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The Melody of Spatial Memory

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Abstract

Music has been studied extensively in psychology, including research on musically-induced emotion. However, the project reported here looked at new effects of musically-induced emotions on spatial memory. Trochidis and Bigand (2013) established that music and emotions are associated. Music of a major mode, or an Ionian mode, is usually associated with positive emotions. Music of minor modes, such the Locrian or Aoelian modes, are associated with negative emotions. These associations with the specific modes are seen by the lowering of the third and sixth scale tones.

Participants for the present study completed a spatial memory task (called the "Tower of Hanoi") while listening to music of different valences (found in previous research to create feelings of positive and negative emotions). Participants completed the task both with and without music playing. Following completion of the tasks, participants reported on emotional state using the Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988). I hypothesized that those who listened to the positive-valanced music while completing the spatial task would perform better (i.e., faster) than those who listened to the negative-valanced music. Results found were not significant when looking at the tower scores and music valence, however data was indicative of supporting my hypothesis. An interaction was found where participants generally reported that mood score on the PANAS decreased, regardless of the induced mood (positive- or negative-valenced) after working on the spatial memory task. This result appears to be related to the inability to complete the task or the length of time needed to complete the task.

Acknowledgements

First to Shelbie Weightman who assisted with data collection: thank you so much for your assistance and time put into this project! Thank you also to the friends and family who supported me on my journey, not only of this thesis, but also to where I am. The biggest thank you goes to Dr. Davis for being my advisor for this thesis. Without her support I would not have been able to see this to the success it was.

Table of Contents

The Melody of Spatial Memory

Music, though extensively studied in psychology, is often a part of our day that fades into the background. When considering how music affects performance it is often looked at using music and verbal memory (Palisson, Roussel-Baclet, Maillet, Belin, Ankri, & Narme, 2015) or autobiographical memory (Belfi, Karlan, & Tranel, 2016). For example, Jänke, Brügger, Brummer, Scherrer, & Alahmadi (2014) found that background music affected no improvement in verbal learning, despite the popular myth that music can help one learn better. Jänke and colleagues found that some music, particularly music with vocals, actually decreased learning, possibly due to the interruptions in learning produced by the vocals. To look at a different kind of memory from those more commonly studied with music, the present study looked at spatial memory. Specifically, this study examined emotions induced by music and their effect on spatial memory.

Ekman and Cordaro (2011) defined seven universal emotions: happiness, sadness, fear, anger, surprise, disgust, and contempt. These differ from other emotions, such as embarrassment or pride, because they are discrete and basic. The present study focused on two of these emotions, happiness and sadness. Happiness was defined by Ekman and Cordaro as a feeling that is enjoyed or sought out by a person. Sadness is defined as the response to the loss of something to which a person is very attached. For the purposes of the present study, music that is happy is defined as positive-valenced and music that is sad is defined as negative-valenced.

There are characteristics of music associated with valence. Music of a minor mode is generally associated with feelings of sadness while music of a major mode is generally associated with feelings of happiness (Trochidis & Bigand, 2013). Minor mode

is created in music by the lowering of specific scale tones, such as the third and the sixth tone. Major mode could be considered music in the Ionian mode, or the natural diatonic scale. Tempo also affects what emotion a piece of music is perceived as portraying (Trochidis & Bigand, 2013). Faster tempi are associated with feelings of happiness and anger. Slower tempi are associated with feelings of sadness and serenity. Feelings of happiness are created when music is a fast tempo and a major mode. Feelings of sadness are created when music is a slow tempo and a minor mode (Gagnon & Peretz, 2003).

To look more specifically at music and memory, older adults have a lower recognition rate for the music than younger adults when listening to different melodies (Narme, Peretz, Strub, & Ergis, 2016). However, positive melodies were better remembered than negative ones and higher-arousing melodies more easily than lower-arousing ones. In terms of spatial memory, participants in a positive-valence music group performed better on some visuospatial tasks than those in negative- or neutral-valence music groups (Palmiero, Nori, Rogolino, D'amico, & Piccardi, 2016). There were also some sex differences demonstrated such that men outperformed women in some conditions, such as the negative music condition. The present study looked specifically at whether musically-induced emotions would have an effect on spatial memory task performance. It was hypothesized that those in a positive-valence music group would outperform (i.e., finish faster) than those in a negative-valence music group, similar to the results demonstrated by Palmiero and colleagues.

Method

Participants

This study was comprised of 15 University of Dayton students. All were between the ages of 18-22. Five were male and ten were female. Students were recruited from both cognitive psychology classes and university choir classes.

Materials

Music Lists. Important to this study were the musical selections. Chosen from a list of previously valenced music from Västfjäll (2002), two playlists were created: one for positive valenced music and one for negative valenced music. (See Appendix A for a list of song selections.) An example of a positive-valenced song is *Yellow Submarine* (The Beatles, 1968), and an example of a negative-valenced song is *Sometimes it Snows in April* (Prince, 2002).

Demographic Questionnaire. A demographic questionnaire was used which asked questions regarding participants' age, year in school, and sex.

Personality Questionnaire. The Positive and Negative Affect Scale (PANAS; Watson, Tellegen, & Clark, 1988) was selected to measure the mood of the participants both before and after they completed the spatial memory task. This questionnaire uses a Likert-type scale to measure positive and negative affect of participants. As can be seen in Appendix B, the PANAS uses 20 affective descriptors of emotions to measure emotional state of an individual. Different time descriptors may be applied such as "in the moment" or "this week". Examples of positive affect items include "interested",

"strong", and "proud". Examples of negative affect items include "upset", "irritable", and "nervous".

Music Questionnaire. A music experience questionnaire (Appendix C) was used to identify whether participants had formal musical training (e.g., choral or band classes, music lessons) how many years of formal training, how many hours, on average, the participants believed they listened to music, and which type of music of a provided selection was the favored type.

Spatial Task. The selected spatial memory task was the Tower of Hanoi (Williams, 1998). This task requires participants to systematically move disks from one tower to the tower on the other end of a platform holding three towers. Certain moves are not allowed, such as putting a larger disk on top of a smaller one or moving two disks at a time.

Spatial Task Post-Performance Questionnaire. This final questionnaire was an exit questionnaire regarding the spatial memory task. This questionnaire included questions asking if the participant completed the task, if they had any challenges with the task, and if music facilitated or hindered work on the task.

Procedure

Participants first completed an informed consent. This was followed by the completion of the PANAS (Watson et al., 1988) to gauge an initial mood. Participants were asked to complete the PANAS (Watson et al.) for how they felt in the present moment. Following the PANAS (Watson et al.), participants were given 25 minutes to complete the Tower of Hanoi without music playing. Either at the completion of the task

or at the end of the 25 minutes participants were asked to reset the tower at the opposite side of the platform. This was done to help reduce practice effects. Participants would complete the task first going right to left then complete it left to right, or vice versa. Music was played before the second attempt at the task began. The music was either positive or negative valence depending on the condition the participants were assigned to, and continued through the second attempt at completing the Tower of Hanoi. Participants were given another 25 minutes to complete the tower with the music playing. Either at the completion of the task, or at the end of the given period of time, participants were asked to complete the PANAS (Watson et al.) a second time while music was still playing to determine if mood had changed. For those in the negative valence music condition, positive valence music was then played to induce a positive mood. Following the second Tower of Hanoi task, all participants completed the Tower Puzzle Exit Questionnaire, Demographic Questionnaire, and Music Experience Questionnaire, were debriefed, thanked, and dismissed.

Results

Primary dependent variables looked at were completion time and PANAS score, both for potential effects of valence of music heard. It is important to note that while only some analyses produced statistically significant results, the relationships between the means were such as to indicate that further research could produce promising results consistent with the hypotheses for this research. Figure 1 reports the mean time of completion for the Tower of Hanoi task according to the valence of the music. Worth noting is the decrease in time it took for participants to complete the task while music was playing in both the negative valence condition (before music: M = 1361.16, SD = 269.21; after music: M = 1284.29, SD = 370.74) and the positive valence condition (before music: M = 1389.75, SD = 212.74; after music: M = 1303.33, SD = 381.04). A 2 (tower score) x 2 (music valence: positive and negative) mixed factors ANOVA was conducted to look at these results and, as previously stated, no significant results were found for either an interaction (tower score x music valence; $F(1,13) = .003$, $p > .05$) or music valence, ($F(1,13) = .032$, $p > .05$) factors.

However, as can be seen in Figure 2 is what appears to be an interaction between PANAS score and music valence. A second 2 (time of PANAS administration: before and after the task) x 2 (music valence: positive and negative) mixed factors ANOVA confirmed the interaction, $F(1, 13) = 4.689$, $p = .05$),), but found no additional statistically significant results for time of PANAS administration, $F(1, 13) < 1.0$, $p > .05$. On the other hand, there was a significant effect of music valence, $F(1, 13) = 6.858$, p = .05). Of interest is the mean difference in scores for before and after the music. Though expected for the negative music condition to increase (before music: M = 14.286, SD =

3.498; after music: *M* = 17.857, *SD* = 8.112) showing a more negative mood, the positive condition decreased (before music: *M* = 25.625, *SD* = 6.589; after music: *M* = 20.125, *SD* = 6.642) also showing a decrease in mood.

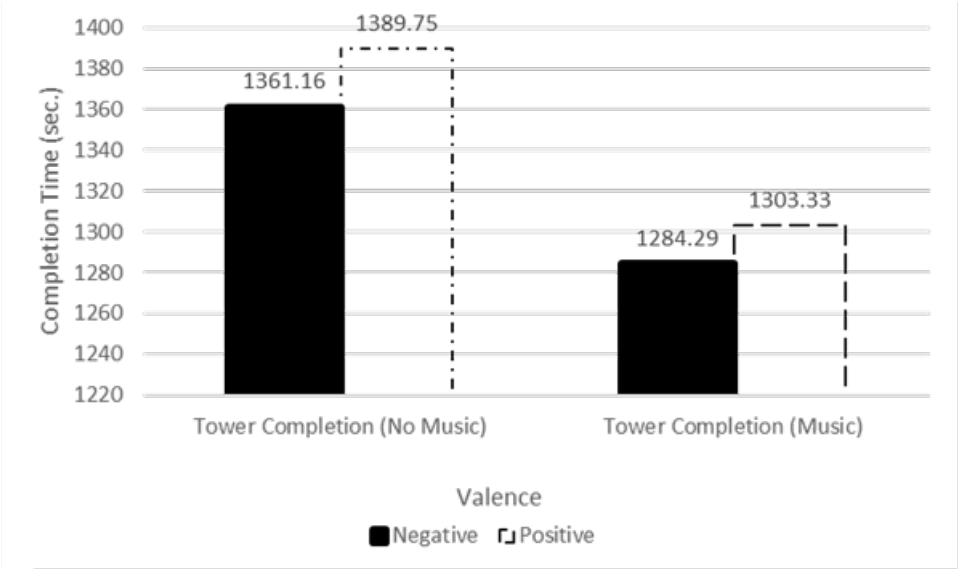

Figure 1. Mean completion time for the spatial memory task by valence of music heard

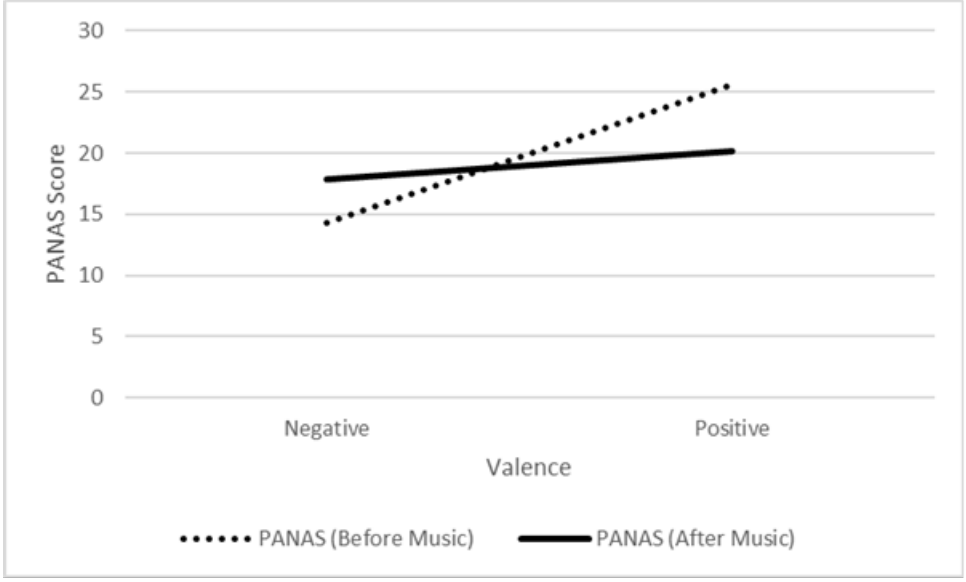

Figure 2. Mean PANAS score by valence of music heard

Discussion

When looking at the results evaluating a possible interaction between PANAS scores and music valence, there is a suggestion that mood always decreases after the completion of the spatial memory task. This could be because of the number of participants who were unable to complete the Tower of Hanoi. A study performed using patients with depression found that those with depression performed significantly worse on a spatial memory task (Gould, Holmes, Fantie, Luckenbaugh, Pine, Gould, Burgess, Manji, & Zatate Jr., 2007). Though the present study did not ask about depression, it did consider negative affect. One could expect that being unable to complete the spatial memory task would increase negative affect, causing a decrease in overall mood, even if the participant was listening to positive-valenced music.

Analyses indicated that positive valence music elicits a stronger mood, such that positive valence music is better in creating a positive mood than negative valence music is in creating a negative mood. Positive valence music is also associated with a shorter completion time on the Tower of Hanoi task. As mood increased, time decreased and as mood decreased, time increased. This evidence supported my initial hypothesis, which was that those in a positive-valenced music condition would outperform those in a negative-valenced music condition on the spatial memory task.

There were some limitations to this study. One is the equipment failure of physiological monitors, experienced both prior to the beginning of the study and, again, once the study was being run. There were also procedural problems with the spatial task, and the questionnaires. Prior to the start of the study there was experimentation with physiological monitors, such as heart rate monitors, to gauge emotion. These were

unable to be used due to an inability to find a data transfer application program that was reliable. In addition, once the study began, it became apparent that the Tower of Hanoi puzzles selected wore down easily. The pegs would often fall out in the middle of the task and would have to be fixed, making participants' completion times longer.

There were also a few issues regarding questionnaires. The Tower Puzzle Questionnaire was not administered to all the participants. The questionnaire was used beginning about halfway through the experiment. Answers received from the questionnaire were helpful in understanding participants' experience with the task, and it became clear that the questionnaire should have been used from the beginning of the experiment. Another point to make is that no question was asked regarding participants' major in school. A diverse group of participants were recruited for this study, and it seemed that some majors were outperforming others on the spatial memory task, but without actually asking the question, this information could not be known.

Future directions for this research should include a more balanced study that looks at gender differences in spatial memory with music. Palmiero and colleagues (2016) found that men outperformed women in some spatial memory tasks while in a negative valence music condition. While no significant differences were found for positive valence music, this difference in negative valence music should be explored further. Differences in tempo should also be examined. Trochidis and Bigand (2013) found that music of varying tempi affected which emotion is perceived in that music. One of their results was that faster music is associated with feelings of happiness and anger, while slower music is associated with feelings of sadness and serenity. Gannon and Peretz (2003) found that tempo plays a larger role than mode in determining the emotion

associated with a piece of music. The present study focused on mode to create emotion. To move this research topic further, conditions may be made consisting of differing tempi and valence in order to elicit four emotions instead of two.

More work is still to be done on this topic to determine if musically-induced emotions actually impact spatial memory task performance. Although little data is significant as of yet, much of it is in the direction towards supporting the hypothesis that positive music helps performance on spatial memory tasks. Further research exploring not only the initial topic, but also considering other factors such as tempo or gender should be looked into to help solidify the results found here, as well as to expand on the topic.

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Appendix A

Musical Selections for Positive and Negative Music Conditions

Musical Piece	Artist (Release Date)
Positive	
Ob-la-di Ob-la-da	The Beatles (1968)
Taking Care of Business	Bachman-Turner Overdrive (1973)
The Good Life	Tim Weisberg (1975)
Yellow Submarine	The Beatles (1968)
Gonna Fly Now (Theme from Rocky)	Bill Conti (1976)
Negative	
I Can't Make You Love Me	Bonnie Raitt (1991)
I Can't Tell You Why	Eagles (1979)
Sometimes it Snows in April	Prince (2002)
Blue Eyes Crying in the Rain	Willie Nelson (1975)

Appendix B

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to the word. Indicate to what extent you feel this way right now, that is at the present moment. Use the following scale to record your answers.

1	2	3	4	5
Very slightly, or not at all	a little	moderately	quite a bit	extremely

_____ interested	_____ irritable
_____ distressed	_____ alert
_____ excited	_____ ashamed
_____ upset	_____ inspired
_____ strong	_____ nervous
_____ guilty	_____ determined
_____ scared	_____ attentive
_____ hostile	_____ jittery
_____ enthusiastic	_____ active
_____ proud	_____ afraid

Appendix C

Musical Experience Inventory

Have you ever had musical training (e.g., Musical lessons, choral or band classes)?
Yes ____ No ____

If so, for how many years? _____

On average, how many hours a week do you spend listening to music? _____

Of the genres listed below, which is the genre of music you listen to most often?

(circle one) Pop Country Rock Indie Classical