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Ericka Kelley
Ball State University

Gabrielle Andrick
Ball State University

Fayelin Benzenbower
Ball State University

Marlene Devia
Ball State University

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Physiological Arousal Response to Differing Musical Genres

Ericka Kelley, Gabrielle Andrick, Fayelin Benzenbower, Marlene Devia, and Leah Cook
Ball State University

Abstract

Music is a complex medium that has social, psychological, and physiological implications. Music elicits early emotional responses (arousal) in the sympathetic nervous system, that later become consciously recognized emotions. We investigated how music genre effects physiological arousal by measuring participant skin conductance level (SCL). Physiological responses of 19 participants (3 male, mean age 23 years) were recorded by way of the iWorx 214 Psychophysiology Teaching Kit. The stimuli were four different genres of music: classical, Dubstep, Celtic, and big band (swing). Stimuli were presented to participants in one of four counterbalanced blocks. Participants' highest SCL matched their reported genre preference 31.57% of the time. Contrary to our hypothesis, participants did not have a higher SCL for their preferred music, leading us to hypothesize that people habituate to their musical preference. The most significant result was that participants were able to accurately describe their emotional arousal to a musical stimulus. Thus, participants were able to recognize their physiological reaction to musical genres.

Key words: music, emotion, sympathetic response, psychophysiology, neuroscience, skin conductance level (SCL)

Introduction

Music is a highly regarded art form and a defining cultural phenomenon that individuals use to experience, communicate, and express emotional states. Music is also known to evoke an emotional response that can be associated with physiological arousal (Olsen & Stevens, 2013). Based on past and present research, arousal is defined as an early emotional response. The present study seeks to examine physiological arousal in response to differing musical genres through the measurement of skin conductance level (SCL). Specifically, the purpose of the present study is to determine if musical preferences affect the amount of physiological arousal experienced by a participant while listening to musical stimuli. SCL relies on passing an electrical current across the skin. It is through the vascular theory that activity on the sweat glands was proven to be critical for

electrodermal activity (EDA) (Dawson, Schell & Filion, 2007). Autonomic brainstem responses regulate heart rate, blood pressure, skin conductance, pulse, body temperature and muscle tension (Chanda & Levitin, 2013). All of these responses are stimulated by music. Due to this, measurements of EDA are useful in observing autonomic responses. When acetylcholine is released by the sympathetic nervous system, a rapid fluctuation in sweat gland activity occurs, which allows the measurement of EDA. Emotions are brief and event related, making EDA an ideal study tool (Khalfa, Peretz, Blondin, & Manon, 2002). If musical genre preferences affect arousal to certain genres, then self-perceived levels of arousal should correlate with musical preferences.

Music and Emotion

According to Damasio (2000), emotions are complex collections of organized

chemical and neural responses to specific external or internal stimuli. Potential external events of relevance are then signaled to the organism through these emotional responses that lead to circumstances that may be advantageous to the organism's survival (Damasio, 2000). Once emotion occurs there are three subsets of interrelated responses; subjective feelings (conscious feeling of emotion), behavioral changes (postures, facial expressions, etc.), and physiological responses (changes in the somatic and autonomic nervous systems, e.g. breathing, heart rate, or perspiration) (Coutinho & Cangelosi, 2011). Besides emotional parameters, cognitive and cultural parameters play a role in musical preference and arousal (Schafer & Sedlmeier, 2010). When examining cognitive functioning, music is associated with expressing one's identity and personal values, gaining important information, or establishing contact with others (Schafer & Sedlmeier, 2010). Cultural and lifestyle components affect musical arousal as well: an individual who listens to music associated with their personal culture or lifestyle is likely to find the music more arousing than someone who does not listen to that type of music (North & Hargreaves, 2007). Familiarity is key when dealing with musical arousal and there is little in the literature on the topic of exposure to music. If habituation to a musical preference occurs due to overexposure to the genre, then listening to novel musical selections should provide a more intense physiological reaction.

The structure of music is also of importance when dealing with arousal levels. According to Coutinho and Cangelosi (2011), the most distinct results pertain to basic variables such as loudness, tempo, timbre, and pitch. Our brains continuously organize dimensions of psychoacoustic features (basic music variables) according to

schemas (Coutinho & Cangelosi). Further neural computations are involved when extracting features of music; this gives rise to higher order musical dimensions (e.g. key, meter, and harmony), intervals, and regularities within musical structure (Coutinho & Cangelosi). This higher order is part of how patterns form within musical structures; these patterns are what allow participants to recognize and anticipate acoustics within a song. Additionally, these patterns and dimensions are how complexity is created within a musical piece.

Physiological Arousal to Music

Studies that use SCL (i.e., electrical conductance aided by sweat), have shown low level intensity stimuli are needed to provide a measurable difference in sympathetic nervous system response. However, more intense stimuli tend to produce more arousal in the peripheral nervous system (Rickard, 2004; McConnell & Shore, 2011; Dillmon Carpentier & Potter, 2007). Thus, a musical piece with more intensity should elicit more skin conductivity. Dean, Bailes, and Schubert (2011) found volume and intensity index to be a stronger indicator of arousal for participants than the musical selection itself. This study depended on self-report for arousal level and did not take a physiological measure of arousal. Participants were continually asked to rate a piece of music or tone during listening. The researchers did not control for the tempo, beat, or rhythmic speed of the musical selections nor did the goal of their research encompass taking into account the genre of music preferred by the participants.

Rickard (2004) found skin conductance to be a truer indicator of emotions rather than methods such as self-report. Furthermore, Rickard's data revealed that

musically induced emotions are just as strong as any other emotion. The sympathetic nervous system, which responds in emotional situations (preparing for action), is activated during music listening. Therefore, the arousal induced from music can be measured like most other emotional arousal. Rickard also found that likeability of a piece of music does not always increase arousal in participants (2004). Most participants who listened to soothing music did not experience increase in skin conductance nor chills of the skin. So affiliation with a piece of music does not necessarily elicit a stronger sympathetic response. However, Labbe' et al. (2007) found self-selected music and classical music to be soothing and mitigated sympathetic responses to stress. In this paradigm, participants were asked to complete a cognitive speed test in which they were instructed to answer as quickly and correctly as possible. After the test was over, participants could either listen to music (self-selected or classical) or silence. Participants who were able to choose the music had the most significant decrease in anxiety levels. Researchers attribute this result to participant's feelings of control after said control was taken from them during the test.

Burns et al. (2002) also studied genre effect on physiological arousal. In their experiment, they also observed tempo's effect on arousal. Similar to the studies of Dillman Carpentier and Potter (2007), Burns et al. (2002) hypothesized that slower, relaxed music would elicit lower physiological arousal and faster, up-tempo music would elicit higher physiological arousal as measured through skin conductance response and heart rate. The 60 participants were assigned to the classical group, hard rock group, relaxing music group, or the control group of silence. The

relaxing music was music the participants were allowed to choose and bring in for themselves. After participants were assigned, they were told that they would have to complete a mentally challenging and stressful task. Results showed that the music conditions were more arousing than the silence. Although music was less relaxing than the silence condition, out of all three of the musical selections the personal preference was most relaxing due to familiarity.

Schafer and Sedlmeier (2010) conducted a study on 53 students from a German university. Over half of participants played an instrument while a large portion had sung in a choir (Schafer & Sedlmeier, 2010). Six different items were used to test for musical preference and because Schafer and Sedlmeier were interested in the variables of preference, participants were to listen to six different musical genres (Schafer & Sedlmeier, 2010). The six songs were chosen based on a survey given to local radio stations; all songs were well known. Participants were asked to bring along a favorite musical piece that would then be added to the experimental collection. Participants listened to segments of all seven songs through headphones (Schafer & Sedlmeier, 2010). The results of the Schafer and Sedlmeier study show that the participants rated their favorite piece of music over the other genres, while rock and pop ranked second and third on the list (Schafer & Sedlmeier, 2010). In conclusion, self-reflection and communication may be key in understanding why an individual may develop preference for a song, especially if the individual assigns a specific meaning to a particular musical piece (Schafer & Sedlmeier, 2010; North & Hargreaves, 2007).

Though a considerable amount of research has been done on musical preference and arousal response, to the best of our knowledge there have been no studies that test SCL on unfamiliar musical stimuli. This article is a first step in making an empirically sound model to test hypotheses and gain understanding of arousal response to musical stimuli. The present study aims to collect data based on physiological arousal to differing musical genres. Three of the musical genres (Celtic, Swing, and Classical) were chosen for lack of popularity based on our mean age of participants, while Dubstep was chosen to see if more mainstream music would increase arousal response. During a data collection, a manipulation check insured participants indicated being unfamiliar with the four musical pieces. Additionally, each piece was chosen based on lack of familiarity. It is anticipated that higher arousal states will be found in participants who regularly listen to Dub step, Celtic, Classical or Swing music, depending on musical preference. All selected stimuli have similar tempos and none of them use verbiage. We selected musical stimuli without verbiage to ensure the arousal response was not elicited by the context (verbiage) of the song. To our knowledge, this is the first study examining SCL to music that controls for tempo, intensity, complexity and lack of verbiage or context. Each song was chosen based on how well we could control for tempo, intensity, complexity and lack of verbiage. Songs were also chosen based on how well their sound embodied their genre. For example, when we chose our Celtic piece, we screened songs that varied in melody and had traditional instruments, such as bag pipes. Big band pieces were screened to be sure they had the elements of a traditional Jazz ensemble (i.e. saxophones, trumpets, piano, electric or acoustic bass guitar and a rhythmic section). The dubstep piece was

selected based on how strong the elements of the drum and bass were and also how well those elements came together to create a piece that sounded complex. Additionally, we knew everyone had most likely been exposed to classical music and that piece was selected based on the tempo, popularity and classical instruments such as violins and cellos. In the Schafer and Sedlmeier study, participants rated their favorite song higher than the other six songs selected (Schafer & Sedlmeier, 2010). Perhaps participants rated their favorite song higher than the other selections due to finding the song emotionally arousing. Participants in the current study may rate certain genres higher than others because it is associated with or reminds them of a favored genre; thus increasing arousal ratings. While an increase in arousal rating is expected to occur when musical stimuli are associated with a favored genre, Dub Step should elicit a higher arousal rating for the majority of participants due to perceived level of complexity. An increased arousal rating is also expected due to participant age as Dub Step is a contemporary form of music to which college students may be regularly exposed.

The view of these authors is based off correlational relationships from other empirical studies, physiological responses and musical preferences. In particular, we argue that music without verbiage will evoke an arousal (early onset of emotion) response when participants favor a particular genre of music. Note that in the current study we are not concerned with labeling the emotional response, but rather the intensity to which the response occurs. Participants are likely to be most aroused by Dub Step musical stimuli due to familiarity of the genre, as opposed to Classical, Celtic or Swing music.

Musical stimuli have been screened and chosen without bias of popularity. This study will operate based on musical genre preference and the arousal response associated with that preference. Preference, cognitive, emotional and cultural parameters will be considered when discussing results.

Methods

Participants and recruitment.

Nineteen students (3 male; mean age 23 years) were recruited from an undergraduate Psychology Research Seminar class at a large Midwestern University in the Fall 2013 semester. No participants reported being hard of hearing and therefore no participants were excluded for hearing deficits. This research was approved through the Ball State Institutional Review Board for the protection of human participants.

Stimuli and Apparati. Musical selections included, "String Quartet No. 4 C minor Allegro" - Beethoven (classical selection) tempo = 138 BPM, "Drop the Bass" - Urban Assault (Dubstep selection) tempo = 140, "An Irish Party in Third Class" - Gaelic Storm (Celtic selection) tempo = 146 BPM, "This Could Be the Start of Something Big" - Count Basie (Big Band/Swing Selection) tempo = 140 BPM (Beethoven, 1801; Ames, 2012; Gerston, 1998; Allen, 1956). SCL was recorded using the iWorx 214 Psychophysiology Teaching Kit (iWorx System). The paradigm was programmed using Windows Live Movie Maker (Microsoft Windows). Participants filled out a short demographic survey prior to recording. SCL readings were acquired using reusable electrodes that were attached to participants' non-dominant middle and index fingers with Velcro collars. A minute electrical current was passed between the two electrodes in order to measure skin resistance. The electrical current,

undetectable by participants, is pain free and safe. As a self-report measure, participants indicated on a 7-point Likert scale the level of arousal they experienced for each 30 second clip. The scores on these scales were tested for correlations to SCL measures.

Procedure. Participants read and signed the informed consent form. Participants were asked to fill out a short survey about basic musical preference and age and were prepared for initial data collection. Participants were asked to wash their hands with the same soap and water and dry their hands to ensure proper skin conductance level (SCL) readings. Musical stimuli were presented to participants in a counter-balanced format (ABCD, BCDA, CDAB, DABC). Note that each participant heard the same four songs but were subject to the songs being played in a different order. To establish arousal baselines, participants focused on a black screen with a grey crosshair for 5 minutes without any auditory stimulation. The same screen stayed present when the musical selections were played. Each musical clip was presented for 30 seconds with a 10 second interval between each. Participants indicated, on a 7-point Likert Scale, their self-perceived level of physiological arousal during the ten second silence. After listening to the paradigm, each participant indicated their familiarity of the song by circling yes or no on the survey.

Statistical Analysis. All SCL measures for musical selections were baseline corrected using SCL response during the initial five minute silence. LabScribe2 (iWorx Systems, Inc.) software was used to extract baseline measures as well as an average response for each music clip. The average response for each clip was then subtracted from the baseline to gain an overall measure of arousal difference from baseline for each musical genre. After

baseline correction, preference scores on the 7-point Likert Scale were correlated with corresponding musical SCL measures with a Correlation Coefficient (Pearson-R). A one-way ANOVA for musical-genre (Celtic, Classical, Dubstep and Big Band) was then performed to gauge the effects on SCL. A one-way ANOVA for musical genre on behavioral reports of perceived arousal to the genre was also performed.

Results

A one-way ANOVA of genre (Classical, Dubstep, Celtic, Big Band) revealed no main effects. A one-way analysis of variance of self-reported arousal levels showed marginally significant differences, $F(3, 2.647) = 19.421, p < .058$ in participant's perceptual experience of being physiologically aroused. Post hoc pairwise comparison revealed Big Band and Dubstep were significantly different ($p < .05$) in the self-report task. Of most interest, examination of the means indicate that self-reported arousal levels roughly emulated the pattern of participant SCL responses (refer to Figures 1 and 2). Self-reported musical preference matched participants' highest SCL 31.57% of the time.

Discussion

The current study was conducted to test physiological arousal responses to differing musical stimuli (Celtic, Classical, Big Band, and Dubstep). The aim of this research was to observe higher physiological arousal states in musical selections in correspondence with participant preference. While participant arousal levels were not always indicative of similar musical preference, participants' highest SCL matched their reported genre preference 31.57% of the time. Contrary to our hypothesis, most participants did not have

higher arousal levels for music in which they normally listened. These findings suggest the majority of participants (nearly 2/3) had habituated to their preferred musical taste, and therefore, are less responsive to familiar music. In compliance with our other hypothesis, differing arousal levels via SCL were observed in each genre, although not significant. Notably, however, Dubstep had the highest arousal levels.

Importantly, analysis and comparison of SCL data and a behavioral survey indicated that participants were able to accurately describe their emotional arousal to a musical stimulus, which could be the reason behind perspiration. Participants were able to recognize their physiological reaction to musical genres. In a clinical setting, music therapy may help a client recognize their stimulation level and provide an example of heightened arousal states. Training a client to recognize their state of arousal through an enjoyable medium, such as music, may be a novel approach to anxiety treatment. Additionally, music could be used to train clients on how to recognize their physiological arousal to certain situations which may allow clients to learn how to cognitively respond and control their emotional responses. For example, a client who presents with persistent and seemingly uncontrollable anxiety could be trained to pair a particular musical stimulus and grounding techniques, such as breathing, to help control the anxiety. So, when the client becomes anxious, they may remember the musical stimulus and pattern of breathing attached to their anxiety and then they can assess the situation to respond properly.

Strengths and Limitations

Young adults, particularly college students, dedicate a large amount of time to music. Coutinho and Cangelosi (2011)

found the most distinct results pertain to variables such as loudness, tempo, timbre and pitch. However, the current study is unique in that loudness (volume), tempo (intensity) and complexity were all controlled to ensure that each musical stimulus did not yield an increased arousal response. The current study also eliminated verbiage from all musical stimuli. It should also be noted that the current research took participant preference into consideration when examining the arousal response.

The results of the current study provide insight into musical preferences of the college population but may not be generalizable to the public, especially an older generation. Variability in race, sex and age was limited in the participant pool and should be accounted for in future research to increase generalizability.

Future Research

Implications of the current study are of importance to the psychological community in regards to music and memory. Regardless of intensity and likability, music is stimulating, and approximately 70% of our sample had a larger SCL response to their non-preferred musical genre. This suggests playing a musical stimulus that a patient does not regularly listen to may be therapeutic in certain contexts. Moreover, the aforementioned and future research implications could be beneficial when dealing with Alzheimer's patients; would introducing a new musical stimulus present with more physiological arousal? And would the increased physiological arousal be able to influence memory retrieval? While some might be concerned that arousal is a negative aspect of Alzheimer's, there is research which suggests otherwise. Simmons-Stern, Budson and Ally (2010) found those with Alzheimer's disease may

have a more holistic encoding process that helps facilitate recognition. Additionally, music heightens arousal in patients with Alzheimer's disease which could allow for better attention and improved memory (Simmons-Stern, Budson, & Ally, 2010). Due to the findings of the current study, future research may also focus on providing insight at decreasing arousal levels which could be beneficial to those who suffer from anxiety disorders, pain disorders or when dealing with children and the elderly.

Additionally, future studies may include repeating the current experiment with an older and more culturally diverse population to test whether their arousal responses mimic those of a younger generation. The implications for the physiological response to music are far reaching. Music therapy has been included in therapies since the formation of modern psychology and has been studied in correlation with stimulation and behavior as early as 1926 (Diserens, 1926). Relaxing music has been shown to reduce feelings of anxiety and increase feelings of relaxation (Stoudenmire, 1975). As Dementia and other age related neurological disorders grow rapidly, a greater understanding of the potential for music therapy in the elderly is emerging. Patients with symptoms of Alzheimer's disease, stroke, and other age related diseases often show increased level of anxiety, psychotic episodes, aggressive tendencies, decreased affect, and depression more so than in normal elderly populations (Pocnet et al, 2013; Van der Mussele et al, 2013). Yet studies testing the physiological response and benefits of different musical genres in elderly populations are limited.

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Figure 1. Means for physiological response, measured in microsiemens.

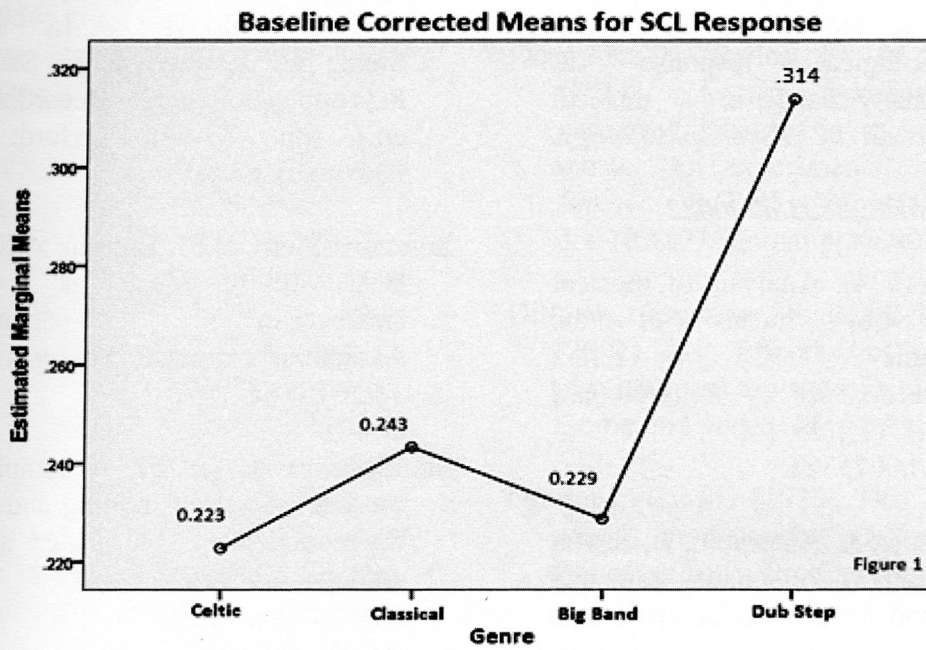


Figure 2. Means for participant self-reported arousal levels measured on a 7-point Likert Scale.
 $p < .058$

