. Dowland, 56bpm, 3:30

Solveig’s Song from *Peer Gynt Suite No. 2*, by E. Grieg, 72bpm, 3:30
Appendix E: Fast/Major Music Selections

Allegro from *Sonata No. 5 in C major*, by W.A. Mozart, 108 bpm, 3:00

Allegro from *Sonata No. 4 in C major*, by J.S. Bach, 112 bpm, 2:35

Allegro from *Il pastor fido, Sonata No. 2*, by N. Chedeville, 132 bpm, 3:10

Menuetto I and II from *Sonata No. 5 in C major for violin or flute*, by W.A. Mozart, 126 bpm, 2:30

Menuetto I and II from *Sonata No. 4 in C major*, by J.S. Bach, 128 bpm, 2:30
References


Table 1

*Descriptive Statistics by Experimental Condition*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Upbeat, Major Key Music</th>
<th>Slow, Minor Key Music</th>
</tr>
</thead>
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<tr>
<td></td>
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<td>SD</td>
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<tr>
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<tr>
<td>Detail-Oriented Task Score</td>
<td>35.20</td>
<td>6.56</td>
</tr>
<tr>
<td>Serene Affect Before</td>
<td>3.04</td>
<td>1.07</td>
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<tr>
<td>Serene Affect After</td>
<td>3.51</td>
<td>1.07</td>
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<tr>
<td>Sad Affect Before</td>
<td>1.44</td>
<td>0.53</td>
</tr>
<tr>
<td>Sad Affect After</td>
<td>1.33</td>
<td>0.43</td>
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<tr>
<td>Jovial Affect Before</td>
<td>2.85</td>
<td>1.02</td>
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<tr>
<td>Jovial Affect After</td>
<td>2.61</td>
<td>0.98</td>
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Table 2

Correlations Between Affect and Task Performance

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<th>Measure</th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<td>2. Detail-Oriented Task Score</td>
<td>36.46</td>
<td>6.84</td>
<td>-0.08</td>
<td>-</td>
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<td></td>
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<td>3. Serene Affect (Time 1)</td>
<td>3.08</td>
<td>0.91</td>
<td>0.29*</td>
<td>0.02</td>
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<td></td>
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<td>4. Serene Affect (Time 2)</td>
<td>3.44</td>
<td>0.94</td>
<td>0.03</td>
<td>-0.11</td>
<td>0.14</td>
<td>-</td>
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<tr>
<td>5. Sad Affect (Time 1)</td>
<td>1.40</td>
<td>0.53</td>
<td>-0.06</td>
<td>-0.29*</td>
<td>-0.09</td>
<td>0.14</td>
<td>-</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>6. Sad Affect (Time 2)</td>
<td>1.30</td>
<td>0.42</td>
<td>-0.09</td>
<td>-0.39**</td>
<td>-0.15</td>
<td>-0.31*</td>
<td>0.66**</td>
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<td>7. Jovial Affect (Time1)</td>
<td>2.95</td>
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<td>0.36**</td>
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<td>-0.32*</td>
<td>-0.11</td>
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<td>8. Jovial Affect (Time 2)</td>
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<td>0.02</td>
<td>-0.15</td>
<td>0.63**</td>
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Note: *p<.05, **p<.01
Table 3

*Frequencies for Perceived Emotional Content per Condition*

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<tr>
<th>Perceived Emotional Content</th>
<th>Upbeat, Major Key Music</th>
<th>Slow, Minor Key Music</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percent</td>
<td>Frequency</td>
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<tr>
<td>Happy</td>
<td>18</td>
<td>66.7%</td>
<td>3</td>
</tr>
<tr>
<td>Sad</td>
<td>1</td>
<td>3.7%</td>
<td>10</td>
</tr>
<tr>
<td>Calm</td>
<td>6</td>
<td>22.2%</td>
<td>9</td>
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Table 4

Descriptive Statistics by Perceived Emotional Support

<table>
<thead>
<tr>
<th>Measure</th>
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<th></th>
<th>Sad</th>
<th></th>
<th>Calm</th>
<th></th>
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<tbody>
<tr>
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<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
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<tr>
<td>Serene Affect Time 1</td>
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<td>1.06</td>
<td>3.09</td>
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<td>Sad Affect Time 1</td>
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<td>Sad Affect Time 2</td>
<td>1.30</td>
<td>0.42</td>
<td>1.45</td>
<td>0.50</td>
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<td>Jovial Affect Time 1</td>
<td>3.11</td>
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<td>0.83</td>
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<td>0.96</td>
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<tr>
<td>Jovial Affect Time 2</td>
<td>2.79</td>
<td>0.95</td>
<td>2.56</td>
<td>0.57</td>
<td>2.44</td>
<td>1.00</td>
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</table>
Figure 1. Proposed mediation of detail-oriented task performance.
Figure 2. Proposed mediation of creative task performance.
Figure 3. Mediation of detail-oriented task performance.

Note 1: *p<.05, **p<.01
Note 2: Coefficients in the present model are unstandardized.
Figure 4. Mediation of creative task performance.

Note1: *p<.05, **p<.01
Note2: Coefficients in the present model are unstandardized.
Figure 5: Interaction between perceived emotional content and serenity scores.