The Inside Out of Music: An Exploration of Music, Mind, and Emotion

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Abstract

The purpose of this study was to better explain the power of music as a physical form of expression through signals from the body and mind. Participants of this study experienced both memory-based emotional reactions and emotional reactions not linked to specific memories when listening to the selected music. It was hypothesized that participants would have a different level of physical reaction when memories were evoked than when there were no conscious memories when listening to the music. Another hypothesis was that participants would exhibit a greater physical reaction when they experienced some emotions over others, specifically fear and sadness. It is reasonable to believe that the intensity of an emotional reaction, as measured by physical changes of arousal, would be affected by the type of cognitive processing involved. Results supported the second hypothesis. The greatest physiological changes were seen when participants were listening to a musical piece which correlated with the emotion of fear. However, evoked memory was not related to emotional experience.

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Music has been known to have immediate effects on the body and the mind and can be used for therapeutic or medicinal purposes. For example, a pair of researchers studied the effects of music's role in managing pain tolerance, in which patients self-selected music that induced emotions to assist in relaxation. They concluded that pain was managed more efficiently when patients listened to happy and relaxing music, rather than when they were not listening to any music (Finlay & Krithika, 2016). Research has been done on the relationships between music and emotion in such disciplines as psychology, medicine, and the arts, potentially making advancements in applied practice. In a study called "Emotional recognition based on physiological changes in music listening," researchers similarly tested the body's reaction to music because facial expressions and speech were not considered to be as precise indicators of physiological change as skin conductivity, respiration changes, and electromyogram and electrocardiogram measurements. The study showed that examining the body as a whole increased accuracy for emotional recognition. (Kim & André, 2008). In reference to Finlay's and Krithika's study, research suggests that clinical studies can provide new information and methods that allow music to be used beneficially in the non-clinical setting too. This group of studies demonstrates the opportunities that research presents for the possibilities for music, thus expanding its many advantageous properties among various fields of study.

Music is in our daily lives, whether we are active or passive listeners. As part of the human condition, people experience mixed emotions in response to the environment, and music has a direct effect on such emotions. This study was designed to better explain the power of music as expression and how it can be impactful on the body and mind by evoking both positive and negative reactions. Studies around this topic have been performed for many years,

identifying the psychological links between music and emotion. These types of studies analyze the different functions of the brain and how peoples' responses to music can be affected by their genetics, social cultures, and aesthetics (Zakrzewski, 2014).

In addition, music may trigger emotions due to specific memories, involving cognitive processes that form a logic around the emotional experience. In 1962, Schachter and Singer theorized that emotion involves both physical arousal and cognitive labels for the arousal. In their theory, similar to a theory by William James and Lange (Cherry, 2017 b), once physiological arousal occurs, the mind seeks a cognitive label with which to identify the arousal (Cherry, 2017a). Other psychologists have theorized that the cognitive and physical reactions occur simultaneously when an emotion evoking event occurs (Cherry, 2017c). Based on these theories, it is reasonable to believe that the intensity of an emotional reaction, as measured by physical changes of arousal, will be affected by the type of cognitive processing involved. Therefore, the first hypothesis of the current study was that participants would have a different level of physical reaction when memories were evoked than when there were no conscious memories when listening to the music. Another hypothesis was that participants would exhibit a greater physical reaction when they experienced some emotions over others. It was believed that for this study, fear and sadness would be rated as the emotions that were felt most intensely by the participants because of the more "extreme" musical qualities that evoke those two emotions.

Method

Participants

In this study, there was a total of 20 participants, all of which are currently students at Ramapo College of New Jersey. Males, females, and non-gender conforming people were all welcomed to participate. By the end of the experimental stage, there were sixteen females and

three males who participated in this study. The participants ranged in age from 18 to 22 years old. This study was also open to all racial identities, which featured participants of white, black or African American, Asian, and Hispanic or Latino backgrounds. Introduction to Psychology students received academic credit for their involvement, but no other form of compensation was granted to participants that were not enrolled in the psychology class. Students were openly approached online on the school's study pool page, where this study was posted and offered slots for students to sign up to participate. There was no requirement for a specific academic major, so it is assumed that participants ranged in fields of study, as well as academic year from freshman to senior. Lastly, two students acted as readers for the polygraph chart on the laptop and recorded the data for me, one of which participated in the study itself prior to their involvement as a reader to ensure that their participation was uninformed and unbiased.

Materials

Materials included a Lafayette Instruments Polygraph Model LX5000. The measures from the polygraph included two respiration measures, called a Thoracic Respiration sensor, a GSR (galvanic skin response) measure, and a plethysmograph (measure of blood flow in the finger) (See Figures 1, 2, and 3 in Appendix A). The equipment was plugged into a laptop and was sanitized after each use with Stop and Shop brand non-toxic disinfectant wipes. The study included a pre-determined selection of five pieces of orchestral music, along with a practice piece not included in the actual survey titled "Piano Sonata No. 16 in C Major" by Mozart. The five tested pieces were "d. Trepak—Russian Dance" (from *The Nutcracker Suite*) by Tchaikovsky, Schoenberg's "6 Little Piano Pieces—Op.19 Liecht, Zart," Samuel Barber's "Adagio for Strings," Rupert Gregson-Williams' "Wonder Woman's Wrath" (from the 2017 film *Wonder Woman*), and Joseph Bishara's "he's looking at us" (from the 2011 horror film

Insidious). Orchestral music was chosen because it does not feature lyrics, which would create a bias because lyrics can indicate the mood of a song, which may persuade participants on how they should feel, rather than allowing them to answer unbiasedly. Each musical piece selected for this study is based off of one of five common human emotions: happiness, fear, sadness, anger, and disgust. The musical selections were chosen based on the embodied and designated meaning theory, meaning the music itself (melody, harmony, timbre, etc.) had an implied meaning that evokes a specific emotion in listeners. The music was played to participants through Sony ZX110 noise cancelling headphones that were connected to a 2017 MacBook Pro laptop, using the streaming service Spotify. Each selection was played for about one minute for each of the five musical pieces. Before their participation in the study, participants were given a consent form (see Appendix B), which they were instructed to read and sign, followed by a debriefing at the end of the study. The consent form presented the optional use of the polygraph equipment and detailed any risks that were possible for the duration of the experimental stage.

Two types of surveys were distributed to participants during this study. The first survey was administered to the first fifteen participants, who were all asked to rate each musical piece's emotional quality on a scale from one to ten in terms of emotional cues that were provided, such as "not at all happy" to "extremely happy." Participants were also asked if any piece was familiar to them or evoked a specific memory in their life. There were three different counterbalanced orders in which the musical pieces were presented and thus three versions of the survey (see Appendix C for Group 1 survey, Appendix D for Group 2 survey, and Appendix E for Group 3 survey). The second survey was administered to the remaining five participants and featured a similar layout but omitted any emotional cues by rating each piece on a scale from one to ten of "not at all emotional" to "extremely emotional." They were asked the same questions about

familiarity and memories as the first set of participants (see Appendix F for Group 1A survey). Participants were divided into three groups based on three pre-determined orders that the musical pieces were presented in. The participants were not told the titles, composers, or the order of the pieces prior to their participation in the experiment. Lastly, the polygraph readers inserted the data from the physical measures recorded by the laptop onto a paper chart, categorized by breathing, blood pressure, and GSR movements; this was only used for Groups 1 and 2 (see Appendix G for polygraph chart).

Procedure

First, the experiment was prepared for by setting up a laptop and polygraph equipment, which includes the GSR, PL, and breathing modules. Each of these measures was set at a value of 1.0 in the polygraph program to ensure that they were visible and could be read by the polygraph reader. An anonymous profile was created in the polygraph program for each participant to record their physical measurements if they chose to use the equipment. When the equipment was properly connected and showed signal on the laptop, another laptop containing the Spotify music playlist was opened, and the headphones were connected to that laptop at a standard volume level. At this point, preparation for participants was complete. When participants arrived, they were given a consent form that stated the option of whether or not they would like to have their physical measurements taken. If participants chose not to be physically recorded, they underwent the experiment by listening to each of the five pre-selected pieces of music over headphones and only recorded their answers on the survey provided between each piece. If participants chose to have their physical measurements recorded, two respiration measures, a GSR (galvanic skin response) measure, and a plethysmograph were placed on each participant. After the equipment was in place, participants were given the headphones listened to

each of the pre-selected pieces of music. Before the actual experiment began, the "practice" piece was played to test the equipment and make sure the participant was comfortable. After each piece of music finished playing, the participant rated their level of emotion for each piece on the scale provided and answered two open-ended questions regarding their reactions. As mentioned, all participants were debriefed as to the purpose of the study. The musical selections were not pre-tested for emotional responses with the expected results, which could have greatly altered the results since music and emotion varies greatly across individuals. However, the first fifteen participants of the study were asked to rate their emotional response on a scale from one to ten of the assumed emotion. For example, the piece from *The Nutcracker* was assumed to evoke happiness, so participants only rated that piece on a scale from one to ten on how happy the song made them feel. The second survey, which Group 1A was assigned, was unbiased and allowed participants to answer on the general level of emotion, rather than an assigned emotion. The total time to test each participant was between 20 and 25 minutes, and participants had about thirty second intervals between each musical piece to record their answers and return to a "normal," resting state. Equipment was also sanitized between each use of participants. After the data was written on the polygraph chart and collected on the survey from the participant, the participant profile on the laptop was deleted to ensure anonymity. All data on paper was locked away safely in a locked closet that is only accessible by faculty in the department, and consent forms and surveys were kept separately to also ensure anonymity. After each experimental session was finished, the equipment and laptop were packed away and locked in the closet as well.

Results

The results from this study were recorded on the paper surveys that were distributed to and completed by each participant. Overall, the final results from the experiment supported one of the hypotheses that were being tested, which were that fear and sadness would be among the highest scoring emotions that were felt during the music listening and that participants experienced different levels of physical reactions when there was a memory evoked by the music, as compared to when there was not a memory evoked.

With studies such as this, it is important to analyze the data to make conclusions, but also review the experimental design and process as a whole to make suggestions of how this type of music-related psychology study can be improved in the future. Based on the results from this particular study, there were a few factors that could be improved if this experiment is to be replicated, repeated, or modified. For one, the greatest element that affected the overall results were the two different types of surveys. Although the first survey was designed a certain way, it was distributed and conducted in an alternative fashion that was not necessarily intended by its original purpose and design. Each participant was meant to rate all of the emotions for each musical piece, rather than one emotional cued scale for a specific piece. For example, for the piece from *The Nutcracker*, participants were asked to rate the emotional intensity on a scale from “not at all happy” to “extremely happy.” However, it was intended that they also rated the piece on scales of anger, sadness, fear, and disgust. Simple miscommunications can cause an experiment to have varying results, as seen by the results from the recreated version of the survey with the last five participants (Group 1A) of this study whose highest scoring emotion was sadness, rather than happiness like Groups 1, 2, and 3. For the future, this study could rely on one survey that is designed and distributed to fulfill its given intentions without any error or miscommunications between researchers. It would also be beneficial to test a larger sample size

with the polygraph and surveys, as a greater sample size will yield more specific and varying data. It was more difficult to retrieve conclusive results from Group 1A since there were only five participants, but if this study was to be repeated in the future, the unbiased and completely subjective nature of the second survey could reveal intriguing results that show more accurate or telling results, as well as more comparable results in comparison and difference to Groups 1, 2, and 3. Although there were limitations for the sample size due to weather and time constraints, the results have still been conclusive for the purpose of this study.

The data in the tables below are input from each participant's response to the survey and polygraph chart, depending on which participant group they were in. Physiological data recorded indicated whether there was a change in the participant's physical reactions from the resting state pattern for each piece of music. Data for blood flow (PL) and GSR are included. The indicated values for these measures are as follow: 'e' is for expanded, 'c' is for contracted, 'u' is for increased, and 'd' is for decreased. There is also data that combines two of these inputs, as indicated by a '+.' Anywhere on the tables that a '-' appears indicates that the participant was not recorded by the polygraph. The number under each emotion indicates the rating from one to ten that the participant chose to indicate how much of the particular emotion that he or she felt during the piece that they heard (See Figures 4, 5, and 6 below).

S#	Any memories?	fear	anger	sad	disgust	happy	PL1	GSR1	PL2	GSR2	PL3	GSR3	PL4	GSR4	PL5	GSR5	Music 1 = Afraid
1	yes	6	5	7	1	8	e+c	u+d	no change	d	e	d	e	d	n/a	n/a	Music 2= Angry
2	no	7	3	5	5	9	no change	u+d	no change	u+d	no change	u+d	no change	u+d	no change	n/a	Music 3 = Sad
3	yes	9	2	5	5	9	e	n/a	unclear	n/a	e	n/a	e	n/a	e+c	n/a	Music 4 = Disgusted
S#	Any memories?	happy	disgust	afraid	angry	sad	PL1	GSR1	PL2	GSR2	PL3	GSR3	PL4	GSR4	PL5	GSR5	Music 1 = Happy

Figure 4. The raw data for Group 1.

S#	Any memories?	happy	disgust	afraid	angry	sad	PL1	GSR1	PL2	GSR2	PL3	GSR3	PL4	GSR4	PL5	GSR5	Music 1 = Happy
1	yes	8	6	7	3	5	e	u	e	u + d	no change	u + d	no change	d	e + c	u + d	Music 2= Disgust
2	yes	3	6	7	0	2	no change	u + d	no change	d	c	u + d	no change	d	no change	d	Music 3 = Afraid
3	yes	6	6	0	0	3	e	u +d	c	u + d	e + c	u + d	e	u + d	e + c	u + d	Music 4 = Angry
4	yes	6	1	4	0	1	no change	u + d	no change	u + d	c	u	c	d	c	d	Music 5 = Sad
5	yes	6	3	4	1	5	no change	no change	no change	no change	c	no change	no change	no change	no change	u + d	
6	no	7	0	7	3	4	-	-	-	-	-	-	-	-	-	-	

Figure 5. The raw data for Group 2.

S#	Any memories?	sad	angry	happy	disgusted	afraid	PL1	GSR1	PL2	GSR2	PL3	GSR3	PL4	GSR4	PL5	GSR5	Music 1 = Sad
1	no	1	1	8	0	10	-	-	-	-	-	-	-	-	-	-	Music 2= Angry
2	yes	8	6	9	3	8	-	-	-	-	-	-	-	-	-	-	Music 3 = Happy
3	yes	7	9	10	2	10	-	-	-	-	-	-	-	-	-	-	Music 4 = Disgusted
4	no	7	5	9	1	6	-	-	-	-	-	-	-	-	-	-	Music 5 = Afraid
5	yes	4	0	4	5	2	-	-	-	-	-	-	-	-	-	-	
6	yes	8	6	9	3	7	-	-	-	-	-	-	-	-	-	-	

Figure 6. The raw data for Group 3.

For example, the first participant in Group 1 (S#1) had memories that he or she associated with one or more of the musical pieces. They rated each emotion with the number that describes the emotional intensity of each piece. For the first piece of music that he or she heard, they rated the amount of fear they felt a 6 out of 10, and the polygraph showed that his or her blood flow expanded and contracted, while the galvanic skin response (the amount of sweat under his or her skin) moved both increased and decreased while listening to the music. The breathing measurement is not shown on the tables because a majority of the results were stable breathing, which did not indicate any clear effects from the music. The order of the musical pieces is shown on the far right of the figures. Since Group 1 was the first group of participants to be tested, there were only three slots scheduled in case errors were to occur during the first round of testing.

The results from Group 1 showed that out of all three of the participants, the highest scoring emotion from the pieces that they listened to was happiness, and secondly, fear. In terms of the original hypothesis that sadness and fear would be the highest scoring emotions, one of the two emotions that was thought to be felt the most, fear, was one of the top two emotions felt in Group 1. The average physical response to fear and happiness in this table shows that there was a greater response to the music shown by the participants' GSRs.

The data in the table in Figure 5 shows the raw data for Group 2, which features a different order of musical pieces than Group 1. This group also had double the number of participants, which allowed for a greater range of results in terms of memory, emotion, and physical reactions to the music. Interestingly enough, all but one of the participants had a memory related to one or more of the musical pieces played to them. Since all of these pieces are purely instrumental, meaning they lack lyrics and singing, the brain searched through its

expansive catalog of memories spanning over each person's entire life up to the point of them hearing the music during this study, and chose a specific time frame or memory triggered by something in the music itself. It can be argued that it is more challenging to think of a specific memory when listening to an instrumental piece as opposed to a song with lyrics, but it seems the participants in Group 2 felt something specific and naturally related to the music in a way that is not forced.

Similar to Group 1's results, Group 2 experienced the highest score of emotions for happiness and fear. First, they showed a mean score of 6.00 for happiness, and second, a mean score of 4.83 for fear. Overall, the participants had a greater physical reaction to the music as shown by the GSR measurements, rather than the plethysmograph measurements (blood flow). For both happiness and fear, a majority of participants showed a combination of contrasting reactions, such as expanding and contracting blood flow and varying sweat levels.

In Group 3, there were no polygraph readers that were available during the scheduled time slots, so the study went on by using just the music and the survey without any of the polygraph equipment. In the table in Figure 6, the participants provided data based on whether or not they experienced any emotions while listening to the music and the score of emotional intensity that they rated each musical piece. On the far right of the table, the order of the music played to the participants is listed, which contrasts from Groups 1 and 2. Group 3 had the same number of participants as Group 2, both of which were double the amount of participants in Group 1, which allowed for more varying results than at the start of the experimental stage.

In Group 3, a majority of the participants wrote they experienced a memory when listening to the music, similar to the results of Groups 1 and 2. Again, happiness scored as the highest emotion with a mean score of 8.16, and fear was second with a mean score of 7.16. Even

though there was no data recorded by the polygraph for this group, the results show that the highest-ranking emotions were consistent with the previous groups that were tested using the polygraph. Also, Group 3 is the only group to feature emotional ratings of a 10 for the scoring of emotions, which were for happiness and fear.

The table shown in Figure 7 indicates how the results compared when arranged by music type collapsed across Groups. The total number of participants that were in Groups 1, 2, and 3 was fifteen; fourteen were females and one was a male. The first part of the data shows the total number of yes' and no's of whether or not each participant had a memory when listening to the music. According to the data, eleven people had memories while four did not. The next set of data shows the mean score of the numerical ratings for the intensity of each emotion felt by all participants and asks whether or not the participants associated the emotion cued by the survey with the music itself, based on a mean score of above or below five.

The mean data indicate that a majority of the participants only associated happiness and fear with the musical pieces selected for those two emotions since both mean scores are above five. On the other hand, disgust, anger, and sadness did not have a mean score of above five, so participants did not associate their own emotions with the expected emotions for those pieces. The rest of the data shows the average physical reactions for each musical piece.

Memories?	Ratings for Sad/ Sad music	Ratings for Happy/ happy music	Ratings for Angry/ angry music	Ratings for Fear/ fear music	Ratings for Disgust/ disgust music	PL Fear	GSR Fear	PL Anger	GSR Anger	PL sad	GSR sad	PL Disgust	GSR Disgust	PL Happy	GSR Happy
no	1	8	1	10	0	-	-	-	-	-	-	-	-	-	-
yes	8	9	6	8	3	-	-	-	-	-	-	-	-	-	-
yes	7	10	9	10	2	-	-	-	-	-	-	-	-	-	-
no	7	9	5	6	1	-	-	-	-	-	-	-	-	-	-
yes	4	4	0	2	5	-	-	-	-	-	-	-	-	-	-
yes	8	9	6	7	3	-	-	-	-	-	-	-	-	-	-
yes	7	8	5	6	1	e + c	u + d	no change	d	e	d	e	d	n/a	n/a
no	5	9	3	7	5	no change	u + d	no change	u + d	no change	u + d	no change	u + d	no change	n/a
yes	5	9	2	9	5	e	n/a	unclear	n/a	e	n/a	e	n/a	e + c	n/a
yes	5	8	3	7	6	no change	u + d	no change	d	e + c	u + d	e	u + d	e	u
yes	2	3	0	7	6	c	u + d	no change	d	no change	d	no change	d	no change	u + d
yes	3	6	0	0	6	e + c	u + d	e	u + d	e + c	u + d	c	u + d	e	u + d
yes	1	6	0	4	1	c	u	c	d	c	d	no change	u + d	no change	u + d
yes	5	6	1	4	3	c	no change	no change	no change	no change	u + d	no change	no change	no change	no change
no	4	7	3	7	0	-	-	-	-	-	-	-	-	-	-
MEAN	**4.800**	**7.400**	**2.933**	**6.267**	**3.133**										
did people experience the emotion associated with the music? Significantly > 5	no	yes	no	yes	no										

N=15 participants

Figure 7. The raw data arranged by music type for the first three groups.

The tables in Figures 8 and 9 present a larger scale representation of the final analysis for Groups 1, 2, and 3. The mean scores for each emotion are shown, again indicating whether or not each emotion scored a mean of five and above or below five. Under the means, the table asks whether or not the means for the participants who experienced a memory are different from the participants who did not experience a memory, to which the data shows no difference.

The data in Figure 9 indicate the greatest changes in blood flow and galvanic skin response per the emotions that were tested. Fear scored the highest, with an average rate of 75% change on both measures during that specific musical piece. The greatest change in galvanic skin response was for sadness, which had a mean score of 87.50%, which is interesting since sadness was not rated one of the most felt emotions in any group. Finally, the table indicates that the most physical changes altogether occurred for fear.

Memories?	Ratings for Sad/ Sad music	Ratings for Happy/ happy music	Ratings for Angry/ angry music	Ratings for Fear/ fear music	Ratings for Disgust/ disgust music
no	1	8	1	10	0
yes	8	9	6	8	3
yes	7	10	9	10	2
no	7	9	5	6	1
yes	4	4	0	2	5
yes	8	9	6	7	3
yes	7	8	5	6	1
no	5	9	3	7	5
yes	5	9	2	9	5
yes	5	8	3	7	6
yes	2	3	0	7	6
yes	3	6	0	0	6
yes	1	6	0	4	1
yes	5	6	1	4	3
no	4	7	3	7	0
Means	**4.800**	**7.400**	**2.933**	**6.267**	**3.133**
did people experience the emotion of the music > 5	**NO**	**YES**	**NO**	**YES**	**NO**

participants N = 15

means for those with memories	**5.00**	**7.09**	**2.91**	**5.82**	**3.73**
means for those without memories	**4.25**	**8.25**	**3.00**	**7.50**	**1.50**
Are these different?	**no**	**t(13) = .98, *p* = .34**	**no**	***t*(13) = 1.04, *p* = .32**	***t*(13) = 1.05, *p* = .09**

Figure 8. Ratings of emotional experience for the five musical pieces by the emotion cued on the survey across all three groups.

	PL Fear	GSR Fear	PL Anger	GSR Anger	PL sad	GSR sad	PL Disgust	GSR Disgust	PL Happy	GSR Happy
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	yes	yes	no	yes	yes	yes	yes	yes	no	no
	no	yes	no	yes	no	yes	no	yes	no	no
	yes	no	no	no	yes	no	yes	no	yes	no
	no	yes	no	yes	yes	yes	yes	yes	yes	yes
	yes	yes	no	yes	no	yes	no	yes	no	yes
	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
	yes	yes	yes	yes	yes	yes	no	yes	no	yes
	yes	no	no	no	no	yes	no	no	no	no
	-	-	-	-	-	-	-	-	-	-
	6 yes	**6 yes**	**2 yes**	**6 yes**	**5 yes**	**7 yes**	**4 yes**	**6 yes**	**3 yes**	**4 yes**
	2 no	**2 no**	**6 no**	**2 no**	**3no**	**1 no**	**4 no**	**2 no**	**5 no**	**4 no**
Sig:	p = .29	p = .29	p = .29	p = .29	p = .73	**p = .07**	p = 1	p = .29	p = .73	p = 1

Percent Showing a Change in These Physiological Measures

	PL Fear	GSR Fear	PL Anger	GSR Anger	PL sad	GSR sad	PL Disgust	GSR Disgust	PL Happy	GSR Happy
PL:	**75%**		**25%**		**62.50%**		**50%**		**37.50%**	
GSR:		**75.00%**		**75.00%**		**87.50%**		**75.00%**		**50.00%**

most change over both measures: FEAR

Figure 9. Changes in blood flow and GSR for each musical piece, by the emotion cued across all three groups.

In terms of the first three groups to be tested, there was more of a change in PL (blood flow) than there was for GSR (galvanic skin response), as indicated by the data in Figure 9. The greatest physiological changes were seen on the polygraph when participants were listening to the musical piece from *Insidious*, which correlated with the emotion of fear. The mean score as indicated by Figure 8 showed 75% change in both PL and GRS respectively. Sadness also showed a great amount of physiological changes, with a mean score of 62.5% for PL and 87.5% respectively for the music. The least amount of physiological changes was seen for the musical piece that represented happiness, which had a mean score of 37.5% for PL and a 50% change in GSR. However, the two types of music that got the most emotional ratings consistent with the music "type" were happiness (M = 7.40) and fear (M = 6.27). The other emotions, including disgust, anger, and sadness, were rated below the midpoint for the assigned emotion, which indicates the participants did not identify with or associate the cued emotions with the musical pieces.

In relation to the original hypothesis, the results from the experiment matched with half of the expected results; the musical piece from *Insidious* that represented fear would be one of the highest scoring emotions that were felt during the listening period. However, instead of sadness being the other highest scoring emotion, the results showed that happiness was the number one emotion that the participants identified with when they heard the musical piece from *The Nutcracker*. The alternative hypothesis, which was that participants would have a different level of physical reaction when memories are evoked than when there are no conscious memories when listening to the music, was not supported by the data, which showed that the physiological results featuring memories and no memories were quite similar in mean score. The

results may have differed if only one type of survey was used, but the data was still conclusive for this study.

The last group that was tested was Group 1A, which is a subsection of Group 1, because it used the same order of musical pieces as Group 1. However, a new survey was created for this group that did not provide any emotional cues on the rating section. Instead of asking for a rating of “not at all happy” to “extremely happy,” the new survey asked for a rating of “not emotional at all” to “extremely emotional” for each of the five pieces of music. It also asked if each piece was familiar or not, any emotions associated with each piece, and the same two open ended questions as the original survey.

	A	B	C	D	E	F	G	H	I
1	S#	Any memories?	fear	anger	sad	disgust	happy	Music 1 = Afraid	
2	1	yes	7	6	7	4	7	Music 2= Angry	
3	2	yes	9	6	7	4	5	Music 3 = Sad	
4	3	yes	7	6	8	5	9	Music 4 = Disgusted	
5	4	yes	3	4	7	4	7	Music 5 = Happy	
6	5	yes	8	4	9	3	8		
7	MEANS	yes	6.8	5.2	7.6	4	7.2		

Figure 10. Raw data for Group 1A.

The results varied more in how they were structured in terms of emotions and wording. The five participants in Group 1A answered with their own adjectives that related to emotions, such “anxious,” “energetic,” or “apprehensive,” but also, with actual emotions such as “fear” and “happiness.” The musical piece that had the highest emotional intensity among this group was sadness, which had a mean score of 7.60, and second was happiness, with a mean score of 7.20.

Overall, the results from Group 1A are most likely different from Groups 1, 2, and 3, which all had similar results, because it did not give any emotional cues whatsoever, and allowed participants to answer subjectively from their own minds. This was also the only group in which all participants had a memory evoked by the music.

For all of the groups that were tested, there were also notable differences among individuals between the GSR and PL measurements recorded by the polygraph. Some of the more varying results may have been a result of participants becoming more accustomed to having the polygraph equipment on them and being aware of the nature of the situation. The order of musical pieces may also have affected the levels of physiological changes, as some groups started with the rather intense "fear" piece from *Insidious*, while another started with a calmer and quieter stringed orchestra sound, such as in Barber's "Adagio for Strings."

Discussion

Based on the results of this study, much of the data refers to the principles of Schachter and Singer's work on the Two-Factor Theory of Emotion in 1962. Essentially, their theory suggests that physical arousal plays an important role in determining the types of emotions that people feel. Schachter and Singer's work relates to James-Lange Theory of Emotion, which states that "people have a physiological response to environment stimuli and that their interpretation of that physical response then results in an emotional experience," (Cherry, 2017b, para. 3) because it also suggests that physical arousal cannot be solely responsible for eliciting emotional responses within people. Both the Two-Factor Theory of Emotion and James-Lange theory of Emotion contrast with the Cannon-Bard Theory of Emotion, which suggests that humans can "feel emotions and experience physiological reactions such as sweating, trembling,

and muscle tension simultaneously" and that the Thalamus tells the brain a message and in result, the body experiences a physiological reaction in response to a stimulus (Cherry, 2017c, para. 1).

In terms of this particular study of testing emotions with physiological changes as seen on a polygraph, it can be justified to state that the combined work of Schachter and Singer, James-Lange, and Cannon-Bard relate to the results from the student participants at Ramapo. The test included specific measures of PL (blood pressure), breathing, and GSR (galvanic skin response for sweating) that would indicate a change in physiology when the participants listened to different types of musical pieces that they interpret to have different emotions associated with them. The data showed that not only did participants experience physiological changes, but specifically in measurements of galvanic skin response with a mean score of 75% change when they collectively heard the musical piece from *Insidious*, which evoked the emotion of fear. However, it is valid to relate the findings to Schachter and Singer's Two-Factory Theory of Emotion because a majority of the participants did not only feel emotions because of physiological changes due to the musical stimuli, but also because they had memories evoked in their mind, alongside their bodily reactions.

This study also presented a series of questions based on different elements that contributed to the process of collecting data and analyzing the results. After reviewing the participant data, it was shown that during the experimental stage, seventeen females and three males participated. However, fifteen out of the twenty participants were students from the Introduction to Psychology course, all of which voluntarily signed up to participate for this study and were all females. The three males that were participants did not sign up, but rather were recruited so that the study would cover more than one gender. Even though academic credit was offered for a fairly simple and fast-paced experimental study, there were no male psychology

students that signed up to participate, which further indicates that there may be a social stigma, even in science, when emotion is involved in a study. Males are often discouraged by society to express their emotions, especially in front of other people, which may be a possible reason that the three males in this study had to be asked to participate, rather than voluntarily signed up themselves. According to an article from UC Berkeley, author Vicki Zakrzewski writes that:

> Studies of infants have shown that neurologically, there isn't much difference between boys' and girls' capacity for empathy. Yet, according to neuroscientists, because girls are allowed to express their emotions, their ability to identify and understand both their own and others' emotions cultivates their empathetic skills beyond those of boys. (Zakrzewski, 2014, para. 4)

Neurological studies show that males and females are equally capable of expressing emotions, but because of the social implications surrounding how they should or should not be expressed, men are often discouraged from reaching a greater level of emotional expression. However, it is ironic that males would not prefer to voluntarily participate in this study because music is known to be a universal art form of expression that is not bound by gender barriers but could remain a personal and private form of emotional expression when it comes to showing physiological changes in front of other people. However, this is not limited to males, as females can sometimes be discouraged or afraid to show emotions in front of people, but maybe to a lesser degree than males. The lack of males in this study could also be because there are not as many males in the different sections of the Introduction to Psychology course or a result of males not being able to schedule time to participate, but it is still a question and piece of the results to consider when studying emotion.

Another point of interest in this study regarding the participants is the age demographic. For this experiment, students were tested who aged between 18 and 22 years old. Despite originating from different backgrounds and experiences, results can be assumed to be linked to being members of the same generation who have mostly exposed to similar types of stimuli, especially music. Although some of the open-ended responses relating to emotions and the memories evoked varied, the data suggests that a majority of participants felt similar emotions and even memories to one another when listening to the music. For example, many of the participants responded that the music reminded them of seeing a movie, growing up with friends, or even memories of finding similar types of music for the first time on their own. However, it can be assumed that the results may vary significantly, especially the memory-testing aspect of this study, if an older age demographic was tested. Different generations experience their own social, political, and artistic movements, preferences, and forms of expression, so it would be interesting to see if a different generation's results would be similar within itself too, and how similar or different the results would be to other generations. It is often suggested that people who are older in age tend to be more nostalgic than younger people since they have lived longer and experienced more memories, therefore it would be beneficial in future studies related to this one to see how music affects emotions and memory in adults who are a part of an older population.

One of the more interesting arguments that may affect results when testing emotion and memory with music is a person's experience and familiarity with music in general. In this study, a majority of participants were assumed to be majoring in a field of study that is unrelated to music. Out of the twenty participants, only two were confirmed to be music majors, both of who were males. However, the interesting prose arose when providing one of the participants with the

debriefing following their participation in the experiments, when he said that this experiment was a pleasure to him because he does not often sit down and listen to music "just to do it," and really listen and feel the music. Even when writing music, he says he often thinks and creates more technically and in terms of musical theory, rather than allowing himself to freely express his feelings, thus stripping his musical creations of full and natural emotional potential. This might suggest that when listening to music, people may not always associate emotion or even a memory at the time that they are listening to a piece. The brain is a complex system full of more neurological connections than there are stars in the Milky Way galaxy, but it seems as though humans are able to voluntarily control what they may want to remember and feel when listening to music, as indicated by one participant who responded that he or she "felt like [they] wanted to experience a memory, but [they] resisted."

In retrospect to the original two hypotheses, the results were not too far off, showing that fear was in fact one of the two most felt emotions during the music listening portion of the experimental stage. It was assumed that sadness would be the other highest rated emotion because of its complex nature and people's desire to listen to a music that resonates with even the lowest of times in life, but it is no surprise that happiness scored the highest among all five emotions. Sadness is the direct antithesis of happiness, which may indicate that they are possibly as emotionally intense as each other, but the participants of this study preferred to feel happy rather than sad when listening to the music. To have more interesting results in the future, this study could be modified to only use the second version of the survey, in which participants are not provided any emotional cues whatsoever, but rather are given the choice to answer unbiasedly to show more honest and authentic results in their responses and therefore the data.

One of the possible explanations of the general results from this study may be indicated by well-known theories around music and emotion. Seven well known theories include: melodic cues, contour and convention, morphology of feeling, embodied and designated meaning, adaptive arousal, the ITPRA Theory, and the Multiple Mechanisms Theory. All of these ideologies revolve around music, emotion, and cognition, and show links between emotion and music because of the complex nature of the brain and body, but also the complex nature of music itself. Sometimes, music may contain melodic cues that inform the listener of how they "should" feel, but also may affect how a person feels in response to musical stimulus because of its embodied and designated meaning if a person connects with it in some way. This may in fact explain why memories related to music are important in understanding the relation between music and emotion for this study. (Thompson, 2015).

Overall, this study was designed and created based on an abstract question: when listening to music, are the emotions we feel from the head or the heart? For some, music listening is a very personal and individualized experience. Emotions and memories are felt and remembered on different levels of intensity person to person, which offers many different possibilities for exploration of why music is responsible for eliciting such strong reactions in humans. Of course, there are several scientific theories, pieces of research, and studies that clearly indicate the physiological and neurological aspects of how music physically affects the body and mind. Overall, it seems as though memory did not play as great of a role in the results as the "heart" because memories are a personal asset that individuals have within them. In an experimental study, especially around other people that one may or may not feel familiar or comfortable around, it may be difficult to have results that reveal that memory is more responsible for the results because memories can be private, especially when they are involved in

the expression of emotions. However, memories may not just affect the brain, and can be argued to affect the heart too, which is translated by the expression of feelings and emotions. Maybe there is not a specific answer of whether the head or the heart is responsible for music's ability to evoke emotions within people, but rather how they correlate with one another to create a full body experience. In reality, it may be impossible to measure or explain why people feel a specific connection to music, as they may claim, deep within their heart or soul, on a physical level. Although there is much evidence surrounding music's relationship to psychology and biology, the reason that music reaches into a person so deeply may remain a mystery, even to science, but a subject that is definitely worth exploring.

This study has been made possible under the exceptional advisory and sponsorship from Professor Donna Crawley, as well as guidance from Professors Jacqueline Braun and Gilad Cohen. The results were also benefitted from the assistance of the polygraph data readers, Dianna Gomez and Abdurrahman Padela. Lastly, thank you to all of the students who participated in this study.

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Appendix A

Figure 1
Respiration Measurement

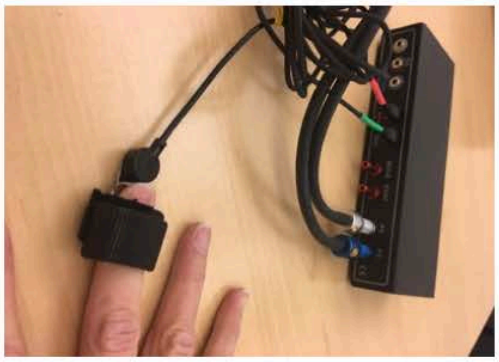

Figure 2
Perspiration Measurement

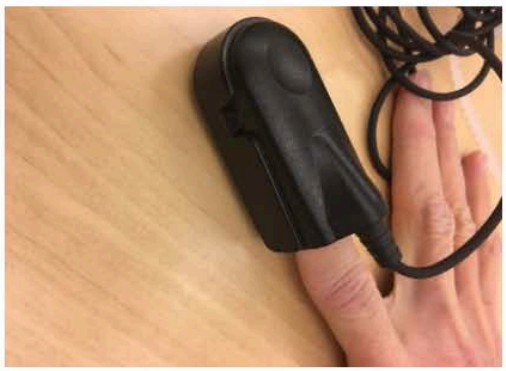

Figure 3
Blood Flow Measurement

Appendix B

Consent Form

You are being asked to participate in an experimental study that is analyzing the physical effects of emotions when listening to music. The expected duration of this procedure is 25 minutes. One option of this study is to participate with physiological data recorded using a measure of the depth of breathing, a measure of galvanic skin response (changes in skin), and a measure of blood flow in your finger. None of these measures are intrusive or uncomfortable. Breathing will be measured with two bands over the clothes, one around the chest area and one around the stomach; participants will be shown these measures. GSR is measured with a clamp on the finger, as is blood flow; the participants will be shown these pieces of equipment. However, if you choose not to have your physical reactions recorded, you can undergo the experiment without it. You will be listening to each of five pre-selected pieces of music over headphones and will complete a survey regarding your reactions between each piece.

If you do select to have your physical reactions measured, the respiration bands will be put over your clothes and the GSR and blood flow clamp will be placed on your finger before the music is played. We will perform one practice run before the actual study begins. If at that point you decide you are uncomfortable using the equipment, it can be removed for the remaining part of the study. After each piece of music is finished, you will answer a brief survey containing two open ended questions regarding your reactions to the music, and five rating scales regarding the possible emotions you experience. **The survey will be shown to participants prior to the experiment**.

The possible risks of this research are:

Some participants may be uncomfortable with the idea of physical measurements being taken, so your choice will be voluntary in this study. The music may be unpleasant, so you may stop at any given time during the experiment, and you may skip any question you do not wish to answer.

The benefits to this study are that participants will hear interesting music and have a meaningful experience. Introduction to Psychology students will be receiving academic credit for their participation.

Your identity will be completely confidential. Your name will not be associated with this study at any time.

For any information regarding this study, please contact my advisor Professor Donna Crawley at dcrawley@amapo.edu. My email is aanton@ramapo.edu. The co-chair of the IRB at Ramapo College is James Woodley, who can be contacted at jwoodley@ramapo.edu. This research has been approved by the IRB (#399).

Your participation in this study is voluntary. Your refusal to participate will not involve any penalty or loss of benefits to which you are entitled. You may discontinue participation at any time during the procedure.

If you are at least 18 years of age and consent to participating in this study, please sign your name below.

_____

Signature Date

Appendix C

Group: 1 Participant:

Were you familiar with any piece? (Please circle your response) Yes No

If they were familiar to you in any way, did any of the pieces evoke a memory related to a specific time in your life? If you had a memory while listening to the music, was it strong/emotional?

Please rate the level of each emotion you experienced using the scale below:

Not Afraid at All Extremely Afraid

0 1 2 3 4 5 6 7 8 9 10

Not Angry at All Extremely Angry

0 1 2 3 4 5 6 7 8 9 10

Not Sad at All Extremely Sad

0 1 2 3 4 5 6 7 8 9 10

Not Disgusted at All Extremely Disgusted

0 1 2 3 4 5 6 7 8 9 10

Not Happy at All Extremely Happy

0 1 2 3 4 5 6 7 8 9 10

Appendix D

Group: 2 Participant:

Were you familiar with any piece? (Please circle your response) Yes No

If they were familiar to you in any way, did any of the pieces evoke a memory related to a specific time in your life? If you had a memory while listening to the music, was it strong/emotional?

Please rate the level of each emotion you experienced using the scale below:

Not Happy at All Extremely Happy

0 1 2 3 4 5 6 7 8 9 10

Not Disgusted at All Extremely Disgusted

0 1 2 3 4 5 6 7 8 9 10

Not Afraid at All Extremely Afraid

0 1 2 3 4 5 6 7 8 9 10

Not Angry at All Extremely Angry

0 1 2 3 4 5 6 7 8 9 10

Not Sad at All Extremely Sad

0 1 2 3 4 5 6 7 8 9 10

Appendix E

Group: 3 Participant:

Were you familiar with any piece? (Please circle your response) Yes No

If they were familiar to you in any way, did any of the pieces evoke a memory related to a specific time in your life? If you had a memory while listening to the music, was it strong/emotional?

Please rate the level of each emotion you experienced using the scale below:

Not Sad at All Extremely Sad

0 1 2 3 4 5 6 7 8 9 10

Not Angry at All Extremely Angry

0 1 2 3 4 5 6 7 8 9 10

Not Happy at All Extremely Happy

0 1 2 3 4 5 6 7 8 9 10

Not Disgusted at All Extremely Disgusted

0 1 2 3 4 5 6 7 8 9 10

Not Afraid at All Extremely Afraid

0 1 2 3 4 5 6 7 8 9 10

Appendix F

Group: 1A Participant: ____

Please rate the level of each emotion you experienced using the scale below:

Not Emotional at All Extremely Emotional

0 1 2 3 4 5 6 7 8 9 10

Are you familiar with this piece? (Please circle your response) Yes No

What emotion(s) [if any] do you feel or associate to this piece of music when listening to it?

Not Emotional at All Extremely Emotional

0 1 2 3 4 5 6 7 8 9 10

Are you familiar with this piece? (Please circle your response) Yes No

What emotion(s) [if any] do you feel or associate to this piece of music when listening to it?

Group: __1A___ Participant: ____

Please rate the level of each emotion you experienced using the scale below:

Not Emotional at All Extremely Emotional

0 1 2 3 4 5 6 7 8 9 10

Are you familiar with this piece? (Please circle your response) Yes No

What emotion(s) [if any] do you feel or associate to this piece of music when listening to it?

Not Emotional at All Extremely Emotional

0 1 2 3 4 5 6 7 8 9 10

Are you familiar with this piece? (Please circle your response) Yes No

What emotion(s) [if any] do you feel or associate to this piece of music when listening to it?

Group: __1A___ Participant: ____

Not Emotional at All Extremely Emotional

0 1 2 3 4 5 6 7 8 9 10

Are you familiar with this piece? (Please circle your response) Yes No

What emotion(s) [if any] do you feel or associate to this piece of music when listening to it?

Please answer in terms of <u>all</u> of the musical pieces played to you:

If any of these pieces are familiar to you in any way, did they evoke a memory related to a specific time in your life? If you had a memory while listening to the music, was it strong/emotional?

Appendix G

Polygraph Data Recording Chart

	Music 1	**Music 2**	**Music 3**	**Music 4**	**Music 5**
PL 1. Expanded 2. Contracted 3. No Change 4. Unclear					
GSR 1. Up 2. Down 3. Up + Down 4. No Change 5. Unclear					
Breathing 1. Steady 2. Large Peaks 3. Flat 4. Unclear					