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I am submitting herewith a dissertation written by Sarah Kathleen N. Fischer entitled "Individual Differences in Emotional Response to Music." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Psychology.

Eric D. Sundstrom, Major Professor

We have read this dissertation and recommend its acceptance:

Jacob J. Levy, Michael A. Olson, Barbara A. Murphy

Accepted for the Council:
Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

Individual Differences in Emotional Response to Music

A Dissertation Presented for the
Doctor of Philosophy Degree
The University of Tennessee, Knoxville

Sarah Kathleen N. Fischer
May 2013

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Dedication

To Yeshua HaMaschiach

You are the reason this is possible.

Acknowledgements

There are many people to whom I owe a deep debt of gratitude for all the help I've received from them during this journey. First of all, I wish to thank my advisor, Dr. Eric Sundstrom. Not only did he give me much of his time and wise advice, he also was, in large part, the one who encouraged me to enter graduate school in psychology in the first place.

I also wish to thank the other members of my committee, Dr. Jacob Levy, Dr. Michael Olson, Dr. Barbara Murphy, and Dr. John Lounsbury for their time and expertise in serving on my committee. Each of you has brought special insights that helped me throughout this process.

Dr. Cathy McKinney, Director of the Music Therapy Program at Appalachian State University, has been very helpful throughout the early formulation of this research, and I wish to thank you for your suggestions and guidance.

I thank my friends and family for their encouragement and patience with me during this season of my life. I really appreciate your interest and the care that each of you has shown me.

Abstract

Although emotional experiences with music have been enjoyed for millennia, research involving music has focused primarily on emotions perceived rather than felt, and not much research exists into differential emotional response to music as a function of individual differences. A recent study (Djikic, 2011) looked at the effect of music on personality, but it did not assess emotional state before or after listening. In an extension of that study, the present research explores how changes in emotion may be related to self-reported personality. Relationships between extraversion and neuroticism, emotional state before and after music listening, and liking the stimulus were examined. It was hypothesized that in predicting final emotional state, an interaction was expected between initial emotional state and liking the stimulus; personality was expected to moderate the relationship between liking the stimulus and its type; and greater change in affect would be found in music than in control conditions. A one-factor between-subjects experiment was conducted in which participants listened to one of four randomly-assigned sound conditions: choral music likely to be perceived as happy, instrumental music likely to be perceived as sad, Brownian noise, or a classroom lecture. Sixty students from a university located in the southeastern United States participated individually in a laboratory setting. Repeated measures assessed affect, extraversion and neuroticism, both before and after listening. Liking the stimulus was found to interact with initial negative affect in predicting negative affect after listening, but no similar interaction was found for positive affect. Highest levels of neuroticism were associated with liking the stimulus likely to be perceived as sad. Significantly greater reduction in negative affect was found in music conditions than control conditions. This study also found partial support for a surprising difference in neuroticism, which changed after exposure to all conditions except the Brownian noise control condition. These findings underscore the importance of individual differences in emotional response to music and the need to take them into account.

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Chapter 1

Introduction

Even from ancient times, music has been admired and purposely used for the emotional experiences produced in the listeners. Over a century ago empirical studies involving music began with studies of perception of emotion during music listening. Since that beginning, much research has been done to identify structural elements of music that are linked to perception of different emotions. While research into stable personality traits has not enjoyed such a long history, the last four decades have witnessed much research concerning the five personality factors (extraversion, openness, agreeableness, conscientiousness, and neuroticism) that have been labeled the "Big Five" by Goldberg (1981). In the last decade work began to explore links between personality traits and preferences for different genres of music. However, there has not been much research yet into differential emotional response to music as a function of individual differences.

Listening to a particular six-minute selection of music was used in a recent study, and that study reported that "the hypothesis that music can increase variability in self-reported personality traits under laboratory conditions has been supported in this experiment" (Djikic, 2011, p. 239). That rather surprising conclusion prompted this proposed investigation of music listening and individual differences. The very word "trait" in that reported finding implies that it is not a momentary condition but a lasting characteristic of the individual, or as McCrae and Costa expressed it, "relatively enduring styles of thinking, feeling, and acting" (1997, p. 509). Therefore, concluding that six minutes of music listening causes change in one's personality is, indeed, surprising. The possibility of the results being an artifact of a mood induction was discussed, but it was concluded that was not the case because "the conditions did not affect differentially extraversion and neuroticism" (Djikic, 2011, p. 239), which researchers have found to be correlated with positive and negative affect (Costa & McCrae, 1980). However, the Djikic study made no appraisal of emotional state before or after listening to the stimulus, so it couldn't possibly establish that change in emotions had nothing to do with their observed results. This research followed up on that study by testing differential emotional response to music as a function of personality traits, which have been found stable in earlier research (Vaidya, Gray, Haig, & Watson, 2002).

Both current emotional state and the dispositional tendencies to experience positive or negative emotions (emotional style) have been shown to be linked with subjective self-reporting. Guided Imagery and Music relies on differential emotional responses to music and client's self-reporting to bring about therapeutic change (Goldberg, 1992). Emotional style has been linked to differences in health symptom self-reporting (Cohen, Alper, Doyle, Treanor, & Turner, 2006). The association of emotional state with self-reported change in these areas of physical and mental health raises the question of how emotions may influence self-reported personality. Personality traits of neuroticism and extraversion have been found to be linked with negative and positive emotions, respectively (Costa & McCrae, 1980), and with differential susceptibility to mood induction (Rusting & Larsen, 1997). Emotional state before listening to music is a significant predictor of emotional state after listening, and enjoyment/liking the selection heard has been found to moderate that relationship (Wheeler, 1985). Music as an emotion induction method has not been frequently studied (Gerrards-Hesse & Spies, 1994). Most music emotion research has focused on emotion perceived rather than on emotion actually felt, and studies that also take into account personality traits are extremely scarce (Kreutz, Ott, Teichmann, Osawa, & Vaitl, 2008). To address this gap in the literature, this research extended the Djikic study (2011) by exploring individual emotional response to music listening and how that relates to self-reported personality, particularly extraversion and neuroticism.

The remainder of this chapter presents summaries of music research, emotion research, and personality research. Particular attention will be given to the intersection of these three areas, and gaps in the literature will be noted where particularly relevant to this study. Then the study that partly inspired this research will be presented in further detail, followed by an overview of this research. The next chapter will give a description of the method used, including its research design, participants, procedure and materials. The following chapter describes analyses that were performed, and the final chapter discusses the findings and their implications.

Music

The ancient Greeks talked of catharsis as the purification of the soul through emotional experience (Cook & Dibben, 2001). Writings of Pythagoras, Aristotle, and Plato indicate that listening to music was intentionally pursued for this therapeutic effect (Ellis, Koenig, & Thayer, 2012). The earliest empirical studies of music perception began in the 1890's (Gabrielsson, 2002). In the 1930's Hevner (1936, 1937) focused on judgments of what emotion the music was portraying or expressing, rather than focusing on what emotion the listener was experiencing. For example, did the listener perceive the music as sad? She used a quadrant approach involving valence and arousal to map different emotions identified in particular music selections. This approach to mapping emotions in emotion space was similar to that used by Russell in his circumplex model of emotion almost 50 years later (Russell, 1980). His work does not reference hers, and he was likely unaware of it. Among musicologists and music therapists, however, her pioneering work is well known.

Delving further into why people perceive music as happy or sad, later music research identified structural elements of music that express different emotions (Västfjäll, 2001; Bruner II, 1990). Gabrielsson and Juslin list over two pages (2006, pp. 521-522) of research results linking structural elements of music to expression of different emotions.

Even though many musical characteristics perceived as expressing different emotions have been identified, what makes one individual like a type of music or dislike another? As recently as 2003, Rentfrow noted that much work has been done in music-related research in the areas of cognitive psychology, biological psychology, clinical psychology, and neuroscience, but that "very little is known about why people like the music they do" (Rentfrow & Gosling, 2003, p. 1237). In studies that investigated individuals' preferences for different musical genres and relationships to personality, a factor-analytic approach revealed four components in music genre preferences: Reflective and Complex, Intense and Rebellious, Upbeat and Conventional, and Energetic and Rhythmic (Rentfrow & Gosling, 2003). In that same study, extraversion was associated with preferring "cheerful music with vocals" which they labeled the Upbeat and Conventional dimension.

Research has found that music listeners report changes in felt emotion (Kreutz et al., 2008; Västfjäll, 2001; Gerrards-Hesse & Spies, 1994; Pignatiello, Camp, Rasar, 1986). Several researchers have investigated the phenomenon of experiencing "chills" and intense pleasure when listening to music (Nusbaum & Silvia, 2011; Rickard, 2004, Blood & Zatorre, 2001). In a study of physiological arousal during listening to music, Rickard (2004) found that extraversion was correlated with heart rate and with the number of occurrences of chills. In a study comparing ratings of perceived emotion with felt emotion during music listening (Kallinen & Ravaja, 2006) it was found that felt emotions were rated stronger than the perception of them when the emotion in question was pleasurable. Gabrielsson (2001) suggested four possibilities for the relationship between felt and perceived emotion experienced while listening to music: positive, negative, no systematic relationship, or no relationship. Investigating those relationships, Evans and Schubert (2008) found that for 61% of their sample, felt and perceived emotions were the same (positive relationship between felt and perceived emotion) and that liking the piece was related to that positive association. Wheeler (1985) found that an interaction between enjoyment of the music and mood before listening was significant in predicting mood after listening. Those who felt happy before the music and did not like the music were found to decrease in happiness, while those who felt sad before listening to the music and enjoyed it reported less sadness after listening. Gerrards-Hesse and Spies (1994) reviewed nearly 250 mood induction studies, and only seven of them used music as the induction method. Despite these mood/emotion induction studies, exploration of individual differences in felt emotion experienced through music listening still has little coverage in the literature (Vuoskoski & Eerola, 2012; Västfjäll, 2001).

Emotion

William James (1884) asked what emotion is, and there is still debate today about how to define it (Mulligan & Scherer, 2012; Izard, 2010; Gendron, 2010; Widen & Russell, 2010). A survey by Izard (2010) collected responses from 35 scientists who had published research involving emotion. He found strong agreement among the researchers that scientists should "make very clear and contextualize what they mean by 'emotion'" (p. 367). In a recent review of the literature on emotion measurement, a model put forth for the components of emotion conceptualized emotions as "experiential, physiological, and behavioural responses to personally meaningful stimuli" (Mauss & Robinson, 2009, p. 209). This model of emotions put forth by psychologists Mauss and Robinson is also consistent with musical emotion researchers Juslin and Västfjall who defined emotions as "relatively intense affective responses that usually involve a number of sub-components – subjective feeling, physiological arousal, expression, action tendency, and regulation" (2008, p. 561). Although moods and emotion are related, emotions are more intense and briefer than mood (Beedie, Terry, & Lane, 2005). Different theorists and researchers have viewed emotions as discrete (Niedenthal, Halberstadt, & Setterlund, 1997), or as dimensions (Coutinho & Cangelosi, 2011) or as related in a circumplex (Russell, 1980; Hevner, 1936, 1937). With the advent of technology that allows continuous measurements, there is more evidence to suggest that experiencing mixed emotions simultaneously, such as "happy" and "sad," is possible, although it may not occur often (Cacioppo & Bernston, 1994; Larsen & McGraw, 2011; Larsen & Stastny, 2011). A number of emotion investigators have pointed out the need to assess emotion change in several systems, not just self-report scales (Mauss, 2009; Brenner, 2000), and physiological and neuroimaging measures are now being used in emotion research (Koelsch, 2010; Brattico et al., 2011; Blood & Zatorre, 2001). As more research on emotion is now employing music and neuroscience as tools, recommendations have been given that future studies involving music, emotion, and neuroimaging should "move beyond group-averaged brain activations, and include individual difference measures (e.g., personality) in the analyses" (Vuoskoski & Eerola, 2011, p. 1100).

Self-verification theory suggests that one chooses information that confirms what one already thinks of oneself (Swann, 1983). In selecting ratings that describe oneself, this theory would predict consistency in self-reporting, unless one's evaluation of self changed. However, associative network theory (Bower, 1981) predicts that free association and categorizations are affected by the current emotion or mood state. According to that theory, emotion functions as a memory unit and the items that match the current emotion are more likely to be recalled. Thus, the associative network theory would predict change in self-reporting if one's emotional state changed and made other information more salient that matched the new emotional state. Prospective studies have shown that subjects who have the tendency to experience positive emotions (positive emotional style) report fewer health symptoms than their biological health markers would indicate, and those whose emotional style is negative report more health problems than their physiology would warrant (Cohen et al., 2006; Cohen, Doyle, Turner, Alper, & Skoner, 2003). Would induced emotion influence self-reported personality traits in a way similar to the patterns seen in self-reported health symptoms? This research proposes to investigate that.

Personality

In the 1930's Allport and Odbert (1936) used an unabridged English dictionary to collect words used to describe people and produced a mammoth collection of terms. They identified four categories for these descriptive terms: personality traits, temporary states indicating mood or activity, words involving evaluation of an individual, and descriptions of physical appearance or ability (John, Naumann, & Soto, 2008). Cattell reduced the list of personality trait terms to sixteen personality factors through factor analysis and created the Sixteen Personality Factor (16PF) scale (Cattell, Eber, & Tatsouka, 1970). Identifying a much smaller set of personality factors from the huge list of personality terms stimulated much work by many different researchers throughout the rest of the century. Five factors were discovered and verified by different researchers: openness, conscientiousness, extraversion, agreeableness, and neuroticism (or reverse-coded, emotional stability), and they were labeled the "Big Five" by Goldberg (1981). Since different researchers developed their own scales to measure the Big Five, there are several different Big Five scales, including the Neuroticism, Extraversion, Openness Personality Inventory, Revised (NEO-PI-R; Costa & McCrae, 1992) and the Big Five Inventory (BFI; John, Donahue, & Kentle, 1991). Concerning stability of the extraversion and neuroticism personality domains, Conley (1985) found evidence for stability, even over five decades, among adults.

Research involving the Big Five model of personality has been shown to predict outcomes in different areas of life including affect. Neuroticism has been shown to be related to negative affect, and extraversion has been shown to be related to positive affect (Costa & McCrae, 1980). Several studies have shown differences in the need for stimulation between extraverts and introverts (Geen, 1984; Brebner & Cooper, 1978; Campbell & Hawley, 1982). Rusting and Larsen (1995) looked at individual differences in the type of moods that people desire. Viewing emotional experience in the dimensional perspective (valence and arousal), personality was found to be highly correlated with the arousal dimension. They found that those high in extraversion desired highly stimulated or activated affect, whereas those high in neuroticism desired moods that were low in activation. Using mental imagery as the mood induction method, Rusting & Larsen (1997) found evidence indicating that extraverts were more susceptible to positive mood induction and that those higher in neuroticism were more susceptible to negative mood induction. Although their findings supported earlier studies (Larsen & Ketelaar, 1991), they cautioned that additional research should be conducted using other affect induction paradigms (p. 611). In order to extend this line of research, this current study used music as the stimulus, rather than mental imagery used in those previous studies.

Individual Differences and Emotional Response to Music

The current research extended the recent study by Djikic (2011) that looked at effects of music on self-reported personality. In that study, students filled out the Big-Five Inventory (BFI;

John, Donahue, & Kentle, 1991) and then experienced one of three experimental conditions: (1) music sung in German with lyrics displayed in German, or (2) the same music sung in German but lyrics displayed in English, or (3) no audible music but lyrics spoken and displayed in English. Participants fluent in German were excluded from the study. After six minutes of listening, subjects again completed the BFI personality measure. Djikic concluded that "music can increase variability in self-reported personality traits under laboratory conditions" (2011, p. 39). However, there was not a specific personality factor that showed significant change across all individuals. Did subjects experience the music differentially, perhaps through different emotions experienced or due to different degrees of enjoyment of the music? Had subjects used psychoactive substances or alcohol recently, which have been linked to impaired emotion regulation (Dorard, Berthoz, Phan, Corcos, & Bungener, 2008; McKinney, 2010)? Since Djikic found that "conditions did not affect differentially extraversion and neuroticism," she concluded that there had not been an induction in mood for the participants. However, no measures of mood or emotion were reported, so it is unknown if there were individual differences in felt emotion that may be related to the variability seen in self-reported personality traits.

In order to compare results of this research with those of the Djikic study, the same personality instrument (Big Five Inventory; John, Donahue, & Kentle, 1991) was used to assess self-reported personality. It was administered before and after listening, as was done in that study. In order to extend the study to examine differential emotional response, current emotional state was also assessed immediately before and after listening, which was not done in the Djikic study. Gerrards-Hesse and Spies (1994) reviewed 250 studies involving emotion induction and reported that in 81% of the studies that they reviewed, the emotion manipulation was checked immediately after the induction procedure. They recommend this immediate checking to verify emotion change because emotional states that are induced experimentally "are assumed to be relatively short-lived" (p. 63). Visual Analog Scales (VAS) may be used to measure emotion. They consist of a straight line with bipolar emotion word anchors on either end, and the respondent marks where on that continuum they are, regarding the two extremes. VAS have been used in music emotion research for over twenty years. Västfjäll (2001) lists 26 studies on the Music Mood Induction Procedure (MMIP), and half used Visual Analog Scales as an emotion measure. A number of reviews of emotion induction studies have recommended that several different ways of assessing emotion should be employed (Mauss & Robinson, 2009; Gerrards-Hesse & Spies, 1994). Rather than relying solely on subjective self reporting using rating scales or emotion checklists, they recommend assessing physiological or behavioral changes, as well. Since slowing of psychomotor processes is observed in clinical depression, emotion researchers have used simple motor tasks as a manipulation check for emotion inductions (Goodwin & Williams, 1982), such as writing speed or counting (Natale, 1977, 1978; Velten, 1968; Pignatiello et al., 1986; Wood, Saltzberg, & Goldsamt, 1990). This research employed a simple counting task, in addition to self reported emotion rating scales, to assess changes in emotion. Thus, relationships between personality traits of extraversion and neuroticism and the emotional state before and after music listening, as well as enjoyment (liking) of the stimulus, will be examined.

A theoretical framework has been proposed for the mechanisms that are involved in experiencing emotion through music listening (Juslin, Liljeström, Västfjäll, & Lundqvist, 2010). The seven mechanisms of the framework include: brain stem reflexes, rhythmic entrainment, evaluative conditioning, emotional contagion, visual imagery, episodic memory, and musical expectancy. The musical stimulus used by Djikic was a choral music selection (*Ständchen*, by

Franz Schubert) sung in German. That work was chosen because participants were unlikely to be familiar with it, and participants were excluded if they understood German. By choosing stimuli unfamiliar to the participants, evaluative conditioning and episodic memory are not likely to be involved during listening, since these involve previous experiences during listening to that music. Thus, using unfamiliar stimuli would simplify response interpretations and possible confounds due to individual differences in previous experience with the music. Brattico and colleagues found evidence that emotional brain area (limbic system) activation occurred when listening to music without lyrics that was perceived as happy and music with lyrics that was perceived as sad (Brattico et al., 2011), which was similar to earlier findings of Ali and Peynircioglu (2006). Responses to music perceived as happy that has lyrics that one does not understand may be similar to listening to music without lyrics. The moderate tempo, quick notes in the accompaniment, and mode (major, rather than minor) of the Schubert work used in the Djikic study are all structures of music that research has found to be linked with perceiving it as happy or bright (Bruner II, 1990; Västfjäll, 2001; Gabrielsson & Juslin, 2006).

This research also extended the study done by Djikic by using several other stimuli, in addition to the choral work by Schubert. A strictly instrumental work (*Suite for Violin and Orchestra in A minor, Op. 10* by Christian Sinding) was also used. In an fMRI investigation of brain activation while listening to classical music (Mitterschiffthaler, Fu, Dalton, Andrew, & Williams, 2007), that piece was given the lowest ratings of emotion (perceived as saddest) of all music used in that study. These two music selections have music structural elements that are likely to provide a contrast. Because of evidence indicating that extraverts were more susceptible to positive mood induction and that those higher in neuroticism were more susceptible to negative mood induction (Rusting & Larsen, 1997), participants would be more likely to show differential response to these contrasting stimuli. Similarly, control conditions were selected that would also show a contrast. Several studies of differences in the need for stimulation between extraverts and introverts have found evidence that suggests that extraverts have a need for more stimulation than introverts (Geen, 1984; Brebner & Cooper, 1978; Campbell & Hawley, 1982).

Changes in emotion and its relationship to self-reported personality were also examined, and individual liking or enjoyment of the sound selection to which they listened was also taken into account. Results were predicted as follows:

Hypotheses

H1. In terms of predicting emotional state change, an interaction was expected between initial emotional state and liking the selection to which they listened. Liking/disliking the stimulus was expected to moderate the change in emotion such that those indicating negative emotion initially who like the selection to which they listen would show a pre- to post-listening change (improvement) in emotion valence. Those showing positive emotion initially who dislike the selection to which they listen would show a pre- to post-listening change (worsening) in emotion valence.

H2.Personality was expected to moderate the relationship between liking the stimulus and the type of stimulus, as follows:

H2a. Lower levels of extraversion would be associated with liking the less-arousing music selection (*Suite for Violin and Orchestra in A minor, Op. 10* by Christian Sinding) and the less-arousing control condition (listening to Brownian noise).

H2b. Higher levels of extraversion would be associated with liking the more-arousing music selection (Franz Schubert's *Ständchen*) and the more-arousing control condition (listening to a literary theory lecture).

H2c. Higher levels of neuroticism would be associated with liking the music that is likely to be perceived as sad (*Suite for Violin and Orchestra in A minor, Op. 10* by Sinding).

H3. Greater change in emotion would be found in the music conditions, as compared to the non-music control conditions.

H4. Changes in self-reported personality would be related to changes in emotion. Those showing more change in emotion from pre- to post-listening would be more likely to show changes in self-reported personality. This is predicted, based on the results reported by Djikic (2011).

By having two different music stimuli, one with structural elements more likely to be perceived as happy and more stimulating because of rhythm and mode, and the other more likely to be perceived as sad and less stimulating, groundwork is laid for the possibility of differential emotional response. Neither musical stimulus is likely to be familiar to participants, thus avoiding possible confounds of differences in individuals' experience with the music that may involve evaluative conditioning and episodic memory related to those experiences with the stimulus. Regarding the setting for stimulus presentation, research on effectiveness of emotion induction techniques that compared procedures involving group versus individual induction found greater change in emotion when the procedure was administered individually rather than in groups (Bates, Thompson, & Flanagan, 1999). Therefore, individual experience of the experiment in a private setting was used. Since evidence has been found that introverts prefer a lower level of sound or noise (Geen, 1984), participants will set the volume control to their own preferred setting before stimulus presentation. Brownian noise and listening to a lecture on literary theory were the two control conditions for this proposed research. Brownian noise was likely to be perceived as calming and provide less stimulation than the lecture, and both served as a contrast to the structural sound elements of music.

Chapter 2

Method

Research Design

This research was a one-factor experiment (music listening, with four levels) to address these hypotheses concerning emotional response to music listening and its relationship to self-reported extraversion and neuroticism. Participants were randomly assigned to listen to one of four stimuli: choral music likely to be perceived as happy, instrumental music likely to be perceived as sad, a Brownian noise control condition, or a literary theory lecture control condition. Subjects participated individually in a laboratory setting where they wore noise-cancelling headphones throughout the experiment and used the experiment presentation computer to view instructions and supply their responses. The design included repeated measures of emotion, personality, and control variables before and after listening to the stimulus. These repeated measures include an emotion 20-item scale; seven Visual Analog emotion scales; several control variables, including a counting backwards control variable; and self-reported personality measures, including 8-item domains of extraversion and neuroticism. Other measures will be completed at the conclusion of the experiment, such as rating enjoyment (liking) of listening to the stimulus and music experience and demographic information, as well.

Pilot Study

In order to verify emotion measurement procedures and computer data collection worked properly, a pilot study was conducted before commencing the primary study. The same one-factor experimental design with repeated emotion and individual difference measures pre- and post-listening that was proposed for the primary study was used in the pilot study.

Thirty-three students and staff of the University of Tennessee took part in the pilot study. Twenty of them met the exclusion criteria (see Participants, below), with five in each of the four stimulus conditions, representing a retention rate of 61%. Computerized Visual Analog Scales and computerized counting tasks were checked to ensure that emotion measures worked properly.

Participants

Students at the University of Tennessee who were at least 18 years of age took part in this experiment. Exclusion criteria included fluency in German (one stimulus was a classical song sung in German), hearing impairment, recent alcohol use (within the prior 24 hours), and psychotropic drug use (within the prior 14 days), as these could alter the perception and emotional response to the stimuli (Dorard et al., 2008). Of the 89 subjects (56 female, 33 male) who participated in this study, 62 of them met the exclusion criteria. Two of those were dropped from the sample because they were outliers in age and demography (>30 years above the mean and staff, rather than students). There were 27 who failed the exclusion criteria as follows: 13/5% were on psychotropic medication, 9% had used psychotropic drugs in the last two weeks, 10% had used alcohol in the last 24 hours, and three spoke German; however two of those were also excluded for other reasons, so just one was excluded solely because of German fluency. Thus, the retention rate was 67%. Therefore, the primary study sample consisted of 60[1] subjects (43 female, 17 male), ranging in age from 18 to 37 (mean=20.7 years, S.D.=3.6 years).

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[1] An *a priori* power analysis was performed using G*Power (Faul, Erdfelder, Buchner, & Lang, 2009), determining that a sample size of 120 was needed to detect a small effect in repeated measures, given $\alpha = .05$, power $(1-\beta) = .8$, and assuming moderately high correlation (.7). However, this experiment is primarily a between-subjects design, not requiring as many participants.

Setting

Subjects participated individually in a laboratory setting where they wore noise-cancelling headphones throughout the experiment and used the experiment presentation computer to view instructions and supply their responses. The room, approximately 12 feet x 18 feet, was carpeted and lit with ceiling fluorescent lights. Participants were seated at a table that contained the computer with attached headphones.

Procedure

After reading and signing the informed consent form (see Appendix), participants were escorted to the experimental presentation computer. They were shown how to adjust the sound to their desired volume and how to use the experimental interface. The software randomly assigned them to listen to one of four sound stimuli: a choral music selection sung in German (Franz Schubert's *Ständchen),* a strictly instrumental work (*Suite for Violin and Orchestra in A minor, Op. 10* by Christian Sinding), a classroom lecture on literary theory, or Brownian noise. Participants completed a personality scale and several scales to assess emotion before listening to the sound stimulus. Afterward, they completed a second set of the same personality and emotion measures. Participants also completed some questionnaires concerning their past musical experiences, listening preferences, and how they liked the selection they heard. They were also asked an open-ended question as a manipulation check on the listening. Then participants were debriefed, thanked, and given an opportunity to provide contact information if they chose to participate in a drawing to win a new Apple® iPad® 3. Total time required for participant involvement was up to one hour.

Students received optional course credit for participating, depending on the policy of their instructor. The amount of credit was determined by guidelines established by participants' instructors. The participants were recruited through a posting in the university's online Human Participation in Research (HPR) recruiting system and by announcements made in university classes.

Equipment

An experiment control computer running MediaLab software by Empirisoft (New York City; Stahl, 2006) and noise-canceling headphones were used to control the experiment, present the sound stimuli, and collect the data [2].

Treatment Conditions

Experimental sound condition was the independent variable in this experiment. Each participant listened to just one of the four randomly-assigned stimuli in this between-subjects design. The sound stimulus was presented for approximately six minutes of listening. Two music conditions and two control conditions consisted of the following stimuli:

Music condition #1 (vocal). Choral music selection (*Ständchen*, by Franz Schubert, sung in German). This Schubert choral work is the selection used in the study by Djikic (2011) described above, and it is likely to be perceived as happy or bright because of its musical elements (moderately fast tempo, major mode).

Music condition # 2 (instrumental). Strictly instrumental selection (*Suite for Violin and Orchestra in A minor, Op. 10* by Christian Sinding). This work was used in an fMRI investigation of brain activation while listening to classical music (Mitterschiffthaler, Fu, Dalton, Andrew, & Williams, 2007). It was given the lowest emotion ratings (saddest) of all music used in that study.

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[2] Analysis Software (JMP 10, SAS 9.2 (SAS Institute, Cary, NC) and IBM SPSS Statistics 20.0 (Chicago, IL) was used for data preparation, analysis, graphing, descriptive and inferential statistics, ANOVA, and regression..

Control condtion #1 (noise). Brownian noise. This type of mathematically-generated noise has more energy in the low frequencies, as compared to white noise.

Control condition #2 (lecture). A lecture on literary theory given at Yale by Paul H. Fry. This particular segment was the beginning of the class on the very first day of the class.

Measures

Big-Five Inventory (BFI). The BFI is a self-report personality inventory of the five factor model of personality with factors neuroticism, extroversion, openness, conscientiousness, and agreeableness (John, Donahue, & Kentle, 1991). The BFI contains 44 items that are rated on a 5-point Likert scale, from 1=”Disagree Strongly” to 5=”Agree Strongly”. Respondents are asked to rate characteristics about themselves by completing the phrase “I see Myself as Someone Who...” Respondents completed all 44 items both before and after listening to the sound stimulus. The traits of extraversion and neuroticism, the target traits of this study, both consist of 8 items. Two of the items rated for the Neuroticism domain included “Can be tense” and “Is relaxed, handles stress well,” (a reverse scored item). Two of the items rated for the Extraversion domain included “Generates a lot of enthusiasm” and “Is sometimes shy, inhibited,” (a reverse scored item).

Positive and Negative Affect Schedule (PANAS). The PANAS (Watson, Clarke, & Tellegen, 1988) is a self-report instrument of twenty items that measures both positive and negative affect. Subjects responded on a 5-point Likert scale from 1=”very slightly to not at all” to 5=”extremely” as to how they feel AT THIS MOMENT. Two sample items are “upset” and “proud.” The PANAS has demonstrated high internal consistency with coefficient alpha’s between .84 and .90. The PANAS was given before and after the sound condition.

Measure of emotion valence and arousal: Visual Analog Scale (VAS). Constructed with a 100 mm line with the endpoints labeled from none to maximum (Aitken, 1969), VAS measures were used to assess positive and negative emotion valence and arousal. For example:

no happy feelings now ______________________ extremely happy feelings now.

VAS measures have been used in music emotion research for over twenty years. Västfjäll (2001) lists 26 studies on the Music Mood Induction Procedure (MMIP), and half used VASs as an emotion measure. VAS measures are also used in a variety of other ways to assess acute stress (Hall et al., 2004), symptom change in mood disorders (Ahearn, 1997), and monitor patients' pain perception (Simcock et al., 2008).

Writing Speed Task Sheet. To check emotion that may affect psychomotor speed of processing, the participants were asked to write numbers in descending order, beginning with 3000 during a specified time of one minute. This task served as a control variable. Since slowing of psychomotor processes is observed in clinical depression, emotion researchers have used simple motor tasks as a manipulation check for mood inductions (Goodwin & Williams, 1982), such as writing speed or counting (Natale, 1977, 1978; Velten, 1968; Pignatiello et al., 1986; Wood, Saltzbeg, & Goldsamt, 1990). This technique has been used in a number of music and emotion studies (Velten, 1968; Pignatiello et al., 1986), including experiments conducted by computers (Mitterschiffthaler et al., 2007).

Listening Experience Sheet. Participants were asked to rate how much they liked the selection, which will serve as a control variable. They were also asked how pleasant they found the selection to which they listened. They also described what they experienced during listening, as an emotion induction check.

Short Test of Music Preferences-Revised (STOMP-R). The STOMP (Rentfrow & Gosling, 2003; Rentfrow, Goldberg, & Levitin, 2011) has been revised to include 23 genres of music. Respondents rate their preferences for each genre on a 1 – 7 Likert scale (dislike strongly – like strongly). "Classical" and "Opera" are included among the genres.

Music Experience Sheet. Subjects indicated their music training and performance experience, their participation in music-making activities, as well as their personal music listening preferences. Items similar to those reported by Nusbaum & Silvia (2011) and Kreutz et al. (2008) were used.

Participant Information Sheet. Subjects indicated their age, gender, college major and minor, and recent alcohol and psychoactive drug use. Recent use served as cause for exclusion, since that may affect the individual's emotional response to or experience of the music (Dorard et al., 2008). Subjects also indicated if they were familiar with German, which would allow them to understand the Schubert song.

Chapter 3

Results

Data Analysis

Descriptive Statistics. Table 1 shows descriptive statistics for variables measured before and after listening to the sound stimulus. It also includes difference variables constructed by taking the difference (Time 2 – Time 1) of values of the repeated measurements of extraversion, neuroticism, positive affect and negative affect. See Table 14 (in appendix) for descriptive statistics of other variables that were not the main focus of this study, including openness, conscientiousness, and agreeableness. Pearson correlations of measured variables are shown in Tables 15 and 16 (in appendix).

Measurement reliability. The personality data (extraversion and neuroticism) and the emotion data (positive and negative affect) measured at Times 1 and 2 (before and after listening to the sound stimulus) were examined for internal consistency using the Cronbach α measure (see Table 2). All showed good internal consistency (between .7 and .9).

Stability coefficients. The stability or test-retest reliability of the personality and emotion data was examined by computing Pearson correlations of the Time 1 and Time 2 values of the respective variables (see Table 2). Both extraversion and neuroticism showed high stability from Time 1 to Time 2 with correlation coefficients at .9 or above. Affect scores were slightly less stable, with positive affect stability coefficient of .75 and negative affect stability coefficient of .66.

Tests

Normality. Personality, stimulus liking, and emotion data were examined for normality in several ways. Skewness or kurtosis values greater than 2.0 were found for negative affect at

Table 1

Descriptive Statistics for Measurements at Time 1, Time 2 and their Difference (Time 2- Time 1)

	Range	Min	Max	Mean	S.D.	Skew	S.E.S.	Kurtosis	S.E.K.
				Time	1				
Age	19	18	37	20.72	3.62				
Extraversion	28	12	40	26.88	7.13	-.192	.309	-.635	.608
Neuroticism	25	10	35	21.90	5.80	.220	.309	-.620	.608
Positive Affect	32	14	46	29.02	7.04	.327	.309	.001	.608
Negative Affect	17	10	27	12.92	3.21	2.200	.309	6.535	.608
				Time	2				
Extraversion	29	11	40	26.78	7.22	-.221	.309	-.437	.608
Neuroticism	28	8	36	20.50	6.37	.278	.309	-.375	.608
Positive Affect	39	10	49	25.72	9.50	.541	.309	-.343	.608
Negative Affect	16	10	26	11.53	2.47	3.794	.309	19.788	.608
Liking of Stimulus	6	1	7	4.25	1.88	-.296	.309	-1.233	.608
Differences:				Time	2 – 1				
Extraversion	10	-4	6	.10	2.01	.451	.309	.175	.608
Neuroticism	13	-9	4	-1.40	2.78	-.367	.309	.328	.608
Positive Affect	31	-16	15	-3.30	6.31	.194	.309	.930	.608
Negative Affect	12	-9	3	-1.38	2.43	-1.024	.309	2.092	.608

Table 2

Internal Consistency and Test-Retest Reliability

	Cronbach α Time 1	Cronbach α Time 2	Pearson r of Time1, Time 2	Pearson r 2-tailed Significance
Extraversion	.89	.89	.961	.000
Neuroticism	.78	.83	.900	.000
Positive Affect	.85	.93	.747	.000
Negative Affect	.68	.71	.662	.000

Times 1 and 2 and their difference, evidence suggesting non-normal distribution (see Table 1). The Shapiro-Wilk W (S-W) statistic was used to test the goodness of fit to a normal distribution for measurements of liking the stimulus, and liking was found to be non-normal (Mean= 4.25, S.D.=1.88, Shapiro-Wilk W=.904, $p<0.002$). The Shapiro-Wilk W (S-W) statistic was also used to test the goodness of fit to a normal distribution for extraversion, neuroticism, positive and negative affect measurements within each sound condition group (see Tables 3-6). In using this method of normality test, small p values for the Shapiro-Wilk statistic give evidence to reject normality. Normality is rejected for negative affect measurements at Time 1, Time 2, and their difference, in all stimulus condition groups, as seen by numerous Shapiro-Wilk p values <.05 (see Table 6). On the other hand, no evidence was found to reject normality for the positive affect data for each of the stimulus groups. Normality is not rejected for extraversion and neuroticism data at Time 1. However, normality of extraversion at Time 2 in the Brownian Noise condition was very close to being rejected ($p=.06$). Normality of neuroticism data for each of the stimulus groups is not rejected at Time 1 or Time 2. However, normality is rejected for the neuroticism difference variable (Time 2 value – Time 1 value) for the group listening to the Sinding instrumental work ($p=.04$).

Homogeneous variance. Personality and emotion data for the stimulus condition groups were examined for unequal variances using several tests for homogeneity. Unequal variances were found among the stimulus groups for positive affect (O'Brien's test, $F(3,56)=3.00$, $p=.04$) and for negative affect (Levene's test, $F(3, 56)=5.26$, $p=.03$) at Time 1. At Time 2, unequal variances among the stimulus groups were found for extraversion (Levene's test, $F(3,56)=2.83$, $p=.05$) and negative affect (Levene's test, $F(3,56)=1.7$, $p=.04$). For the difference variables constructed by subtracting measurement at Time 1 from measurement at Time 2, unequal variances were found for the positive affect difference (Bartlett's test, $F(3)=2.79$, $p=.04$).

Stimulus Group Differences at Baseline. Comparisons of the means of extraversion, neuroticism, and positive affect among the stimulus groups were conducted by one-way ANOVA. Testing for difference between stimulus groups at Time 1 in extraversion found no significant differences ($F(56,3)=.91$, $p=.44$), and extraversion explained approximately 5% ($R^2=.046$) of the variance in the groups. No significant difference between stimulus groups at Time 1 in neuroticism was found ($F(3,56)=1.95$, $p=.13$), and neuroticism explained approximately 9% ($R^2=.094$) of the variance in the groups. Because of the unequal variances found among the stimulus group measurements

Table 3

Extraversion Normality within Stimulus Groups

	Time	Mean	S.D.	S-W	S-W p
			Extraversion		
	1	27.8	4.84	.911	.14
Music-Choral	2	28.0	4.80	.907	.12
	2-1	0.2	2.11	.951	.54
	1	24.6	8.04	.947	.49
Music-Instrumental	2	24.3	8.97	.952	.56
	2-1	-0.3	1.95	.929	.26
	1	28.5	6.86	.952	.56
Brownian Noise	2	29.1	6.19	.888	.06
	2-1	0.6	2.23	.898	.09
	1	25.8	8.33	.962	.72
Lecture	2	25.7	7.94	.939	.37
	2-1	-0.1	1.83	.970	.86

Table 4

Neuroticism Normality within Stimulus Groups

	Time	Mean	S.D.	S-W	S-W p
			Neuroticism		
	1	24.7	5.07	.926	.24
Music-Choral	2	22.4	6.49	.905	.11
	2-1	-2.3	2.79	.971	.87
	1	19.9	5.40	.893	.08
Music-Instrumental	2	17.9	5.47	.916	.17
	2-1	-1.9	2.76	.871	.04
	1	22.0	7.11	.951	.55
Brownian Noise	2	22.6	7.03	.981	.98
	2-1	0.6	2.67	.913	.15
	1	21.1	4.79	.923	.21
Lecture	2	19.1	5.61	.970	.86
	2-1	-2.0	2.04	.899	.09

Table 5

Positive Affect Normality within Stimulus Groups

	Time	Mean	S.D.	S-W	S-W p
		Positive Affect			
	1	28.7	9.75	.952	.56
Music-Choral	2	26.4	10.35	.941	.39
	2-1	-2.3	4.81	.928	.26
	1	29.9	4.81	.947	.49
Music-Instrumental	2	26.5	8.14	.945	.44
	2-1	-3.4	7.35	.956	.62
	1	27.3	6.22	.956	.63
Brownian Noise	2	22.6	7.34	.946	.46
	2-1	-4.7	4.22	.981	.97
	1	30.1	6.84	.937	.34
Lecture	2	27.4	11.77	.942	.41
	2-1	-2.7	8.34	.948	.49

Table 6

Negative Affect Normality within Stimulus Groups

	Time	Mean	S.D.	S-W	S-W p
			Negative Affect		
	1	13.1	2.12	.926	.24
Music-Choral	2	11.3	1.23	.878	.05
	2-1	-1.7	2.15	.956	.63
	1	12.7	3.20	.709	.00
Music-Instrumental	2	10.7	1.11	.660	.00
	2-1	-2.1	2.22	.742	.00
	1	11.8	1.78	.883	.05
Brownian Noise	2	11.5	1.92	.774	.00
	2-1	-0.3	1.87	.956	.63
	1	14.1	4.76	.815	.01
Lecture	2	12.6	4.14	.624	.00
	2-1	-1.5	3.13	.863	.03

of positive affect, Welch's ANOVA, which allows for unequal variance, was used. As with extraversion and neuroticism, no significant difference between stimulus groups at Time 1 in positive affect was found ($F(3,30.4)=.62$, $p=.61$). Because of the non-normality of the negative affect measures, the nonparametric Kruskal-Wallis rank sums test was used to compare stimulus groups at baseline for equality in negative affect. As with the other variables, no significant difference was found between stimulus groups at Time 1 in negative affect ($\chi^2(3)=.39$). Thus, no evidence was found to conclude that the randomly-assigned groups were different[3] in these variables at Time 1.

Hypotheses

H1. In terms of predicting emotional state change, an interaction is expected between initial emotional state and liking the selection to which they listen such that those indicating negative emotion initially who like the selection to which they listen will show a pre- to post-listening change (improvement) in emotion valence. Those showing positive emotion initially who dislike the selection to which they listen will show a pre- to post-listening change (worsening) in emotion valence.

A series of regressions was performed that successively added terms to the equation to predict affect at Time 2. This process was done for positive affect, and then it was repeated for negative affect. First, Time 2 affect was regressed onto Time 1 affect. Then Liking the stimulus was added as another term. Finally, a third regression was

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[3] See Note 1 (in Notes section) regarding gender differences. See Note 3 (in Notes section) regarding differences in other variables in the sample consisting of all participants (N=87), including those that did not pass the exclusion criteria.

performed in which the interaction of affect and liking was tested by adding a product term. Thus, the interaction was tested for significance by regressing the affect measured at Time 2 ($\hat{Y}$) onto affect measured at Time 1 (X) and onto liking (Z) and onto a product term of liking*affect at Time 1 (XZ), as follows:

$$\hat{Y} = B_0 + B_1 X + B_2 Z + B_3 XZ$$

The X and Z variables were centered about their means to help in interpreting the results. Tables 7 and 8 give the results for these successive regressions for positive and negative affect. As seen in the R^2 values and significance for the models, each successive term improved the amount of variance described by the model. However, for predicting positive affect at Time 2, the last model increased the R^2 value only by (.002) and the coefficient for the interaction term of liking * positive affective at Time 1 was not significant ($t=.672$, $p=.504$). Of these models, the equation that best described prediction of positive affect at Time 2 was found to be:

$$PA2 = 25.720 + 0.984 * PA\ 1 + 1.583 * Liking$$

where PA2 is positive affect measured at Time 2, PA1 is positive affect at Time 1, and Liking is the participant’s level of liking the stimulus sound selection to which they listened. Therefore, hypothesis 1 was not supported for predicting positive affect. Although liking the stimulus was significant, in addition to the positive affect level at Time 1, in predicting positive affect at Time 2, the interaction of liking with positive affect at Time 1 was not significant.

The same process was performed to test models that predict negative affect at Time 2. The R^2 variance explained by each of these models successively improved, with

Table 7

Regressions of Time 2 Positive Affect onto Time 1 Positive Affect and onto Liking the Stimulus

Regressed onto:	Equation	Coefficient	Significance (t)	p	R^2	Model Test	Model p
Positive Affect	PA2= B0 + B1 * PA1	B0=25.720	31.30	000	.559	F(1,58)=73,383	.000
At Time 1 (PA1)		B1=1.008	8.57	000			
PA1 and	PA2=B0 + B1 * PA1 +	B0=25.720	35.18	.000			
Stimulus Liking	B2 * Liking	B1=.984	9.38	.000	.657	F(2,57)=54.517	.000
		B2=1.583	4.04	.000			
PA1,	PA2=B0 +	B0=25.69	34.91	.000			
Stimulus Liking,	B1 * PA1 +	B1=.979	9.28	.000	.659	F(3,56)=36.146	.000
Product of	B2 * Liking +	B2=1.574	3.99	.000			
PA1 * Liking	B3*PA1*Liking	B3=.038	.672	.504			

Table 8

Regressions of Time 2 Negative Affect onto Time 1 Negative Affect and onto Liking the Stimulus

Regressed onto:	Equation	Coefficient	Significance (t)	p	R^2	Model Test	Model p
Negative Affect	NA2= B0 + B1 * NA1	B0=11.535	47.894	000	.438	F(1,58)=45.129	.000
At Time 1 (NA1)		B1=.509	6.718	000			
NA1 and	NA2=B0 + B1 * NA1 +	B0=11.535	53.99	.000			
Stimulus Liking	B2 * Liking	B1= 0.521	7.741	.000	.565	F(2,57)=37.029	.000
		B2= -0.468	4.087	.000			
NA1,	NA2=B0 +	B0=11.564	60.86	.000			
Stimulus Liking,	B1 * NA1 +	B1= 0.490	8.133	.000	.662	F(3,56)=36.638	.000
Product of	B2 * Liking +	B2= -0.443	4.344	.000			
NA1 * Liking	B3*NA1*Liking	B3= -0.116	4.020	.000			

the last model that included the interaction of liking and negative affect at Time 1 explaining 66% of the variance (R^2=.662). All of the coefficients, including the interaction term of negative affect at Time 1 * liking the stimulus, were significant. The equation that best described the prediction of negative affect at Time 2 was found to be:

$$NA2 = 11.564 + .490 * NA1 - 0.443 * Liking - 0.116 * NA1 * Liking$$

where NA2 is negative affect measured at Time 2, NA1 is positive affect at Time 1, and Liking is the participant's level of liking the sound selection to which they listened. This finding supports hypothesis 1 that an interaction of liking and affect is significant in predicting negative affect at Time 2.

H2. Personality is expected to moderate the relationship between liking the stimulus and the type of stimulus, as follows:

H2a. Lower levels of extraversion will be associated with liking the less-arousing music selection (*Suite for Violin and Orchestra in A minor, Op. 10* by Christian Sinding) and the less-arousing control condition (listening to Brownian noise).

H2b. Higher levels of extraversion will be associated with liking the more-arousing music selection **(**Franz Schubert's *Ständchen***)** and the more-arousing control condition (listening to a literary theory lecture).

A preliminary ANOVA to compare liking in the arousing sound conditions, as compared to the non-arousing conditions, found no significant difference in liking (F(1,58)=.3777, p=.542) between the two types of conditions. Figure 1 shows stimulus liking by sound stimulus type. To test if liking arousing stimuli was predicted by

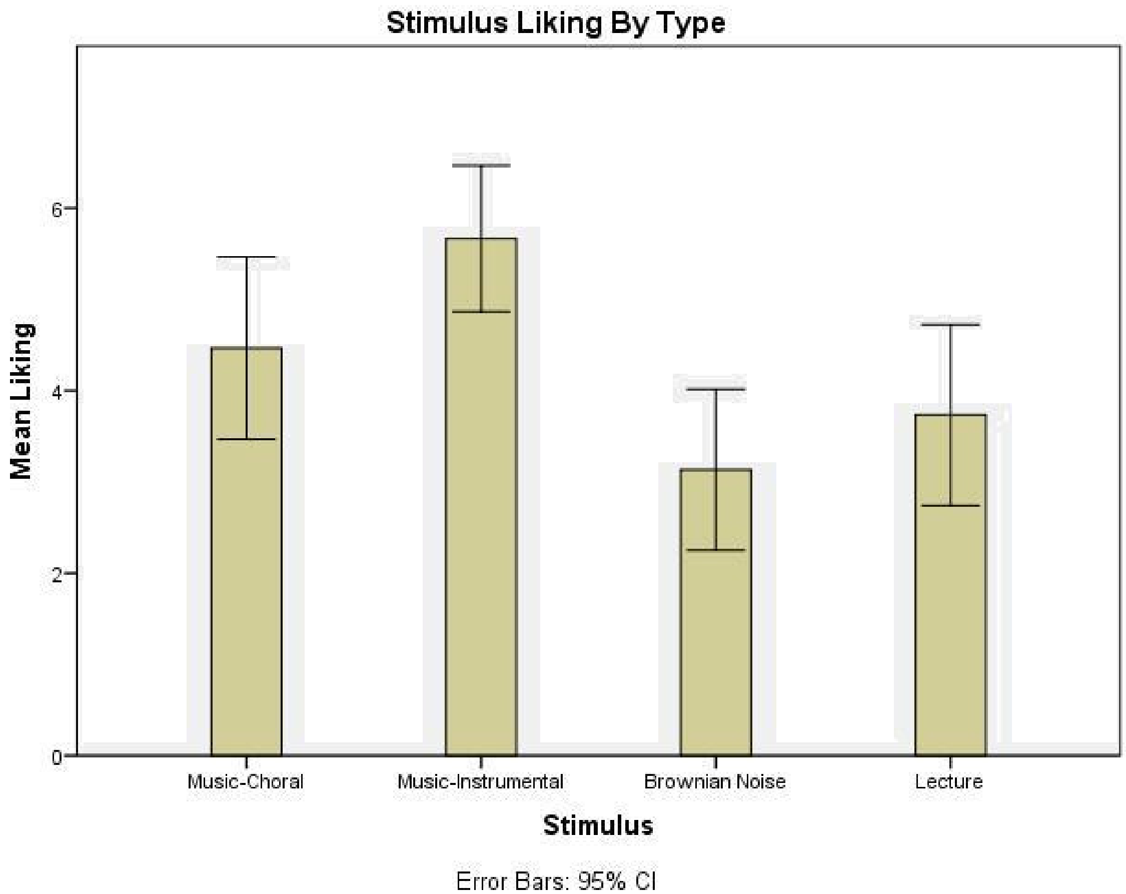

Figure 1

Stimulus Liking by Type

extraversion, liking was regressed onto extraversion at Time 1 and ArousingIndex (whether the stimulus was arousing or not) as follows:

$$\text{Liking} = B0 + B1 * AI + B2 * Ext1$$

where AI is 1 for arousing stimuli and 0 for non-arousing stimuli, and Ext1 is extraversion measured at Time 1. Another model was also constructed by adding an interaction term of the product of AI*Ext1. None of these models significantly modeled the data, (F(2,57)=1.064,p-.352; F(3,56)=1.189, p=.322). Therefore, Hypotheses 2.a. and 2.b. were not supported by these data.

H2c. Higher levels of neuroticism will be associated with liking the music that is likely to be perceived as sad (*Suite for Violin and Orchestra in A minor, Op. 10* by Christian Sinding).

In order to distinguish higher levels of neuroticism at time 1, the neuroticism responses were divided into Low (10-18), Medium (19-24), and High (25-35) categories in order to distribute all responses equally into three categories. Then frequency analyses were performed to chart these Low, Medium, and High categories of neuroticism at Time 1 against categories of liking for the instrumental stimulus. Those highest in neuroticism in this music condition chose only Liking=5 ("Like a Little") or Liking=7 ("Like Strongly). Table 9 summarizes the counts of those who disliked or liked this stimulus, breaking it down by category of neuroticism at Time 1. Thus, in the instrumental stimulus condition, which was likely to be perceived as sad, those highest in neuroticism rated their liking of this stimulus only as liked.

H3. It was hypothesized that greater change in emotion would be found in music conditions, as compared to non-music control conditions.

Testing for a difference between music and control conditions with ANOVA found no significant difference between music conditions, as compared to control conditions, in positive affect change (Time 2 – Time 1), (F(1,58)=.279, p=.599). Similarly no significant difference in negative affect change (Time 2 – Time 1) was found for music conditions, as compared to control conditions (F(1,58) = 2.797, p=.10). Figure 2 shows a graph of Positive and Negative Affect at both Time 1 and Time 2.

Because of issues of non-normality in the negative affect measurements, another method besides ANOVA was sought to make the comparison of negative affect change in music stimulus groups, as compared to control condition stimulus groups. A matched pair analysis was made of the negative affect measurements (negative affect at Time 2 - negative affect at Time 1), and this was done for each stimulus group. The non-parametric two-tailed Wilcoxon signed rank test was used in each case to test if a significant change in negative affect had occurred for that stimulus group (see Table 10).

Table 9

Category of Neuroticism at Time 1 by Liking in Instrumental Music Condition

	Category of Neuroticism at Time 1			
Count Total % Col % Row %	Low	Mid	High	
Disliked	1	1	0	2
	6.67	6.67	0.00	13.33
	12.50	33.33	0.00	
	50.00	50.00	0.00	
Liked	7	2	4	13
	46.67	13.33	26.67	86.67
	87.50	66.67	100.00	
	53.85	15.38	30.77	
	8	3	4	15
	53.33	20.00	26.67	

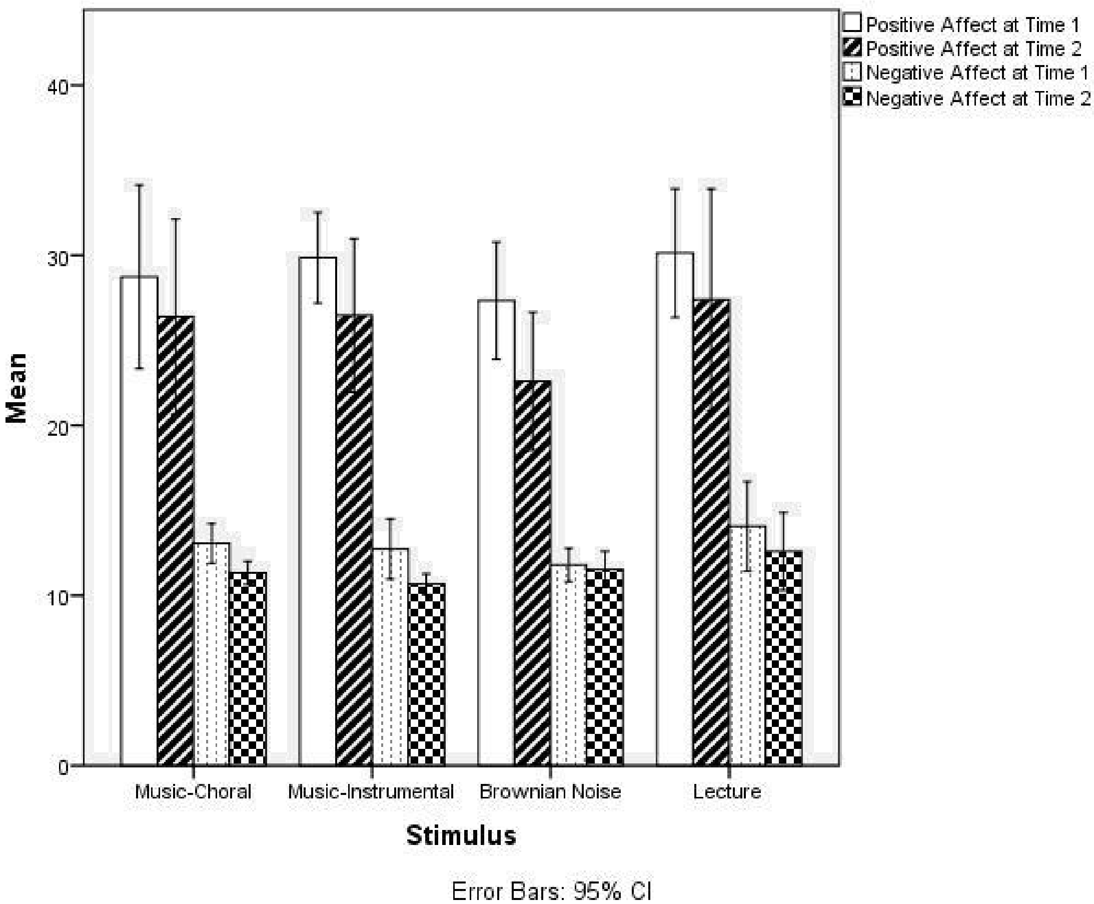

Figure 2

Positive and Negative Affect at Times 1 and 2

That test revealed evidence that significant changes in negative affect had occurred in both music conditions, but not in the noise group or the lecture group, although the lecture group had a marginal difference (p=.06).

Table 10

Changes in Negative Affect By Stimulus

	Negative Affect Mean Difference	Wilcoxon Signed Rank Statistic	Wilcoxon Significance p
Music-choral	1.73	39.5	.01
Music-Instrumental	2.07	39.0	<.00
Brownian Noise	0.27	5.5	.62
Lecture	1.47	18.5	.06

Similarly, a matched pair analysis with non-parametric test was made of the negative affect measurements (negative affect at Time 2 - negative affect at Time 1) for music stimulus groups versus control stimulus groups. That test showed a significant difference between the groups in negative affect change, with those in the music group reporting greater reductions in negative affect than those in the control conditions (see Table 11).

Table 11

Negative Affect Change (Time 2-Time 1) in Music Versus Control Conditions

	Negative Affect Mean Difference	Wilcoxon Signed Rank Statistic	Wilcoxon Significance p
Music Conditions	-1.90	378.0	.0001
Control Conditions	-0.87		

With respect to change in negative affect, a categorical analysis of negative affect change category (decrease, stayed same, increased) by stimulus condition showed that two participants in the music conditions and eight participants in the control conditions increased in negative affect. Regarding a decrease in negative affect, 24 participants in the music condition reported decreases in negative affect, and 13 in the control conditions also reported reduced negative affect.

H4. Changes in self-reported personality will be related to changes in emotion. Those showing more change in emotion from pre- to post-listening will be more likely to report changes in self-reported personality.

The difference in extraversion (Time 2 value - Time 1 value) was regressed onto the difference in positive affect (Time 2 value - Time 1 value) as follows:

$$ExtDif = B0 + B1 * PADif$$

where ExtDif is the difference in extraversion and PADif is the difference in positive affect. This model was not found to be significant (F1,58)=1.651, p=.204). Negative affect was tested by:

$$ExtDif=B + B1 * NADif$$

where NADif is the difference in negative affect. It also was not found to be significant (F(1,58)=.393,p=.533). Paired tests were also performed to compare extraversion at Time 1 and Time 2, and no significant difference was found (Wilcoxon Signed Rank S=17.50, p=.702). Figure 3 shows extraversion at Times 1 and 2 by stimulus condition and the lack of significant change in extraversion from Time 1 to Time 2 in all stimulus conditions is apparent.

The same process was repeated to investigate neuroticism measures at Time 1 and Time 2. Neuroticism at Time 2 was found to be significantly lower than at Time 1 (Wilcoxon Signed Rank Test S=-343.0, p=.000). The change in neuroticism (Time 2 value - Time 1 value) was regressed onto the change in positive affect (Time 2 value - Time 1 value) as follows:

$$NeuDif = B0 + B1 * PADif$$

where NeuDif is the difference in neuroticism and PADif is the difference in positive affect. A slight trend toward significance was found (F(1,58)=3.140,p=.082).

A regression was also done to examine the relationship of neuroticism change to negative affect change by the following:

$$NeuDif = B0 + B1 * NADif$$

where NADif is the change in negative affect. No significant relationship was found (F(1,58)=.043,p=.8337).

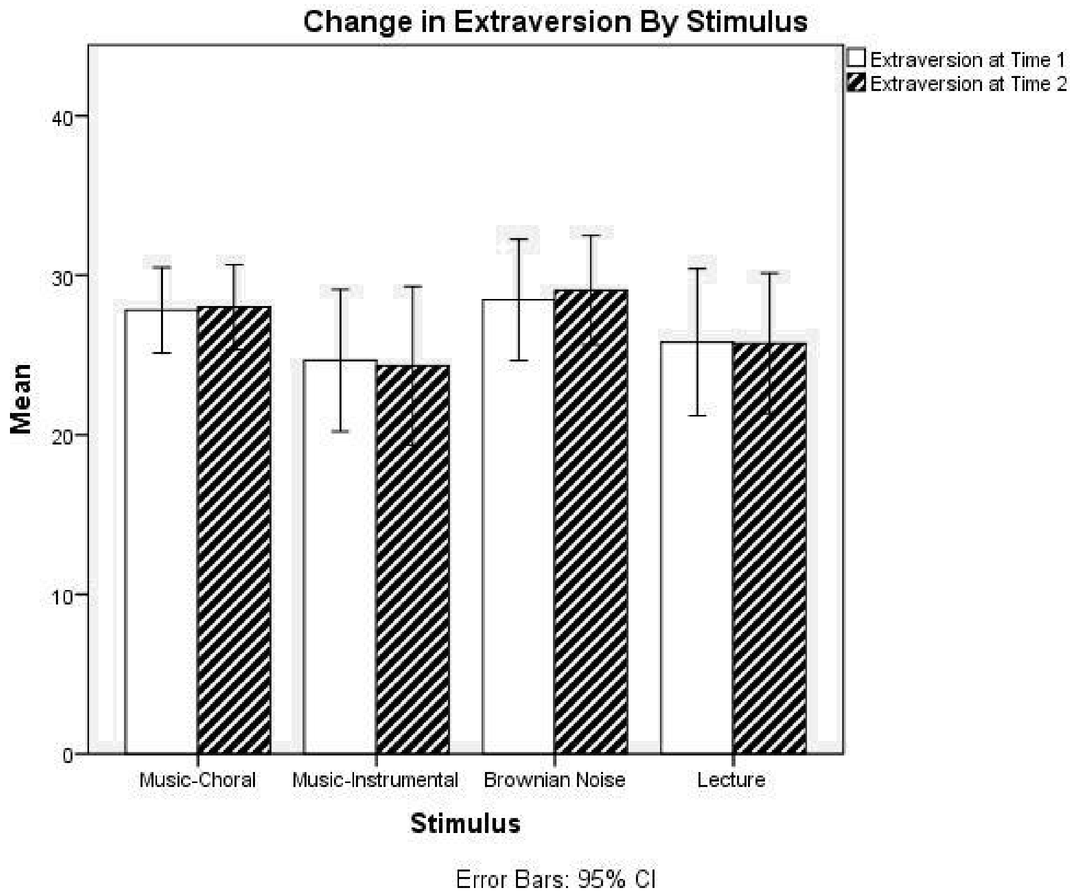

Figure 3

Extraversion by Stimulus

A graph of neuroticism at Times 1 and 2 by stimulus condition suggested that neuroticism may have decreased in all stimulus conditions except in the Brownian noise condition (see Figure 4). Because of the non-normality of the neuroticism difference variable (formed by Time 2 value - Time 1 value), the non-parametric Kruskal-Wallis test was used to determine that there was a significant difference in change in neuroticism by

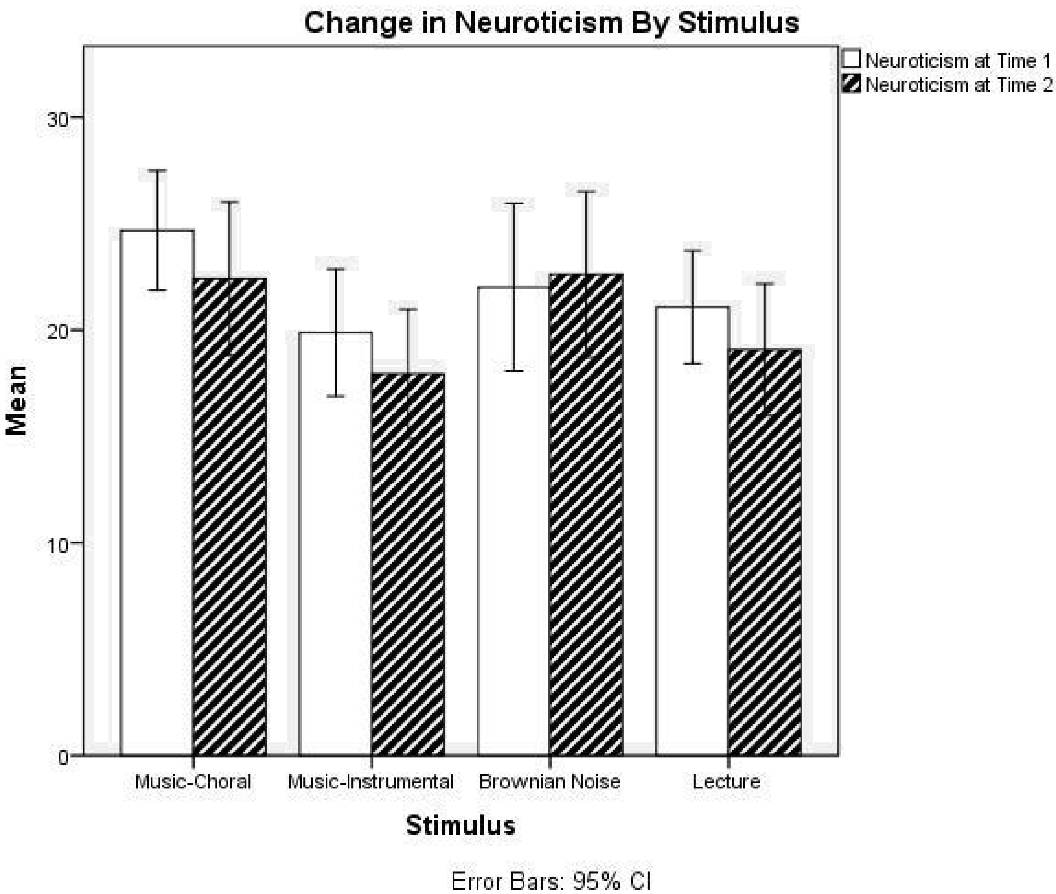

Figure 4

Neuroticism by Stimulus

stimulus group (χ2(3)=11.00, p=.01). Dunnett's Method was used to compare the Brownian Noise control condition with the other stimulus groups. Neuroticism dropped significantly at Time 2 for all three other stimulus groups, but not for the Brownian noise condition (Choral music: Dunnett's LSD=.59, p=.01; Lecture: Dunnett's LSD=.323, p=.02; Instrumental music Dunnett's LSD=.257, p=.03). A matched pairs analysis of neuroticism at Times 1 and 2 by negative affect change category (decreased, stayed same, increased) also confirmed that there was a significant difference in neuroticism that differed with negative affect change category (Wilcoxon S=343.0, p<.000). This was examined for each stimulus group. No significant change in neuroticism was found in the Brownian noise stimulus group, whereas all the other groups had significant reductions in neuroticism.

Chapter 4

Discussion

This research aimed to extend the study by Djikic (2011) by exploring differential emotional response to music as a function of personality traits extraversion and neuroticism. Djikic found variability in self-reported personality but did not find a specific personality factor showing significant change across all individuals. Did subjects experience the music differentially, perhaps through different emotions experienced or due to different degrees of enjoyment? This research extended that study to examine differential emotional response by assessing current emotional state immediately before and after listening, which was not done in that study. Thus, relationships between emotional state before and after music listening, extraversion and neuroticism, and enjoyment (liking) of the stimulus were examined. The rest of this chapter discusses the results of this research, its implications and limitations, as well as conclusions.

Summary of Results

H1. In terms of predicting emotional state change, an interaction was expected between initial emotional state and liking the selection to which they listened such that those indicating negative emotion initially who liked the selection to which they listened would show a pre- to post-listening change (improvement) in emotion valence. Those showing positive emotion initially who disliked the selection to which they listened would show a pre- to post-listening change (worsening) in emotion valence.

Partial support[4] was found for this hypothesis. The interaction of liking the stimulus and negative affect at Time 1 was, indeed, significant in predicting negative affect at Time 2. However, evidence was not found for this in the case of positive affect. Liking the stimulus and positive affect at Time 1, but no interaction of the two, was found to be a better model for predicting positive affect at Time 2.

H2. Personality is expected to moderate the relationship between liking the stimulus and the type of stimulus, as follows:

H2a. Lower levels of extraversion will be associated with liking the less-arousing music selection (*Suite for Violin and Orchestra in A minor, Op. 10* by Christian Sinding) and the less-arousing control condition (listening to Brownian noise).

H2b. Higher levels of extraversion will be associated with liking the more-arousing music selection (Franz Schubert's *Ständchen*) and the more-arousing control condition (listening to a literary theory lecture).

H2c. Higher levels of neuroticism will be associated with liking the music that is likely to be perceived as sad (*Suite for Violin and Orchestra in A minor, Op. 10* by Christian Sinding).

No support for H2a or H2b was found, but this research found evidence that supported H2c. Those participants categorized as high in neuroticism who were in the stimulus group that listened to the Sinding violin suite all reported liking that stimulus,

[4] Analyses were repeated using data from all participants (N=87), including those who did not pass the exclusion criteria. Results were not the same: H1 was not supported in that larger unrestricted sample. No significant interaction between liking and affect was found for positive or for negative affect.

which is consistent with self-verification theory proposed by Swann (1983). Those individuals in this current research who scored lowest in emotional stability (highest in neuroticism) rated the violin suite as liked, which was music that was perceived as saddest in a previous study (Mitterschiffthaler, Fu, Dalton, Andrew, & Williams, 2007). However, it must be noted that this selection was liked by all but two of the participants, one of which was categorized as low in neuroticism at Time 1, and one that was categorized as medium in neuroticism at Time 1. Because of the high degree of liking overall for this stimulus, as well as the small number of participants categorized as high in neuroticism, this result must be considered with caution[5].

H3. It was hypothesized that greater change in emotion would be found in music conditions, as compared to non-music control conditions.

Support was found for this hypothesis with regard to negative affect change, but not for positive affect change[6]. Participants in both music conditions reported highly significant decreases in negative affect after listening ($p \leq .01$), while those in the noise condition did not report any significant change in negative affect, and those in the lecture

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[5] Analyses were repeated using data from all participants (N=87), including those who did not pass the exclusion criteria. Results were the same: H2a and H2b were not supported, and H2c was supported in that larger unrestricted sample.

[6] Analyses using data from all participants (N=87), including those who did not pass the exclusion criteria, gave different results for H3 regarding which type of affect showed a significant difference: In comparing the drop in positive affect between music and control groups for the N=87 sample, music groups decreased in positive affect significantly less than control groups. Music appeared to buffer the overall drop in positive affect. .

condition showed a trend toward significant change (p=.06) in negative affect. Comparing music conditions to control conditions, a significant difference in change in negative affect from Time 1 to Time 2 was found between music and control conditions. Although both music and control groups had significant reductions in negative affect after listening, the music groups had a significantly greater reduction in negative affect.

H4. Changes in self-reported personality will be related to changes in emotion. Those showing more change in emotion from pre- to post-listening will be more likely to report changes in self-reported personality.

No significant change in extraversion was found, but a significant reduction in neuroticism was found between Times 1 and 2. No regression model was found that significantly modeled this relationship of neuroticism change linked to negative affect change. Mean differences in neuroticism were found to differ significantly with negative affect change categories. It was seen that no significant change in neuroticism was reported by those in the Brownian noise control group[7]. All the other stimulus groups showed neuroticism changes that varied significantly with negative affect categories of change (categories=negative affect decreased, stayed the same, or increased).

Since personality, as a construct, is intended to reflect enduring qualities that do not change from moment to moment, this reduction in neuroticism for all groups but the

[7] When analyses were repeated with all participants (N=87), including those who did not pass the exclusion criteria, the same results were obtained for H4. No significant change in extraversion was found, and a significant change in neuroticism was found. Only the noise condition showed no significant change, and change in neuroticism varied as a function of negative affect change category.

Brownian noise condition after six minutes of listening to a sound stimulus is a surprising finding. Vaidya and colleagues point out that if all other things are equal, "scales that show lower reliabilities should also have lower stability coefficients" (Vaidya, Gray, Haig, & Watson, 2002, p. 1470). Neuroticism at Times 1 and 2 in this research showed internal consistency (.78 and .83, respectively). It also showed high test-retest reliability (Pearson correlation of Time 1 x Time 2 = .900, $p<.001$). Other researchers have found that extraversion is the most stable over time and neuroticism the least (Vaidya, Gray, Haig, & Watson, 2002; Conley, 1985). However, these studies had retest periods from months to years, rather than minutes, as in this research. This study and the Djikic study (2011) may be the first to use the Big Five Inventory (John, Donahue, & Kentle, 1991) in repeated measurements over such a short retest period.

An argument could be posed that perhaps the BFI neuroticism scale measures state, as well as trait, characteristics. Participants in the Brownian noise condition in this research showed no significant change in negative affect from Time 1 to Time 2, a current state measurement. Participants in the Brownian noise condition in this research also showed no significant change in neuroticism from Time 1 to Time 2 (see Figure 4 and data analysis for Hypothesis 4). The H4 data analysis also showed a link between change in neuroticism and change in negative affect. Although this is not enough evidence to conclude that the change observed in neuroticism in this research may be due to the BFI neuroticism scale being overly sensitive to current state, it does suggest that this may be a possibility and should be investigated in future work.

Implications

This research extended the Djikic (2011) study in order to examine emotional response to music as a function of individual differences. The results summarized in the preceding section will be explored for their implications.

Liking the stimulus was found to interact significantly with the amount of negative affect reported after listening, but no interaction with liking and positive affect was found when considering the sample of participants that passed the exclusion criteria (N=60). The interaction was not found to be significant with negative or with positive affect when the previously excluded participants were included (N=87). In both these analyses, however, liking the stimulus was found to be significant. It is worth noting that the sign of the coefficient for the liking term in the models that best predicted negative emotion at time 2 was negative in both of these analyses (for N=60 analysis, B2=-0.443; for N=87 analysis, B2=-.372). This means that negative affect at Time 2 is reduced by an amount related to how much they liked the stimulus. In settings where the intent is to improve or reduce the amount of negative emotion being experienced, this result may indicate the need to accommodate individual liking of sound selections. This finding has implications for settings where music or other background sound is being used. What may be effective in reducing negative affect for one individual may have the opposite effect for those who do not like it, and the linear models that were tested here support that quantitatively.

Those highest in neuroticism were found to report liking the music that had been found in other studies to be perceived as sad (Sinding's *Suite for Violin and Orchestra in*

A minor, Op. 10). The Associative Network Theory proposed by Bower (1981) predicts that free association and categorizations are affected by the current emotion or mood state. Although this study did not set out to explore that theory, it may be consistent with this rating of liking a stimulus that may be perceived as sad by those reporting the highest level of neuroticism. However, because of the high degree of liking of that stimulus among most of the participants, this result must be considered with caution.

Those in the music conditions showed a significantly greater change in negative affect. After listening to the music, participants in the music stimulus groups had significantly greater reductions in negative affect than participants in the control groups, even though the control group participants also had significant reductions. It is important to note that when groups are considered individually rather than aggregated into just music and control groups, those in the Brownian noise stimulus group did not report a significant change in negative affect. No significant change in positive affect was observed. The use of noise generators and background music is ubiquitous, and this finding has implications for the intent of their use. They may be useful to mask other sounds, but this finding brings into question how they may (or may not) influence negative affect.

No significant change in extraversion was found in this study, neither over all conditions nor as a function of sound condition. However, significant change was found in self-reported neuroticism after listening to a sound stimulus for six minutes in a laboratory setting, except for the case of listening to Brownian noise, in which case no significant change of either extraversion or neuroticism were reported. These results (no change for extraversion observed, but significant changes in neuroticism in all but the Brownian noise condition) were found in both samples of participants considered (N=60 participants who passed exclusion criteria; and N=87 participants, which included those who did not pass the exclusion criteria). In addition, a significant link was found between change in neuroticism and category of negative affect change. To find any significant change in what has, in the past, been found to be a stable trait over time (weeks to decades) is a surprising finding. This extends the finding of Djikic (2011). It shows a difference in this finding related to what activity (or stimulus) is being attended between the pre- and post- measurements, and it shows a link to change in negative affect.

Because the data for several of the study variables were not found to be significantly normal (liking the stimulus, negative affect at both measurement times and their difference, and the difference in neuroticism from Time 1 to time 2), ANOVA and least squares regression were not suitable for inferences. Other non-parametric tests and categorical methods were pursued in order to examine these data and their relationships. This has implications for researchers using individual difference data. Care needs to be exercised to choose statistical methods that are warranted by the nature of the sample, rather than relying on simpler techniques that are often used in psychological research.

This research has implications for emotion research, and especially research that relates to felt emotion rather than perceived emotion due to listening to music. Not only are some of the data likely to be non-normal, but relationships between study variables may prove challenging to assess. The importance of individual differences, and especially individual liking of the stimulus, has proven important in this current research. That implies that other studies may need to take that into account, even if that is not the focus of the study.

An increasing number of emotion studies are using neuroscience techniques as part of their methodology. The results of this current research underscore the importance of controlling for liking the stimulus. This has particular implications in brain studies because of activations related to salience or personal relevance to the individual. Another implication of this research also relates to studies involving neuroscience. The default mode network is the system of brain areas active when the individual is not being asked to attend to a task (Raichle, et al., 2001). Those are also areas that are active when the stimulus is very self-relevant or rewarding (de Greck, et al., 2008). Of the four stimuli used in this research, the Brownian noise condition may be likely to engage those areas more which become active when not being asked to attend to a task. The two music conditions, as well as the lecture, offer much more variety in stimulus to engage attention, whereas the Brownian noise condition may offer more opportunity for rumination or self-relevant reflection. Future work may be warranted to use physiological and neurological measures in examining the differences observed in negative affect and neuroticism.

Limitations

Sixty university students, primarily in their early twenties, participated in this study. Although these students came from a variety of different majors, the fact that they were all university students may preclude them from being representative of the general population at large. Each stimulus group consisted of 15 randomly-assigned participants. This small N for each group is also a limiting factor in considering this research.

This between-subjects design relied on random assignment of participants to conditions to make them comparable on individual differences. It also made no attempt to balance sex, age, or other demographic characteristics of participants. Although the groups thus formed were not found to be significantly different on study variables at Time 1, several of the study variables were not found to be normally distributed. Because no significant differences were found between genders in any variables (see Note 1, Notes section), there is no evidence to suspect that gender played a part in these findings.

Roberts & DelVecchio (2000), in their meta-analysis of 152 longitudinal studies involving 3,217 test-retest correlation coefficients, found increasing stability of personality traits from .54 in the college years to .64 in the thirties to .74 in older adulthood. They also reported that extraversion was found to be the most stable trait and that neuroticism was the least. The retest intervals for those longitudinal studies were years, rather than minutes, as in this study. Despite the interval difference, the results of this study are somewhat comparable to those found by Roberts & DelVecchio. In this study, neuroticism was found to change upon exposure to all sound conditions except Brownian noise, and no significant change in extraversion was observed. This leads to the question – is it possible that measures of neuroticism are more sensitive to current state and are, therefore, more subject to change? If they are tapping state inordinately, rather than strictly measuring trait, this could be a source of the differences seen. This possibility of measurement error due to differences in content validity between the traits could be investigated through future research that uses other measures of neuroticism.

The consistent lack of findings concerning positive affect may possibly be related to some degree with the measurement instruments used. The findings that Djikic (2011) referred to concerning the link between positive affect and extraversion and the link between negative affect and neuroticism was based on the work by Costa & McCrae (1980) which led to their development of the NEO-PI-R (Costa & McCrae, 1992). However, the Djikic study, as well as this work, used the BFI personality measure (John, Donahue, & Kentle, 1991), which may not exhibit this link between positive affect and extraversion.

Note that the consistent lack of findings concerning positive affect was observed when only the participants that passed the exclusion criteria were considered (N=60). When those excluded participants were included, a significant difference was seen in positive affect between music and control conditions, but the significant difference in negative affect disappeared that had been observed in that restricted group. Both of these changes in results deal with affect variables primarily, rather than personality variables. Hypotheses H2 and H4, which dealt primarily with personality variables, were supported with both participant samples (including or excluding those who did not pass exclusion criteria). Because other research has linked psychoactive substances to impaired emotion regulation (Dorard, Berthoz, Phan, Corcos, & Bungener, 2008) and to differential experience of music (McKinney, 2010), future work should investigate further these differences observed when considering screened versus unrestricted participants.

This study focused on the personality domains of extraversion and neuroticism. It found a significant change in neuroticism that was a function of sound condition (no change in noise condition, and varying degrees of change in the other conditions). These results suggest looking for change in the other domains of the Big Five (openness, conscientiousness, agreeableness), as the Djikic (2011) study did[8]. It also indicates that looking at a range of sound stimuli may reveal differential response in those domains, as well.

Conclusions

In extending the study by Djikic (2011) in order to examine individual differences in emotional response to music, the current research has shed new light on relationships between changes in self-reported emotion, personality, and liking of a sound stimulus. The importance of liking the stimulus was seen to be significant in predicting affect after listening, and a significant interaction was found between liking the stimulus and negative affect. Extraversion was not found to change significantly during the six minutes of listening to a sound selection. Self-reported neuroticism, however, did significantly decrease from time 1 to time 2 in this research in all conditions except in the Brownian noise condition, and the change was linked to category of negative affect change (decreased, stayed same, increased).

Research into emotion felt in response to music listening is still limited in quantity, compared to other aspects of music listening, such as perceived emotion or genre preferences. This research shows the importance of considering individual differences when assessing change in felt emotion.

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[8] See Note 2 (in the Notes section) concerning change in the other personality domains.

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Notes

1. Differences in gender in the N=60 sample were investigated for all personality, emotion, and liking measures by one-way ANOVA. F-test, Welch's test, and the non-parametric Wilcoxon sign test all confirmed that no significant difference was found between genders in any variables. Figure 5 shows the composition of the stimulus groups formed by random assignment, and Table 12 shows the respective counts.

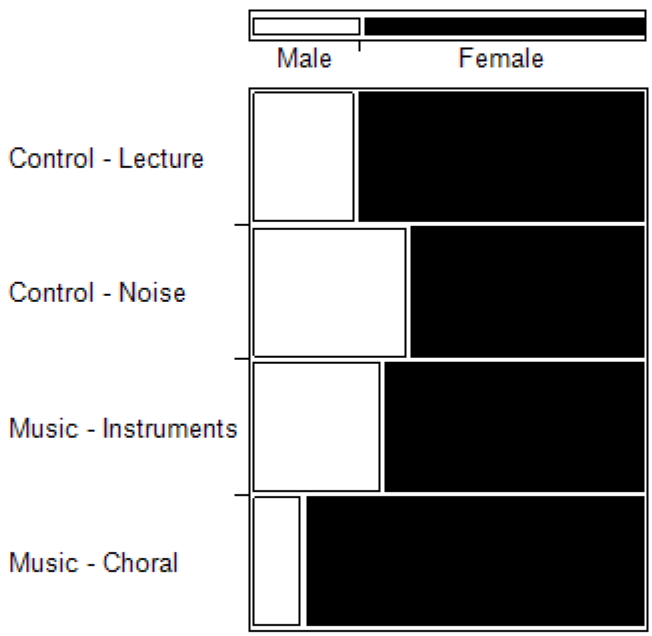

Figure 5

Composition of Stimulus Groups by Gender

Table 12

Stimulus Group Gender Composition

	Male	Female	
Music - Choral	2	13	15
Music - Instruments	5	10	15
Control - Noise	6	9	15
Control - Lecture	4	11	15
	17	43	60

Analyses were repeated with all participants, including those that did not pass the exclusion criteria. Through use of ANOVA, no evidence was found for differences between genders in any variables in this sample (N=87), except for a trend toward a difference in positive affect change (F(1, 85)=3.678, p=.058).

2. The repeated measures of openness, conscientiousness, and agreeableness were found to have test-retest stability (see Table 13). Matched pair t-tests were performed to investigate change from measurement Time 1 to measurement Time 2. A significant drop in openness, a trend for increase in conscientiousness, and no significant change in agreeableness were found (see Table 13).

Table 13

Testing Change in Openness, Conscientiousness, and Agreeableness

	Stability		Evidence for Significant Change			
	Coeff.	p	Change?	Direction (T2-T1)	Matched Pair t-test	Wilcoxon
Open.	.85	.000	Yes	Drop	t(1,59)=-2.74, p=.008	p=.015
Consc.	.94	.000	Trend	Increase	t(1,59)=1.949, p=.056	p=.061
Agree.	.88	.000	No	None	t(1,59)=0.682, p=.498	p=.172

3. Analyses were repeated with all participants (N=87), including those that did not pass the exclusion criteria. Through use of ANOVA, no significant differences in variables were found at Time 1 in groups formed by random assignment, except for the following: There was a significant difference between the two music groups in levels of neuroticism at Time 1 (Tukey's HSD=5.182, p=.027) and between the choral and lecture groups (LSD=-4.018, p=.032). The choral and lecture groups were also found

to be significantly different in conscientiousness at Time 1 (LSD=-3.919, p=.017) and in agreeableness (Tukey's HSD=-4.909, p=.029).

Appendix

Informed Consent Form

Title of Project: Personal Perceptions Following a Listening Task

Principal Investigator: Sarah Fischer, M.S.
Faculty Advisors: Eric Sundstrom, Ph.D.

Introduction: The purpose of this study is to examine personal perceptions and preferences relating to listening to various sounds.

Participant's Involvement: After providing consent, you will use a computer to complete some questionnaires, rate your current feelings, and do a writing task. Then you will listen to a randomly selected sound stimulus for several minutes. Then you will be asked to complete several of the questionnaires and writing task again and fill out a final set of questionnaires.

Amount of time required: Your time requirement will be approximately one hour.

Risks and Benefits: Your participation in this study is strictly voluntary, and risks to you are minimal. There are no forseeable risks from participating in this study beyond what you experience in daily life. If you withdraw from the study before data collection is complete, your data will be destroyed. You will be given class credit or extra credit for your participation, depending on your instructor's policy. Refer to your instructor's guidelines for the actual number of points that you will receive. If you so choose, your name will be entered for a drawing in which one participant will win a new Apple© iPad® 3.

Confidentiality: Data from this study will be archived for use with this and future studies. The data will be coded with a participant number, not a name. Your name will not appear on any questionnaire or with any electronic data. This signed consent form, which is the only form that will have your name on it, will be stored in a locked file in the Austin Peay Building at the University of Tennessee, Knoxville for three years after your participation. The data gathered in this study will be shared professionally in published works; however, no personally identifying information will be released to anyone for any reason. No reference will be made in any oral or written report that could link participants to the study.

Contact Information If you have questions at any time about the study or the procedures (or should you experience adverse effects as a result of participating in this study), you may contact the Principal Investigator, Sarah Fischer at sfische1@utk.edu or the Faculty Advisor, Dr. Eric Sundstrom at esundstr@utk.edu or 865-974-4780. If you have questions about your rights as a participant, contact Research Compliance Services of the Office of Research at 865-974-3466.

Consent: I have read and understand the above information and have been provided with a copy of this form. I have had all of my questions answered to my satisfaction, and I voluntarily agree to participate in this study. I agree that data collected during my participation in this study may be archived and used in professional publications and presentations, and that nothing will be reported that personally identifies me or my participation in this study.

Participant's signature ________________________________ Date ______________

Investigator's signature ________________________________ Date ____________

Table 14

Descriptive Statistics for Other Variables Measured at Time 1, Time 2, and their Difference (Time 2- Time 1), N=60

	Time	Range	Min	Max	Mean	S.D.	Skew	S.E.S.	Kurtosis	S.E.K
Openness	1	26	22	48	37.60	6.79	-.252	.309	-.644	.608
	2	33	17	50	36.60	7.83	-.457	.309	-.319	.608
	2-1	13	-9	4	-1.00	2.82	-.618	.309	.351	.608
Conscientiousness	1	19	25	44	35.43	4.70	-.257	.309	-.608	.608
	2	18	26	44	36.08	4.78	-.208	.309	-.718	.608
	2-1	19	-4	15	.65	2.58	3.021	.309	15.721	.608
Agreeableness	1	33	12	45	36.50	5.80	-1.560	.309	4.453	.608
	2	28	17	45	36.75	5.94	-.810	.309	.791	.608
	2-1	23	-15	8	.25	2.84	-2.117	.309	14.221	.608
Happy	1	69	30	99	65.02	15.54	.056	.309	-.483	.608
	2	82	18	100	56.63	16.16	.052	.309	.243	.608
	2-1	92	-62	30	-8.48	16.64	-.631	.309	.855	.608
Calm	1	67	33	100	78.82	17.17	-.680	.309	-.180	.608
	2	56	44	100	78.85	17.18	-.231	.309	-1.182	.608
	2-1	68	-26	42	.03	12.89	.334	.309	.986	.608
Energized	1	85	11	96	49.98	16.34	.263	.309	.177	.608
	2	99	1	100	45.95	23.34	-.196	.309	-.606	.608
	2-1	122	-63	59	-4.03	22.72	-.211	.309	.851	.608

Table 14 (continued)

	Time	Range	Min	Max	Mean	S.D.	Skew	S.E.S.	Kurtosis	S.E.K.
Fear	1	65	1	66	14.70	17.58	1.573	.309	1.651	.608
	2	51	1	52	10.03	13.46	1.676	.309	1.747	.608
	2-1	70	-30	40	-4.67	10.66	.613	.309	4.766	.608
Sad	1	62	1	63	14.42	18.64	1.405	.309	.704	.608
	2	65	1	66	16.50	17.35	1.220	.309	.855	.608
	2-1	95	-37	58	2.08	19.65	.468	.309	.765	.608
Angry	1	55	1	56	8.10	11.55	2.179	.309	5.015	.608
	2	38	1	39	7.45	10.20	1.727	.309	1.873	.608
	2-1	62	-29	33	-0.65	9.93	.389	.309	4.385	.608

Table 15

Zero Order Correlations for Repeated Measurements

	Variable	1	2	3	4	5	6	7	8
1	Extraversion	(.961***)	-0.305*	-0.005	0.189	0.331**	-0.025	-0.242	0.052
2	Neuroticism	-0.339**	(.900***)	-0.155	-0.365**	-0.477***	-0.095	0.253	-0.081
3	Openness	0.01	-0.129	(.935***)	0.032	0.167	0.386**	-0.296*	0.103
4	Conscientiousness	0.115	-0.269*	-0.072	(.852***)	0.374**	-0.119	-0.064	0.043
5	Agreeableness	0.277*	-0.461***	0.155	0.324*	(.883***)	0.098	-0.189	0.170
6	Positive Affect	-0.04	-0.09	0.176	0.015	0.1	(.747***)	-0.054	0.412***
7	Negative Affect	-0.352**	0.244	-0.086	-0.234	-0.232	0.009	(.662***)	-0.207
8	Happy	0.253	-0.432***	-0.01	0.268*	0.267*	0.550***	-0.227	(.450***)
9	Calm	0.066	-0.437***	0.041	0.307*	0.273*	0.017	-0.496***	0.357**
10	Energized	0.292*	-0.288*	0.175	0.089	0.424***	0.363**	-0.141	0.509***
11	Fear	-0.238	0.408***	0.092	-0.193	-0.353**	-0.054	0.568***	-0.372**
12	Sad	-0.129	0.343**	-0.045	-0.196	-0.380**	-0.21	0.437***	-0.463***
13	Angry	-0.102	0.463***	-0.031	-0.342**	-0.391**	-0.215	0.372**	-0.499***

Values in parentheses ( ) are stability coefficients (Time1 x Time2 correlations).
Values below the diagonal are for Time 1.
Values above the diagonal are for Time 2.
***. Correlation is significant at the 0.001 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 15 (continued)

	Variable	9	10	11	12	13
1	Extraversion	0.149	0.127	-0.234	-0.253	0.016
2	Neuroticism	-0.429***	-0.027	0.361**	0.185	0.332**
3	Openness	0.154	0.300*	-0.022	-0.063	-0.112
4	Conscientiousness	0.186	-0.111	-0.148	-0.277	-0.042
5	Agreeableness	0.291*	0.127	-0.334**	-0.474***	-0.326*
6	Positive Affect	0.220	0.396**	-0.045	-0.195	-0.113
7	Negative Affect	-0.383**	0.000	0.582***	0.156	0.286*
8	Happy	0.343**	0.161	-0.301*	-0.353**	-0.288*
9	Calm	(.718***)	-0.105	-0.570***	-0.073	-0.423***
10	Energized	0.227	(.387**)	-0.166	-0.326*	-0.185
11	Fear	-.629***	-0.21	(.796***)	0.383**	0.502***
12	Sad	-.525***	-.484***	.639***	(.406***)	0.277*
13	Angry	-.436***	-.332**	.542***	.486***	(.589***)

Table 16

Zero Order Correlations for Other Variables

	Variable	Extr1	Neur1	Open1	Cons1	Agre1	PosAf1	NegAf1	Happy1
14	Liking	-0.173	0.002	.301*	-0.25	-0.178	0.058	0.043	-0.144
15	Extraversion Difference	-0.098	0.011	0.149	0.054	0.244	0.033	0.012	-0.13
16	Neuroticism Difference	0.01	-0.025	-0.228	0.041	-0.029	-.319*	0.042	-0.04
17	Openness Difference	-0.039	-0.119	0.189	-0.173	0.069	0.107	-0.107	-0.012
18	Conscientiousness Difference	0.139	-0.187	0.19	-0.243	0.248	0.176	-0.02	0.184
19	Agreeableness Difference	0.126	-0.054	0.031	0.12	-0.197	0.091	-.255*	0.182
20	Positive Affect Difference	0.007	-0.042	.385**	-0.196	0.036	0.009	0.048	-0.191
21	Negative Affect Difference	0.219	-0.065	-0.186	0.243	0.114	-0.067	-.648***	0.246
22	Happy Difference	-0.186	.325*	0.109	-0.208	-0.085	-0.114	0.011	-.497***
23	Calm Difference	0.11	0.01	0.151	-0.16	0.025	.270*	0.15	-0.019
24	Energized Difference	-0.079	0.179	0.182	-0.178	-0.174	0.146	0.101	-0.2
25	Fear Difference	0.097	-0.217	-0.18	0.132	0.16	0.033	-0.202	0.233
26	Sad Difference	-0.101	-0.163	-0.012	-0.059	-0.058	0.027	-.276*	0.127
27	Angry Difference	0.135	-0.197	-0.079	.354**	0.12	0.098	-0.14	.284*
28	Alternative	-0.075	0.125	0.177	-0.089	-0.113	0.179	0.056	0.072
29	Bluegrass	-0.05	-.296*	.310*	-0.068	0.151	0.233	0.025	0.218
30	Blues	-0.121	-0.11	.315*	-0.196	-0.091	0.123	0.208	-0.048
31	Classical	-.384**	0.039	.382**	-0.205	-0.17	0.105	0.118	-0.155
32	Country	.369**	-0.134	-.379**	-0.013	0.032	-0.023	-0.024	0.186
33	Dance/Electronica	0.069	-0.029	0.005	0.115	0.053	-0.083	-0.037	-0.079
34	Folk	-0.096	-.303*	.425***	-0.052	-0.014	0.097	0.017	0.04

***. Correlation is significant at the 0.001 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 16 (continued)

	Variable	Extr1	Neur1	Open1	Cons1	Agre1	PosAf1	NegAf1	Happy1
35	Funk	-0.049	-0.064	0.131	-0.042	0.084	-0.058	0.109	-0.104
36	Gospel	0.154	0.07	0.026	-0.072	.262*	.281*	-0.147	0.01
37	Heavy Metal	-0.139	-0.203	0.029	0.111	-0.147	0.144	0.132	0.134
38	International	-0.188	-0.083	.433***	-0.102	-0.068	0.152	0.08	-0.027
39	Jazz	-0.164	-0.117	0.208	-0.068	-0.132	0.018	0.192	-0.084
40	New Age	-0.035	-0.076	0.232	0.018	0.04	0.062	0.08	0.052
41	Oldies	-.257*	0.171	.266*	0.02	0.046	0.01	0.133	-0.065
42	Opera	-0.122	-0.103	.315*	-0.094	0.064	0.203	0.068	-0.042
43	Pop	.263*	-0.086	-0.171	-0.014	0.047	-0.148	-0.161	0.043
44	Punk	-0.001	-0.117	0.037	0.085	-0.007	0.153	0.069	0.175
45	Rap	.399**	-0.244	-0.015	-0.134	0.093	-0.044	-0.049	0.03
46	Reggae	0.021	-0.016	0.198	-0.196	0.058	0.047	0.169	0.01
47	Religious	0.057	.256*	0.038	-0.019	0.16	0.176	-0.042	-0.049
48	Rock	0.058	-0.103	0.042	-0.051	-0.072	-0.032	0.077	0.156
49	Soul/R&B	0.015	0.176	-0.034	-0.241	-0.046	-0.094	0.131	-0.132
50	Soundtracks	0.083	0.056	-0.142	-0.227	-0.145	0.153	-0.06	0.002

Table 16 (continued)

	Variable	Calm1	Energ1	Fear1	Sad1	Angry1	Liking	ExtDif	NeurDif	OpenDif
14	Liking	-0.19	-0.158	0.225	.256*	-0.029	1			
15	Extraversion Diff.	0.025	0.209	0.11	0.035	0.013	-0.025	1		
16	Neuroticism Diff.	-0.011	-0.017	0.087	-0.03	0.106	-.279*	-0.084	1	
17	Openness Difference	0.049	0.029	-0.071	-0.047	0.008	0.14	0.101	0.067	1
18	Conscientious. Diff.	-0.036	0.135	0.011	-0.034	-0.021	.280*	0.199	-0.244	0.207
19	Agreeable. Difference	.282*	-0.04	-.267*	-0.068	-0.171	0.109	-0.067	-0.133	.273*
20	Positive Affect Diff.	-0.135	-0.168	-0.034	0.131	0.163	.471***	0.166	-0.227	0.235
21	Negative Affect Diff.	.530***	0.084	-.602***	-.472***	-.295*	-.390**	-0.082	0.027	0.059
22	Happy Difference	-0.12	-.328*	0.063	0.152	0.182	.365**	0.217	0.121	.274*
23	Calm Difference	-.375**	0.046	0.187	0.077	-0.008	.378**	0.016	-0.113	-0.102
24	Energized Difference	-.271*	-.321*	0.068	.273*	.277*	.306*	0.124	-0.138	.361**
25	Fear Difference	.318*	0.137	-.645***	-.437***	-.292*	-.257*	0.103	-0.038	0.055
26	Sad Difference	.433***	0.171	-.268*	-.590***	-0.004	-0.043	0.048	0.025	0.022
27	Angry Difference	0.073	0.196	-0.115	-.282*	-.558***	-0.21	0.091	-0.003	0.031
28	Alternative	0.096	0.113	0.02	-0.076	0.027	-0.21	.260*	-0.044	0.012
29	Bluegrass	0.102	0.183	-0.12	-0.159	-0.147	0.103	0.104	-0.087	0.058
30	Blues	-0.059	-0.039	0.001	0.004	0.112	0.249	0.037	-0.094	0.104
31	Classical	-0.142	-0.149	0.187	0.103	0.085	.645***	0.137	-0.142	0.205
32	Country	0.009	0.083	-.261*	-0.239	0.079	-.267*	-0.118	0.098	-0.109
33	Dance/Electronica	0.149	0.113	0.077	0.014	0.077	-0.006	0.045	0.061	-0.12
34	Folk	0.126	0.133	-0.006	0.024	-0.053	0.099	0.087	-0.061	0.08
35	Funk	0.007	0.021	0.066	0.056	0.047	-0.006	.269*	-0.098	-0.086
36	Gospel	-0.141	-0.076	-0.124	-0.013	-0.14	0.029	0.251	-.396**	0.109
37	Heavy Metal	-0.001	-0.02	0.068	-0.118	-0.069	-0.009	-0.052	0.029	0.081

Table 16 (continued)

	Variable	Calm1	Energ1	Fear1	Sad1	Angry1	Liking	ExtDif	NeurDif	OpenDif
38	International	-0.151	-0.019	.314*	0.105	0.18	0.207	0.225	0.013	0.076
39	Jazz	-0.081	-0.118	0.085	0.073	0.07	0.187	0.06	-0.07	0.164
40	New Age	0.148	0.108	0.024	-0.136	-0.048	-0.002	0.118	-0.146	-0.113
41	Oldies	-0.057	-0.04	0.189	-0.15	0.07	0.114	.257*	-0.036	0.013
42	Opera	-0.193	0.019	0.142	0.097	0.052	.479***	0.222	-0.232	0.179
43	Pop	0.012	0.079	-0.188	-0.123	-0.042	-0.234	0.057	0.015	-0.016
44	Punk	0.184	0.184	-0.217	-0.163	-0.142	-0.045	-0.017	-0.111	-0.059
45	Rap	0.114	0.121	-.278*	-0.048	-0.056	-0.125	-0.035	-0.033	0.114
46	Reggae	-0.013	0.098	0.053	0.066	0.184	0.004	0.195	-0.109	-0.045
47	Religious	-0.167	-0.128	0.1	0.102	0.019	0.145	.366**	-.329*	0.047
48	Rock	.287*	0.093	-0.19	-0.225	-0.107	-.309*	-0.006	0.163	0.083
49	Soul/R&B	-0.206	-0.197	0.086	0.085	0.174	-0.002	0.087	-0.036	-0.028
50	Soundtracks	-0.094	0.032	0.002	0.023	-0.132	-0.057	0.025	0.023	-0.118

Table 16 (continued)

	Variable	ConDif	AgrDif	PosAfDif	NegAfDif	HapDif	ClmDif	EnerDif	FearDif
18	Conscientious. Difference	1							
19	Agreeableness Difference	0.142	1						
20	Positive Affect Difference	.349**	0.055	1					
21	Negative Affect Difference	-0.057	0.24	-0.098	1				
22	Happy Difference	0.097	-0.053	.518***	-0.06	1			
23	Calm Difference	0.186	-0.105	0.243	-.381**	0.201	1		
24	Energized Difference	0.19	0.156	.630***	-0.221	.542***	0.115	1	
25	Fear Difference	-0.086	0.14	0.107	.461***	0.027	-0.096	0.084	1
26	Sad Difference	0.018	0.08	-0.195	.257*	-0.165	-0.103	-.365**	0.018
27	Angry Difference	-0.153	0.18	-0.195	0.244	-0.244	0	-0.199	-0.153
28	Alternative	-0.024	-0.037	-0.064	0.06	0.001	-0.052	0.003	-0.024
29	Bluegrass	0.155	-0.037	0.166	-0.088	-0.028	0.002	0.015	0.155
30	Blues	0.055	-0.006	.308*	-.336**	0.113	0.045	.258*	0.055
31	Classical	0.075	0.067	.449***	-.316*	.305*	.263*	.390**	0.075
32	Country	0.012	-0.013	-0.014	0.107	-0.19	-0.074	0.023	0.012
33	Dance/Electronica	-0.027	-0.104	-0.002	0.062	0.027	0.229	-0.167	-0.027
34	Folk	0.047	-0.105	0.197	-0.123	0.01	0.028	0.015	0.047
35	Funk	-0.009	-0.108	0.202	-0.146	-0.009	0.164	0.022	-0.009
36	Gospel	0.102	0.104	0.095	0.018	-0.024	0.134	0.229	0.102
37	Heavy Metal	-0.119	-0.113	-0.116	-0.106	-0.22	0.063	-0.117	-0.119
38	International	0.174	-0.154	.313*	-0.222	0.108	0.188	0.152	0.174
39	Jazz	0.044	0.005	0.195	-.361**	0.048	0.058	0.216	0.044
40	New Age	-0.027	-0.109	0.08	-0.061	-0.119	0.144	-0.14	0.02
41	Oldies	0.054	-0.025	0.173	-0.104	0.116	0.129	-0.006	-0.047
42	Opera	0.134	0.002	.460***	-.270*	.259*	0.206	.353**	-0.097
43	Pop	0.1	0.134	-0.046	0.117	-0.148	0.145	-0.088	0.076
44	Punk	-0.065	0.038	0.045	-0.032	-0.078	0.087	-0.108	0.147

Table 16 (continued)

	Variable	Condif	AgrDif	PosAfDif	NegAfDif	HapDif	ClmDif	EnerDif	FearDif
45	Rap	0.078	0.104	0.001	0.037	-0.21	-0.007	-0.01	0.038
46	Reggae	0.181	-0.093	0.241	-0.245	-0.084	0.033	0.168	-0.091
47	Religious	0.114	-0.081	0.155	-0.084	0.101	0.085	.335**	-0.112
48	Rock	-0.078	0.224	-0.138	-0.004	-0.223	-0.118	-0.172	0.099
49	Soul/R&B	0.109	-0.098	0.054	-0.193	-0.021	0.098	0.168	-0.176
50	Soundtracks	0.099	0.033	-0.066	0.062	0	.312*	-0.082	0.015

Table 16 (continued)

	Variable	26	27	28	29	30	31	32	33	34	35
26	Sad Difference	1									
27	Angry Difference	-0.05	1								
28	Alternative	0.141	-0.039	1							
29	Bluegrass	0.055	-0.028	.343**	1						
30	Blues	0.111	-0.139	0.251	.725***	1					
31	Classical	0.089	-0.253	0.061	.317*	.461***	1				
32	Country	0.176	0.045	-0.145	-0.007	0.075	-0.193	1			
33	Dance/Electronica	0.123	-0.109	0.05	-0.121	-0.102	-0.08	-.272*	1		
34	Folk	0.074	-0.085	.364**	.715***	.560***	.385**	-0.13	0.009	1	
35	Funk	0.107	-0.124	.494***	0.251	.341**	0.162	-0.169	.451***	.291*	1
36	Gospel	-0.145	0.052	0.135	0.113	0.184	0.17	0.101	-0.208	-0.139	0.183
37	Heavy Metal	.274*	0.082	.295*	0.061	0.172	0.042	0	0.143	0.189	.369**
38	International	0.08	-0.063	0.182	.282*	.273*	.399**	-.261*	.273*	.375**	.283*
39	Jazz	0.106	-0.13	.256*	.437***	.701***	.380**	0.053	0.081	.404***	.415***
40	New Age	0.248	-0.168	.377**	.285*	0.058	0.155	0.02	0.202	.257*	.300*
41	Oldies	0.115	0.034	0.127	0.149	0.203	0.209	-0.065	0.024	0.026	.272*
42	Opera	-0.085	-0.121	0.075	.393**	.442***	.752***	-0.18	-0.039	.411***	0.206
43	Pop	0.119	0.153	0.023	-0.088	0.028	-0.249	.352**	0.194	-0.015	0.136
44	Punk	0.103	-0.057	.438***	0.196	0.21	-0.058	-0.022	.356**	.290*	.526***
45	Rap	0.01	-0.071	-0.096	-0.086	0.058	-0.172	0.239	0.199	-0.04	0.114
46	Reggae	0.063	-.349**	.394**	0.186	.404***	0.137	-0.023	.362**	0.192	.743***
47	Religious	-0.135	-0.055	0.072	0.181	0.237	.346**	0.044	-0.133	-0.026	0.153
48	Rock	0.252	0.115	.491***	0.253	.276*	-0.182	0.163	0.077	.260*	.365**
49	Soul/R&B	0.043	-0.11	0.058	-0.012	.371**	0.093	0.077	0.17	-0.041	.339**
50	Soundtracks	0.014	0.165	-0.032	0.036	0.054	-0.021	0.073	.282*	0.078	0.128

Table 16 (continued)

	Variable	36	37	38	39	40	41	42	43	44	45
36	Gospel	1									
37	Heavy Metal	-0.065	1								
38	International	-0.164	.280*	1							
39	Jazz	0.142	0.197	.275*	1						
40	New Age	-0.113	0.128	0.201	0.233	1					
41	Oldies	0.09	0.24	0.204	0.093	0.18	1				
42	Opera	0.202	-0.009	.464***	.340**	0.116	0.12	1			
43	Pop	0.195	0.081	-0.174	0.169	-0.083	-0.093	-.325*	1		
44	Punk	-0.086	.562***	0.186	0.201	0.231	0.213	-0.006	0.092	1	
45	Rap	0.195	0.09	-.269*	0.126	-0.103	-0.232	-0.231	.560***	0.141	1
46	Reggae	0.224	.271*	.273*	.438***	0.145	0.091	0.076	0.206	.455***	.371**
47	Religious	.737***	-0.088	0.007	0.172	0.039	0.143	.351**	-0.012	-0.198	0.016
48	Rock	-0.095	.470***	0.083	0.202	0.226	0.222	-0.248	.351**	.607***	.268*
49	Soul/R&B	.419***	0.081	0.009	.365**	-0.236	0.068	-0.052	.505***	0.035	.493***
50	Soundtracks	0.086	-0.072	0.191	0.111	0.002	0.02	0.011	.392**	0.022	0.155

Table 16 (continued)

	Variable	46	47	48	49
46	Reggae	1			
47	Religious	0.199	1		
48	Rock	.336**	-0.156	1	
49	Sl/R&B	.580***	.337**	0.179	1
50	Soundtrk	0.005	0.073	0.124	0.199

Vita

Sarah Fischer was born in Wheeling, West Virginia where she was raised with one sibling. After receiving a Bachelor of Science degree in mathematics from the College of William and Mary in Williamsburg, Virginia, she relocated to Lexington, KY where she worked as a computer programmer for IBM. After relocating to Tennessee for employment at Oak Ridge National Laboratory (ORNL), she received a Master of Science degree from the University of Tennessee, Knoxville in computer science. She continued her employment at ORNL as a computer analyst and software developer. As part of a multi-disciplinary research team at ORNL, she began to investigate new areas in medical research, which led to her discovering new research areas involving both music and medicine. She entered the School of Music at the University of Tennessee, Knoxville and then pursued training in psychology to equip her to pursue research in this growing area. During her pursuit of the doctorate degree in psychology, she did research that explored the neuroscience of joy and gratitude before undertaking this current work. She hopes to apply her skills in advancing research and its application in areas related to stress management and trauma recovery.