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Psychophysiology in relation to music and behavior

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Abstract

This thesis was based off of my experience as a research assistant in a study conducted by principle investigator Edward Roth and student investigator Alycia Sterenberg entitled "The determinants of affect, emotional arousal, and autobiographical memories on music-evoked nostalgia." Roth and Sterenberg investigated the relationship between nostalgic music, autobiographical memories, and the physiological response of electrodermal activity (EDA). This was done by recruiting 30 college students between the ages of 18-28 to listen to music based off of five songs they listed as being nostalgic to them. They would then rate how familiar, nostalgic, and enjoyable each song was, in addition to discussing any memories associated with the song. EDA was collected during the listening portion to determine autonomic arousal throughout each song, and as a research assistant I was involved in flagging EDA for later analysis. The role of the present study was to determine commonalities in research involving music and psychophysiology. After conducting a literature review on psychophysiology, especially the physiological response of electrodermal activity, as it is seen in music research, some conclusions were made. Electrodermal activity, while easy to use and reliable, needs to be standardized so that the autonomic response of the body via skin conductance can be measured with better validity. In addition, the areas of perception and measured response need to continue to be researched. Music can elicit both psychological and physiological responses which is an important consideration in music therapy.

Literature Review

Psychophysiology

It is very evident in research that music produces psychological and physiological responses and so it is important to understand the fields of science that study these responses. The Dictionary of Medical Terms (2012) defines physiology as a "branch of science dealing with the normal, chemical, and physical functioning of living organisms." It defines psychology as a "study of mental activity, especially as it relates to behavior." Psychophysiology then is a science within the field of psychology and involves the observation of physiological changes as they relate to thought and behavior. Another definition provided by Andreassi (2007) gives further insight on psychophysiology, "Psychophysiology is the study of relations between psychological manipulations and resulting physiological responses, measured in the living organism, to promote understanding of the relation between mental and bodily processes" (p. 2). Andreassi (2007) talks about how definitions of psychophysiology have changed over time and that at one point, independent and dependent variables were used to explain psychophysiology: "in psychophysiology, the dependent variables are physiological and the independent variables are psychological" (p. 1). It is important to note another field of study called physiological psychology where physiological conditions are manipulated to produce psychological changes. The chapter on psychophysiology by Lykken (2002) in the Encyclopedia of the Human Brain supports these definitions.

In a study by Bach and Friston (2013), psychophysiology is described as a way to study unobservable processes by observing detectable related processes. Bach and Friston (2013) give the example of skin conductance being the observable process of the unobservable sympathetic nervous system becoming aroused by a particular stimulus. In psychophysiology, emotional

responses and cognitive activities are some of the psychological processes involved with the corresponding physiological responses in the brain, heart, eyes, muscles, and skin that are studied (Andreassi, 2007).

Lykken (2002) states that physiological dependent responses are often measured as electrical signals or reflexive movements, but rarely recorded through changes in urine, blood, or sweat. Lykken states that the goal of measurement in psychophysiology is to generate an electrical signal that can be analyzed visually, which is most commonly done by electrodes and transducers. Electrodes take the flow of ionic electric current and make it electronic. The most common electrode is coated with silver chloride and is nonpolarized, although both polarized and nonpolarized electrodes are used in measurement (Lykken, 2002). Transducers convert pressure or temperature into electrical signals using a strain gauge, which measures breathing movement, or a thermistor, which measures temperature. Transducers are important in electrodermal activity measurement because skin conductance response can only be seen when a certain amount of voltage is applied to the electrodes. Weak, high frequency currents can be applied to measure blood flow, heart action, muscle contraction, and respiration (Lykken, 2002).

Many physiological measures are common due to accuracy, ease, or for detection of particular responses in psychophysiology. A study conducted by Liu and Du (2017) used electrodermal activity (EDA), electrocardiograms (ECGs), skin temperature (ST), blood volume pulse (BVP), and pupil diameter (PD) as psychophysiological sensors but claimed that EDA and ECGs were the most important for detecting stress. Another study by Barret and Janata (2016) used physiological measurements that analyzed blood oxygen level dependent (BOLD) signals within different areas of the brain using an fMRI. Other physiological measures include electroencephalograms (EEGs), event related brain potentials (ERPs), electromyograms (EMGs),

pupillometry, electrooculography (EOG), heart responses, blood pressure, respiration, oxygen consumption, salivation, immune function, endocrine function, and gastric motility (Andreassi, 2007). Similarly, Lykken (2002) talks of the major channels of psychophysiology which include the cardiovascular system, the electrodermal system, electromyography, eye movements, pupillary response, eye blink, electroencephalography, and event related cortical potential. It is worth mentioning that while all the physiological measures mentioned above are used in research, they are rarely, if ever, all used at the same time (Andreassi, 2007). If more than one is used in a study, it is usually only two or three. Most physiological measures used in research are able to be taken from the surface of the body and so are non-invasive to participants (Andreassi, 2007).

Psychophysiology is typically seen in research involving behavior and some sort of physical reaction. Two fascinating areas where psychophysiology can be applied is in biofeedback and in using event-related brain potentials to study sensory capacities. Biofeedback is a procedure that provides information about physical processes happening in the moment and gives the person opportunities to learn to control their behavioral and physical response (Andreassi, 2007). Lykken (2002) describes the use of psychophysiology in biofeedback and polygraphic detection of lies or guilt. Common measures for biofeedback are EMGs and EDA responses because participants can visually see that they are tense or aroused and then apply techniques such as deep breathing or tensing and releasing of muscles to change their physiological response (Lykken, 2002). Another applied psychophysiology component is event-related brain potentials which are used to study sensory capacities. These are used daily in screening newborns for vision and hearing problems.

Physiological responses are influenced by emotion and other stimuli such as music. Physiological responses are under control of the nervous system, with many of the responses we can measure being under control of the autonomic nervous system (Andreassi, 2007). Similarly, components such as emotional arousal are identified by physiological changes in the sympathetic branch of the nervous system (Salimpoor, Benovoy, Longo, Cooperstock, & Zatorre, 2009). Psychophysiology is a unique field because the impact of behavior on an individual can be observed on the physiological level.

Electrodermal Activity

Electrodermal activity (EDA), the physiological measure used in the study by Roth and Sterenberg, has recently become an important measurement of arousal in research studies. EDA is defined as the "activation of sweat glands in the skin in response to stress or other stimuli" (Boucsein, 2012) and also defined by Braithwaite, Watson, Jones & Rowe (2013) as "a proxy measure to determine the strength of emotional arousal through skin conductance levels." EDA is typically measured on the fingertips but has also been measured on plantar regions. This is because the sweat glands in these palmar and plantar regions have the most density and are also the location of "emotional sweating" (Boucsein, 2012; Du & Liu, 2018).

Electrodermal activity can be measured using two different methods, exosomatic or endosomatic. In this study, the exosomatic method, which requires an external current on the skin, was used. EDA is measured when electrodes, with gel on, are placed on the fingertips. A very tiny amount of voltage is applied to the skin and "fluctuations in the electrodermal system can be read through the variations of the partial voltages" (Boucsein, 2012). The electrodes are attached by wires to a calibrator on the wrist creating a closed circuit of current. This then sends information to a computer so researchers can see the voltage changes that occur when the sweat

response changes. For example, if a participant becomes aroused to a particular stimuli, sweat glands in the palmar region will increase. The increased moisture on the fingertips causes EDA to increase which then in turn causes peaks in the graph.

EDA has different levels that researchers can look at, the most important being skin conductance level (SCL) and skin conductance response (SCR). The SCL is the "tonic level of electrical conductivity of skin" and the SCR is the "phasic change in electrical conductivity of skin" (Braithwaite et al, 2013). This means that the SCL shows the general changes in arousal and usually includes the entire duration of a period. The SCR then shows those receptors that adapt quickly and then fade, usually shown on the graph in peaks that gradually get lower after the initial arousal response. Figure 1 shows the difference between tonic and phasic level EDA in a study by Greco, Valenza, Lanata, Rota, & Scilingo (2014). The blue represents the phasic level and the red represents the tonic level while the black is the raw EDA signal.

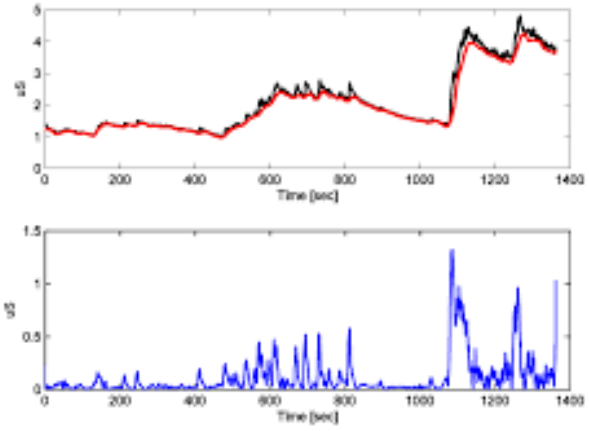

Figure 1. Example of EDA signal and related components with raw EDA (black), tonic EDA (red), and phasic EDA (blue). Greco, Valenza, Lanata, Rota, & Scilingo (2014).

There are a variety of ways in which to analyze electrodermal activity when used in experiments. However, before beginning analysis of EDA, the visual signal seen in the program needs to be inspected and then cleaned if necessary (Braithwaite et al, 2013). One way of

analyzing EDA is to take the mean of a focused area of response, usually determined by stimulus and time. Another way that the mean is used in analyzing EDA is to take the mean amplitude of events which calculates the average amplitude of peaks that have been identified as significant. Finally, you can also analyze EDA by doing a frequency count of events that have been identified as significant (Khalfa, Peretz, Blondin, & Manon, 2002).

There are many reasons why EDA has recently become a popular measurement of physiological response. It is accessible, generally easy to use, and has an advantage over other measures of the autonomic nervous system because SCR is under control of the sympathetic branch, providing an almost direct presentation of sympathetic activity (Andreassi, 2007; Boucsein, 2012; Mestanik, Visnovcova, & Tonhajzerova, 2014; Khalfa et al, 2002). Sweat gland activity and its involvement in thermoregulation also occurs in the autonomic nervous system. The process of thermoregulation demonstrates an extreme physiological reaction when observed under stress; secretions of two liters of sweat per hour have been recorded (Boucsein, 2012). This is important to note in EDA recording, where on a smaller scale a stress reaction is observed through sweating on the fingertips.

There are limitations to analyzing EDA measurements to determine a heightened or lessened sense of arousal. External factors such as temperature and humidity and internal factors such as medication and hydration of a participant can all influence EDA ([The Audiopedia], 2017). Additionally, “approximately 10% of participants are estimated to be non-responders (hypo-responsive) in terms of their EDA” (Khalfa et al, 2002). This means that some participants will not even show a change in EDA in response to any stimuli. However, due to cost-effectiveness, accuracy, and ease, EDA is one of the most widely used tools to measure arousal (Du & Liu, 2018).

Electrodermal activity can be applied in many different research studies but there are some common trends to where it is used. There are many studies in which EDA is used to determine a relaxation response to stimuli (Burns, Labbe, Williams, & McCall, 1999; Sandler, Fendal, Buβe, Rose, Bösel, & Klapp, 2017). Characteristically, EDA tends to decrease during a relaxation response. In another way, EDA has also been used to identify a stress response (Liu & Du, 2017; Haarmann, Boucsein, & Schaefer, 2009; Novak, Mihelj, Ziherl, Olensek, & Munih, 2010). There is also a significant amount of research around EDA response to musical emotions, including a "chill response" (Koelsch, 2010; Blood & Zatorre, 2001; Guhn, Hamm, & Zentner, 2007; Van der Zwaag, Janssen, & Westerink, 2013; Barrett & Janata, 2016; Khalfa et al, 2002).

Psychophysiology and EDA in relation to music and behavior

Music and Physiological Responses

Common physiological measurements used in music research include changes in blood-oxygen-level-dependent (BOLD) signals, heart rate, respiration, body temperature, electrodermal activity, and blood volume pulse (Barret & Janata, 2016; Salimpoor et al, 2009). Measuring EDA or SCR (skin conductance response) has been done in many music-based studies before (Khalfa et al, 2002). In a study by Van der Zwaag et al (2013), the physiological response of SCL and psychological response of mood to music were investigated. They discovered that specific songs could be used to alter the SCL of participants. Participants did not report significant mood changes although the recorded mood did correlate with the SCL. "Hence, even though changes in mood were maybe not always conscious to the user, the bodily changes validated that music had an effect on the user" (Van der Zwaag et al, 2013).

A common use of EDA in music research is to analyze the chill response. A chill is "an emotional response with apparent physiological manifestation" or "a sudden, arousing reaction

that is accompanied by goose bumps, shivers, or tingles in the spine" (Guhn et al, 2007). This study by Guhn et al (2007) found that SCR response was higher for those who experienced chills but heart rate did not differ. This contrasted a study about music and pleasurable responses in which heart rate increased but there were no differences in SCR (Blood & Zatorre, 2001). Another conclusion from Guhn et al (2007) is that the most potent trigger for eliciting chills is probably music, although, because of external measurement tools, there is a delay of one to five seconds.

Koelsch (2010) continues the study of how music affects emotions, specifically with the chill response, by looking into brain activity as a physiological response. In the study, Koelsch mentions that "music-evoked emotions can modulate activity in virtually all limbic and paralimbic brain structures." This was measured using a PET scan to identify changes in regional cerebral blood flow (rCBF) and an fMRI to identify changes in activity, in addition to measuring blood-oxygen-level-dependent (BOLD) signals. Even though not all participants felt the "chills," or emotional experiences leading to shivers down the spine or goosebumps, their pleasure still activated dopaminergic pathways in different areas of the brain. The most intense reaction was seen in the ventral striatum, where voluntary movement is initiated. Interestingly, the rCBF decreased when "chill" response increased, meaning that when a "chill" was experienced, the brain had less control over movements (including shivers down the spine). Other areas of the brain that were monitored include the midbrain which is involved in movement and auditory processing, the anterior insula which influences your subjective emotional experience, the anterior cingulate cortex which regulates emotion and cognition, and the orbitofrontal cortex which is involved in emotional processing and decision making (Koelsch, 2010). All of these parts of the brain influence our emotional, psychological, and physiological experiences.

Another area of research in music that uses physiological measures is music-evoked emotions, especially music-evoked nostalgia. A study by Barrett and Janata (2016) used BOLD signals as the physiological measure to determine arousal representative of feeling nostalgic. Research by Khalfa et al (2002) suggested that SCRs, the phasic level of EDA, can be evoked and changed by musical emotional arousal but the response will not present emotional clarity. This means that we can see how music does elicit a response but we don't always know what that response is using only physiological measures. So even though EDA is a "reliable measure of autonomic expressions of emotion, in domains other than music," psychological measures may be needed to determine which emotion is being expressed or aroused (Khalfa et al, 2002).

In addition to research with music and emotion and music and relaxation, the relationship between music and stress response are also investigated. According to Liu & Du (2017), the physiological responses that are most important for detecting stress are electrodermal activity and electrocardiogram which measures the electrical activity of the heart. Music and physiology are seen in research involving stress or relaxation response with measures of heart rate and EDA being common physiological measures (Lai & Li, 2011).

Research shows that music can elicit physiological responses such as changing activity in the brain, heart rate, and arousal response. This is important because if music can be influential in the healing process, then psychophysiology in music needs to be researched more. This might provide music therapists insight into how biofeedback, an applied psychophysiological concept described earlier, might benefit the individuals they are serving. Physiological measurements such as EDA and heart rate are generally easy to measure and might allow more research to be done in music and psychophysiology.

Music and Psychological Responses

In addition to physiological responses, music has also been used to elicit psychological responses. In many of the studies mentioned above, psychological responses are involved as well. In the study by Barrett, Grimm, Robins, Wildschut, Sedikides, & Janata (2010), upon which the current study on music-evoked nostalgia was based, psychological responses were recorded along with physiological ones. The measures used were the Positive and Negative Affect Schedule (PANAS) to assess mood state, the Southampton Nostalgia Scale (SNS) to assess nostalgia proneness, and the Big Five Inventory (BFI) and the Affective Neuroscience Personality Scales (ANPS) to assess personality traits. These were all administered at the beginning of the study. Similarly, the current study being investigated administered the PANAS and SNS at the beginning of the study but also administered the PANAS again as a post test. This is an example of how music was used as a stimulus to modulate mood state.

Other examples of studies investigating music and psychological responses include other music-evoked emotions (Koelsch, 2010), modulating mood state through music (Shatin, 1970), managing pain with music (Brown, Chen, & Dworkin, 1989; Lee, 2016), and cuing a relaxation response with music (Scheufele, 2000). In a study by Shatin (1970), the iso-principle is used to change the listener's mood state. The iso-principle is the concept that by matching the music to a person's mood state or level, you can then alter the music to get the listener to a desired mood state. In a meta-analysis by Lee (2016), music and pain was researched in over 97 studies. Lee (2016) concluded that music can be an effective intervention to relieve pain because music interventions have shown statistically significant results in decreasing pain perception. In a study by Brown et al (1989), music is used to alter pain perception, although this is highly individualized based on how each person feels pain and because music does not actually remove

pain. Brown et al (1989) found that music can alter psychological responses by prompting the individual to focus on the music and not the pain, but that altering psychological responses does not necessarily change physiological response. In a study by Koelsch (2010) music is used to evoke specific emotions, specifically looking at how music can produce the feeling of "chills."

In a study by Scheufele (2000), music was used with a progressive relaxation technique to induce a relaxation response. This was measured by the Upright Relaxation Scale (URS), a modification of the Behavioral Relaxation Scale (BRS), which was completed by an observer. Additionally, the subjects took two self-report measures for relaxation including a Visual Analog Scale ranging from "very tense" to "very relaxed" and the Profile of Mood State-Short Form (POMS-SF). Tseng, Chen, and Lee (2010) researched music and stress responses in postpartum women. They used The Perceived Stress Scale and State Anxiety Inventory as psychological measures.

Psychological responses are susceptible to change in response to musical stimuli and so music can change a person's mood and behavior. However, psychological responses do not always correlate with physiological response. Using music to change perception of experience might be useful in providing a focus point during pain or stress. Music can also be used to modulate mood in order to increase arousal or increase relaxation which can be useful in many music therapy interventions.

Summary

Psychological and physiological responses have been researched in music as shown above. However, each type of response only provides part of the picture. According to Khalfa et al (2002), the combination of psychological and physiological responses might give researchers the most accurate information into what is occurring in the mind, brain and body. Thus,

psychophysiology is an important field of study, and can be applied to many settings including music research.

Purpose

This thesis was based off of my experience as a research assistant in a study conducted by principle investigator Edward Roth and student investigator Alycia Sterenberg entitled "The determinants of affect, emotional arousal, and autobiographical memories on music-evoked nostalgia." The purpose of this thesis is to provide a literature review and discussion in which these questions are answered: What is psychophysiology? What is electrodermal activity? How do these topics relate to music and behavior? The role of music to elicit psychological responses such as mood change or relaxation response is investigated because of its clinical application in music therapy. In addition, electrodermal activity, the physiological response used in this study, is investigated further to find commonalities in research and common applications in music research for further study.

Methodology

This thesis was based off of my experience as a research assistant in a study conducted by principle investigator Edward Roth and student investigator Alycia Sterenberg titled "The determinants of affect, emotional arousal, and autobiographical memories on music-evoked nostalgia." Because nostalgia involves memory and mood, the investigators wanted to see what effect music had on nostalgic experience and measured this using self-reports and electrodermal activity. One important factor of this study was that while music-evoked nostalgia has been studied in the past with self-reporting data collection methods and other psychophysiological measures, this is the first replication that has included EDA measurements.

Participants included 30 college students from Western Michigan University. The college student population was chosen due to convenience and location of study, in addition to prior research using the same population. Only students between the ages of 18 and 28 were included. Students who self-reported hearing loss could not participate due to the requirement to listen and respond to an auditory stimulus.

Participants were required to go to two sessions, the first about 15 minutes and the second about 45 minutes. The first session included reading the informed consent and giving the participant time to ask the researcher any questions. This session also included time for the participant to fill out his/her demographic information and preferred music information. This included identifying five songs that participants considered as nostalgia-provoking. The second session included the application of EDA electrodes, a nostalgia proneness (SNS) and mood (PANAS) survey, and then 30 minutes of listening to music and answering questions totaling to about 45 minutes. The music chosen was based off of the five songs participants had selected in the first session which were inputted into Pandora. Pandora then created a playlist related to

those songs from which four songs were played during the second session. Participants listened to songs over headphones and answered questions in between each song. Questions asked included how familiar the song was, how enjoyable the song was, how nostalgic the experience was, and then listing what autobiographical memories were associated with the song.

BioNomadix MP150 (model 507) was the system used for EDA data acquisition and system analysis. Additional materials used to help gather the data were disposable electrodes, a wireless transponder and a Velcro strap. The disposable electrodes were placed on the fingertips with electrode conductivity gel, disposable adhesive discs, and medical tape. The two points of contact allowed a current of electric potential to start. Skin conductance level (SCL) could then be measured by calculating this current of electric potential (Braithwaite et al, 2013). Once EDA was set up, the participant was asked to keep still and a towel was placed over the hand to keep it warm so that the temperature of the hand did not disrupt a signal. The *Publication Recommendations for Electrodermal Measurements* (Fowles, et al., 1981; Boucsein, et al., 2012) was referenced for correct voltage for EDA.

During the data collection portion, I, as a research assistant, was able to assist in calibrating EDA and marking or flagging important moments. EDA was flagged when participants began the pre-listening assessments such as PANAS (Positive And Negative Affect Schedule) and SNS (Southampton Nostalgia Scale), when each song was started, when each song was ended, when the post-PANAS was started, and when testing was complete. After each song, participants answered a few questions related to their familiarity and nostalgic experience for each song, along with memories associated with the song. Since EDA measurements were being taken the whole time, EDA levels during set up and answering questions provided a

baseline for each participant. After participants had completed the listening and answered the questions during data collection, I was also able to help clean the electrodes.

Each individuals' EDA range and range correction were calculated in order to find the inter-individual differences so that comparisons between participants would be possible. EDA was used in order to determine the validity of the self-reported data and to find out if EDA can predict nostalgia. EDA was analyzed by gathering the mean SCL (Skin Conductance Level) for each participant's music listening sample. A simple regression analysis was used to compare the mean SCL with self-reports.

Discussion

The purpose of this thesis is to review literature on psychophysiology, electrodermal activity, and how music can influence these measures. Another part is to discuss common themes or trends in EDA and music research using a current study being conducted by student investigator Alycia Sterenberg. In addition, areas of study that need to be researched or replicated will be mentioned. As mentioned in the literature review and methodology, EDA is a common measure of physiological response to behavior or arousal caused by a music-related stimuli, and was the physiological measure used in this study.

The most common measurement of EDA occurs on the tonic level, and measures skin conductance level (SCL) as evident by the current review of literature (Van der Zwaag et al, 2013; Sandler et al, 2017; Guhn et al, 2007; Salimpoor et al, 2009). Khalfa et al (2002) says that the majority of music related studies in his literature review analyzed the phasic level which measured the skin conductance response (SCR) as his study did. Some studies analyze both the tonic level and phasic level (Greco et al, 2014). Because there are different ways to measure EDA, there is still a lot of confusion in EDA research since SCL and SCR may not reflect the same physiological and psychological processes. EDA is most commonly seen in music research that analyzes emotional or relaxation responses. Another use of EDA in research is when responses are evaluated to adapt task difficulty in real time (Van Der Zwaag et al, 2013; Haarmann et al, 2009; Novak et al, 2010).

The most common placement of electrodes when recording EDA, both in the literature and what was used in the current study, is on the non-dominant third and fourth fingertips. Additionally, the most common type of electrodes were Ag/AgCl electrodes. These Ag/AgCl electrodes were either applied dry (Van der Zwaag et al, 2013; Salimpoor et al, 2009) or with

some sort of adhesive gel including molar NaCl paste or isotonic electrode paste (Guhn et al, 2007; Haarmann et al, 2009; Khalfa et al, 2002). One study discussed above used EKG foam electrodes with a carbon push button and adhesive gel (Sandler et al, 2017).

Often, EDA was not the only physiological measurement. The most common companions to EDA were blood oxygen level dependent responses, heart rate, and blood volume pulse. In most cases, the other physiological measurements supported the EDA response. However, in two studies, EDA and heart rate did not seem to correlate, perhaps having something to do with perception versus actual physical response (Guhn et al, 2007; Blood & Zatorre, 2001). The idea that perception, or psychological response, does not always match reality, or the physiological response, is a phenomenon that has interested many researchers. Intriguingly, most research in music and psychological response focuses on perception so it makes sense that perception can be changed when physiological response is not changed (Brown et al, 1989).

EDA seems to be able to identify even unconscious changes in mood or emotion. This was seen in a study by Van der Zwaag et al (2013), where changes in mood correlated with SCL. So bodily changes were able to validate that music had an effect even though changes in mood could have been unconscious. The difference between perception of arousal and actual arousal needs to be clarified as sometimes music only increases the perception of relaxation or arousal and there are no physiological responses to validate this (Burns et al, 1999). The idea that the body reacts to stress differently than the brain is interesting and should be studied further. If we can alter psychological responses to stimuli such as pain, maybe there is a way to alter physiological responses as well. This might be a difficult line to cross because some research suggests that even the different ways to analyze EDA may not reflect the same physiological processes. In the study by Koelsch (2010), music therapy is offered as a method to alter both

psychological and physiological responses. Koelsch demonstrates this by recording psychological responses of positive mood state induction and physiological responses of changing activity in brain structures.

All these findings point to the fact that researchers should continue to use EDA in psychophysiology research. However, EDA measurement should become such a standard that everyone follows the same protocol, using the same types of electrodes, electrode paste, electrode placement, and same voltage and computer system. While this might seem like a lot of work, it would improve the validity and reliability of EDA measurement.

Further research should be done in the areas of psychophysiology in music, specifically in the difference between perception, or psychological response, and reality, or physiological response. If this is researched within music, the topic can be further applied to clinical research in music therapy.

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