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The Effects of Music on the Induction of Emotional States Over Time

Abstract

Music has been a subject explored rigorously throughout the sciences because of its apparent influences on the human mind and body. By taking an embodied perspective towards cognition, and more specifically towards an agent's interaction with music, great progress can be made in understanding the interaction in depth. This paper is concerned with capturing both the intrinsic and extrinsic effects of music on *sad* and *happy* emotional states, the various ways scientists have gone about recording these states, and the implications that come from these studies.

Introduction

While there are several theories that hold positions on music and the expression of human emotion, the embodied cognitive perspective offers one of the most promising frameworks for understanding how music affects emotional states. Embodied cognition is not constrained by behavior being mediated by internal processes, but rather allows for our perceptual access to the world and the environment as central resources alongside internal representations (Wilson & Golonka, 2013). By embracing this perspective, much work has been done to better understand the interaction between music and one's emotional states. Many of the great accomplishments within the field of Music Embodied Cognition can be found in work

by pioneers in the field such as Arnie Cox, Lawrence Shapiro, and many others. In Arnie Cox's book, *Music, and Embodied Cognition: Listening, Moving, Feeling, and Thinking*, he lists the eight avenues of musical affect, which are not meant to be a full explanation of how music affects emotions, moods, desires, and other extrasensory experiences, but are meant to show that these eight avenues are always relevant and integral to one's emotional experience with music. Many modern-day scientific studies attempt to account for many of these avenues and have been able to accurately measure the induction of several emotional states.

While there are many emotional states that have been recorded, *happy* and *sad* states are the most commonly verifiable. These states can be verified through a combination of measurement tactics such as skin conductance levels, heartrate levels, and valence/arousal self-report. These methods have been used in many recent studies including *Emotional induction through music: Measuring cardiac and electrodermal responses of emotional states and their persistence* (Ribeiro, et al. , 2019), *Role of tempo entrainment in psychophysiological differentiation of happy and sad music?*(Khalfa, et al., 2008), and many others. While there are great insights made from these studies, there are many critiques and limitations as well. These insights, critiques, and limitations will all be addressed later on within this paper, and it will be argued that the Embodied Cognitive Perspective can help make better sense of these critiques and limitations.

In this paper, I will make the claim that carefully selected positive and negative excerpts can be effective in inducing *happy* and *sad* states, and that these states are heavily dependent on the Eight Avenues of Musical Affect in Arnie Cox's book, *Music Embodied Cognition: Listening, Moving, Feeling, & Thinking*. I will then discuss why I make this specific claim, then discuss any limitations or possible critiques of the claim.

Overview of Cognitivism and Embodied Cognition

In order to discuss how music can be better understood and the Embodied Cognition field interact, it is important to first discuss the original assumptions about mental representations under the Cognitivist perspective. Early cognitive psychologists typically took the belief that human behavior is mediated by something *internal* to the organism. In general, these psychologists invoke *mental representations* as a way to explain any internal mediation. When these ideas emerged, research on perception suggested that one's perceptual access to the world is *flawed,* (ex. Marr, 1982) which creates a massive workload for mental representations. Wilson and Golonka mention this problem in their 2013 paper, "Embodied cognition is not what you think it is", when they state,

> 'Because perception is assumed to be flawed, it is not considered a central resource for solving tasks. Because we only have access to the environment via perception, the environment also is not considered a central resource. This places the burden entirely on the brain to act as a storehouse for skills and information that can be rapidly accessed, parameterized, and implemented on the basis of the brain's best guess as to what is required, a guess that is made using some optimized combination of sensory input and internally represented knowledge. This job description makes the content of internal cognitive representations the most important determinant of the structure of our behavior. *Cognitive science is, therefore, in the business of identifying this content and how it is accessed and used.*' (((2a))).

The job of mental representations towards understanding cognition is paramount under the Cognitivist perspective, and doesn't allow for any help from one's perception or the environment. Therefore, advances in perception research have allowed for the problem of understanding cognition to *change*.

Eventually perception-action research advanced to the point where perception wasn't necessarily seen as critically flawed, but rather as a reliable source of information, and by extension, making the environment another useful resource (see – Gibson, 1966) . If perception is *not* flawed, then this creates a problem for the Cognitivist perspective, which leads to Lawrence Shapiro's *replacement hypothesis*. In his book titled "Embodied Cognition", Shapiro lays out three hypotheses/themes that he believes to be the most

prominent aspects of Embodied Cognition: *Conceptualization, Replacement,* and *Constitution*. The replacement hypothesis specifically states that an organism's body in interaction with its environment *replaces* the need for representational processes thought to have been at the core of cognition. This means that under this hypothesis, cognition does not depend on algorithms working with symbolic representations, but rather with dynamic interactions between an organism's brain, body, and environment (Shapiro, 2011). Shapiro establishes the *conceptualization hypothesis* as, "An organism's understanding of the world- the concepts it uses to partition the world into understandable chunks – is determined in some sense by the properties of its body and sensory organs," (p.68). If it is the case that perception is not flawed, and that our physical bodies determine an organism's understanding of the world, allowing for high quality access to one's environment, then Shapiro's hypotheses seem inevitable.

There are many examples of embodiment in action within studies involving robots, animals, and people. One of the most well-known examples would be the *A-not-B error,* which was an experiment done in 1954 by Jean Piaget, in which children were tasked to search for objects that were hidden behind other objects in view of the children. Children younger than 7 months didn't even try looking for the object, and after 12 months, children will happily retrieve the object. However, the error occurs after the 12-month-old children successfully reach for the hidden object in location A, where they fail to reach for the object hidden behind location B, even though they were in full view of the hiding of the object. *Why is this happening?* Standard cognitive explanations would say that the child *lacks* some quality or competence in order for them to have complete object concept. Spencer et al.'s (2001) study addressed this issue from an embodied perspective and used a dynamical systems model for the reaching task. They stated that, "The A-not-B error is not about what infants *have* and *don't have* as enduring concepts, traits, or deficits, but what they *are doing* and *have done*," (p. 4). Rather than focusing on the object concept, the embodied perspective focuses on the dynamics of reaching to grasp objects, and whether or not the child has actually experienced something or not.

With perception and the environment now being credited as central resources of cognition, there need to be more preparation when designing studies involving cognitive processes. Wilson & Golonka's 2013 study suggest four key questions they believe any research within embodied cognition should address: (*1*). *What is the task to be solved?* Embodied cognitive solutions solve specific tasks rather than general

problems, so it is essential to identify the task it is trying to solve at that time (((2b))). (2). *What are the resources that the organism has access to in order to solve the task?* With embodied cognition comes the implication that there are *multiple* resources (brain, body, environment, and their interaction) available to an agent, meaning a list of resources starting with those available via perception-action should be made. More complex resources should only be hypothesized or added to the list when the other resources have become exhausted (((2c))). (3). *How can these resources be assembled so as to solve the task?* Wilson and Golonka explain that because we only have access to information about our bodies and the environment via perception, there must be a detailed account of the perceptual information used to connect these resources (((2d))). (4). *Does the organism, in fact, assemble and use these resources?* This last question refers to whether the assembled resources within question 3 are an accurate description of the system the organism has assembled to solve the task. (((2e))). If researchers within the cognitive science field adhere to these four questions when designing their studies, they will be able to better capture the interaction between a participant's brain, body, and environment.

Overview of Music Embodied Cognition

If we entertain Shapiro's hypotheses, doesn't this mean a person's interactions with music will be way different than originally thought? Of course, which is why there is an entire subfield of cognitive science dedicated to understanding this paradigm called Music Embodied Cognition (MEC). Within *The Routledge Handbook of Embodied Cognition*, it leaves the entirety of chapter 8 to discuss music perception and the EMC field. The authors of the chapter, Leman and Maes, discuss how music has been guided in the past by focusing on the *anticipation* of perceived structural components in music. Specifically, they describe music perception in terms of a cognitive process as an abstract pattern-processing model which is independent from the physical carrier (body) (Leman & Maes, 2017). They describe the process of music perception as consisting of (1) a *pattern learning module* that takes structures from music and organizes it into memory, (2) a *pattern prediction module* that uses musical input and previously learned structures to predict the next input, (3) a *pattern-association model* that relates the consequences of the prediction to cognitive, emotive, and motor outcomes (((5c))). Within the same chapter, *figure 8.1* is

given, which shows a model of music perception as being interdependent on emotion and movement, while still being in contact with language and music.

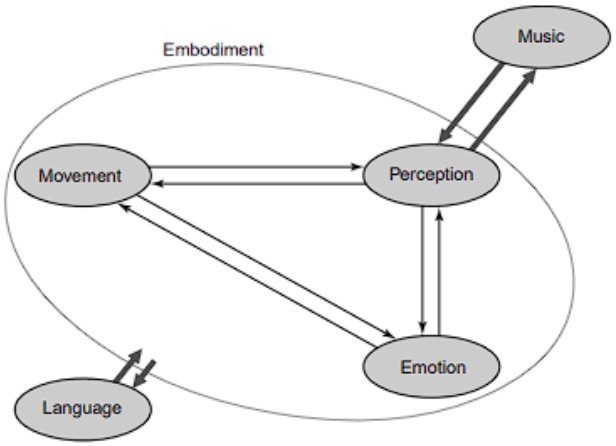

Figure 8.1 Music perception as embodied cognition. The model suggests interdependencies between perception, movement and emotion as part of an embodiment module that is connected with music and language.

Much of the work within MEC is incredibly recent and has many areas of focus. Some of the most direct evidence of embodied cognition is provided through studies that show how changes in the motor system correlate with changes in perception of structural and expressive features of music. Therefore, there are typically two areas addressed within changes to the motor system, *impairments* (motor disorders) and the *development of the sensorimotor* system (((5e))). The chapter provides many examples of studies which deal with capturing these changes in the motor system. Some prominent studies include *Phillips-Silver and Trainor, 2005* (interaction between body movement and perception of musical rhythm) and *Sedlmeier, Weigelt, and Walther, 2011* (showing real or imaginary body movements during music listening may co-determine music preferences).

From the perspective of Embodied Cognition, music needs to be separated into some of its intrinsic and extrinsic properties in order to better understand their roles in their interactions with music perception. The intrinsic properties of music refer to the structural components of music while the extrinsic properties of music refers to the interaction between the musical piece and the individual/environment. While there are many different ways to represent the many aspects of music, and there may be more that we don't understand completely, Arnie Cox's 8 avenues of musical affect encompass the core intrinsic and extrinsic

properties that affect how one feels while listening or performing music. The intrinsic properties are included within the 4th avenue of musical affect – Acoustic Impact, and the 5 components that shape this avenue: Pitch Height, Duration, Timbre, Strength, and Location. The extrinsic properties of music are included within the rest of the avenues: Memetic Participation, Anticipation, Expression, Implicit and Explicit Analysis, Associations (Cultural and Personal), Exploring Taboos, and The Invisibility, Intangibility, and Ephemerality of Musical Sounds. The next two sections will explore these properties in more depth, and lead to a discussion on how these properties affect an individual within a study.

The Intrinsic Properties of Music

As mentioned above, the 4th avenue of musical affect given by Arnie Cox offers a respectable representation of the intrinsic properties of music. Cox describes *Acoustic Impact* as the way that sounds seem to "come at us," which involves the 5 components pitch, duration, timbre, strength, and location. (Cox, 2016). Some examples of acoustic impact might be that a musical piece sounds *warm, sharp, cold, etc.* as you experience it. The 5 components are largely mutually dependent on each other to create a specific acoustic impact on an individual, however it is still important to differentiate between them.

Pitch Height can be described as the difference between the lowest and highest pitched sounds (low pitches able to shake the ground, while high pitches seem to screech in one's head). Of course, pitch height can work in tandem with other components within the 4th avenue such as timbre and strength to create a stronger impact, and even with other extrinsic properties. For instance, when the floor shakes, the impact is implicitly associated with sounds of an instrument large enough to create the acoustic impact (Cox, 2016). This implicit association towards an object to be large/soft enough to have a particular impact also works with the other 5 components. While *Sound Duration* may not seem massively essential to the acoustic impact of a song, patterns of duration such as rhythm and meter constantly shape the impact of sounds (Cox, 2016). Repeated notes can contribute to a certain impact, while sustained notes could contribute to an entirely different acoustic effect. *Timbre* can be understood in terms of the degree of *focus*

when playing a note. For example, sounds can be both quiet and 'diffused' or they can be quiet and 'intense' (Cox, 2016). One could play a note quietly, but there is an underlying intensity that can be changed without particularly changing the volume, which would be its timbre.

Perhaps the most readily apparent intrinsic property of music would be its *strength.* A note's strength refers to its amplitude, volume, etc., and applies to the specific sound's entire wavelength: (1) its attack (initial onset), (2) its sustain (any variations within the sustained note), and (3) its decay, (Cox, 2016). The attack of a note can of course be light or heavy, as can it sustain, but the decay is where the impact of the note ceases. Volume automation at any of these points within a note will affect its acoustic impact. When talking about the strength of a note or succession of notes, it is closely associated with actual/apparent proximity also known as *location* (Cox, 2016). When talking about *location* in reference to acoustic impact of music, Cox refers to *proximity* as the most important factor. When in a physical space like a concert or when far away from a live singer, greater distances will weaken the notes' *timbre* and *strength*, and possibly even modify *pitch*. Lastly, there is the use of illusionary space created by music producers and film producers in order to artificially replicate this musical component in various ways, adding to a particular way of 'experiencing' the music (Cox, 2016).

The Extrinsic Properties of Music

While the intrinsic properties of music are undoubtedly necessary for how a person feels while listening to music, the extrinsic properties of music are essential for understanding musical perception from an embodied viewpoint. The first extrinsic property of music given by Arnie Cox is called *Mimetic Participation*. Memetic behavior in general can be seen as humans understanding other entities and events in their environment through Mimetic Motor Action (MMA) and Mimetic Motor Imagery (MMI), which put simply by Cox himself, MMA corresponds to "monkey see, monkey do,", while MMI corresponds to "monkey see, monkey *imagine*-do". MMA includes *any* actions performed including limb movement, vocalizations, facial expressions, etc., while MMI doesn't *require* the actions to be performed (((1b))). It is important to note that mimetic participation can occur between the performer of the song, the music,

other listeners, or a combination of these. *Anticipation* is involved with mimetic participation and has multiple roles to play in musical affect. Huron's work from (2006) covered many important aspects of anticipation, and four general principles can be taken into account. (1) *explicit anticipation of events (ex. looking forward to a birthday, favorite musical moments) are rarer than the constant stream of implicit anticipation of events (ex. anticipating each step you take)* (2) *Anticipation is automatic and more or less continuous* (3) *successful prediction is positively valenced, while failed prediction is negatively valenced* (4) *Repeated exposure to particular musical works, genres, and idiosyncrasies of individual performers increases one's ability to predict what will happen next in a given context* (Cox, 2016). Anticipation in this context also refers to the anticipation of what someone does mimetically as the listener.

Cox's third avenue *Expression* refers to the expression of emotions in other people both objectively through nonmimetic perception and empathetically via mimetic comprehension. He explains that a mimetic perspective offers a convincing explanation for the expression of emotions within music, or at least part of the process. (1) simulate the observed behavior and (2) the person experiences an affective state based on one's own prior experience that correlates with the behavior (Cox, 2016). Both nonmimetic perception and mimetic comprehension are important aspects of determining what a person will feel in a given context, especially when in contact with music. In relation to both expression of emotions and anticipation is the 5th avenue of musical affect, *Implicit and Explicit Analysis*. Cox states that when analyzing something, humans ask questions like, *what is that?* Or *what will happen next?* Out of need to maintain homeostasis which are tied to feelings of wanting to understand and evaluate feelings related to one's progress in answering those questions. So, in the musical context, humans ask these questions both implicitly and explicitly, which will affect the musical experience whether or not one engages in explicit music analysis (Cox, 2016). Implicit analysis tends to answer questions that are *not* asked by the conscious self, and the resulting successes or failures will contribute to positive and negative feelings towards the situation. The results of this analysis include implicit and explicit recognition of people, inanimate objects, processes, etc. Once you begin to ask analytical questions explicitly, the prior implicit analysis has already laid the groundwork and continues to contribute (Cox, 2016).

Associations within the context of music perception includes both cultural associations, like a popular song to play at weddings or a party, and personal associations, such as a couple having a 'song' together.

Cox states that in these associations, the music is the trigger activating an affective state that is part of the associated experience (Cox, 2016). Both types of associations are essential for determining how a song may affect someone emotionally and should be controlled within studies in the MEC field. The last two avenues of musical affect are both harder to control within studies and are a bit more abstract in nature. The 7th avenue, *Exploring Taboos*, is exactly as it sounds. There are individuals that *enjoy* being made sad or scared in a normally safe environment. The sense of 'surviving' artificially made negative experiences can give individuals a sense of empowerment/pleasure. Exploring Taboos differ from the other avenues in the sense that,

> 'It is entirely dependent upon a person treating certain kinds of experiences as taboo and enjoying such experiences as transgressing a taboo boundary. The sense of transgressing a boundary, however, need not be fully conscious. While the seven other avenues normally apply to every musical experience in some form or another, the exploration of taboos depends on the creation and/or acceptance of, and violation of, taboo boundaries,' (Cox, 2016).

Even though it may not be as common of an avenue of musical affect, as taboos are seen culturally as a *bad* thing, it is still worth mentioning as there are plenty of different types of taboos (pitch, rhythm, timbre, strength, location, etc.) both with mimetic and nonmimetic aspects, that still potentially affect any music listener. The 8th and final avenue which is also not typically accounted for within studies is the *Invisibility, Intangibility, and Ephemerality of Musical Sounds*. This avenue overlaps with many other avenues including Acoustic Impact (non-mimetic experience of sounds), Analysis (relationship of knowing/understanding), and Taboos (this avenue deals with fear/vulnerability). Cox lists the central element of affect in this section as a fear of something that we cannot see or touch, which affects us via our ears, and manifests as feelings of wonder, curiosity, and confusion (Cox, 2016). Because of this, it is important to distinguish the different contexts which these musical features play out: (1a) Live performance by human performers; (1b) audio-only recordings of human performance; (2a) live performance with previously recorded sounds; (2b) recordings of these; (2c) works composed for media that mix human performed sounds and electronically produced sounds; and (3) media recordings which human exertion is not directly evident in any of the sounds. These differences in contexts directly influence

one's experience with music (Cox, 2016). When dealing with a study within embodied cognition, one should at the very least record the context of the musical experience from the list created above.

Recording Emotional States within a Study

Studies within the MEC field and within general psychological investigations employ a few common methods of capturing the induction of emotional states. Most studies tend to use a combination of these methods, and others may use different methods. However, these three methods seem to be some of the most common and reused among current studies. While these methods may not encapsulate all of the information needed to indicate a wide variety of emotional states, they give enough data to yield effective and significant results for *happy* and *sad* emotional states. Within these studies, electrodermal activity is often recorded – often the Skin Conductance Response (SCR). SCR is due to rapid fluctuations in eccrine sweat gland activity and is under strict control of the sympathetic branch of the nervous system (((3a))). Heartrate is often recorded alongside electrodermal activity as further proof of a sad or happy emotional state induced. Lastly, self-report methods are used to both get a rough timeframe and estimate of the participants perceived feelings when listening to music, to compare to HR and SCR levels recorded. While these methods aren't perfect (I will address this in my criticisms portion), they are reliably able to portray changes in a participant's emotional states.

There are many examples of current studies within the respective fields that employ these recording tactics. Riberto et al., 2019 specifically uses all three of the methods listed above to measure emotional states and their persistence when induced by musical excerpts. With regards to the self-report method within the study, they would rate their emotional state on the valence dimension out of nine adjectives. Three positive adjectives (happy, excited, euphoric), three negative adjectives (sad, melancholic, and distressed), and three neutral adjectives (neutral, indifferent, and unresponsive) (((1d))). Khalfa et al., 2006 recorded electrodermal activity, blood pressure, and heartrate/respiration rate to determine the role of tempo entrainment in the distinction between happy and sad music. Fuentes-Sánchez et al., 2021 recorded electrodermal activity, heartrate, facial EMG, and self-report methods to capture emotional elicitation

through music. The list of studies utilizing these three specific measurement tactics is extensive, which demonstrates their importance in recording emotional states.

How Does Music Effect the Induction of Happy and Sad Emotional States?

So now to the main question, how does music affect someone's emotional state? While there are some aspects of emotion induction through music that are repeatable and verifiable, there are also some mixed responses which will be addressed. The study mentioned in the previous section, Khalfa et al., 2007, studied the role of tempo entrainment on the differentiation between happy and sad music. The study found that by removing pitch variations, it was difficult for people to determine whether it was 'happy' or 'sad', and the *happy/sad* distinction cannot be made through tempo and rhythm alone (((4c))). There are many other studies that demonstrate clear differentiations between happy and sad music as well. Khalfa et al., 2002 shows that 'happy' excerpts tend to elicit larger skin conductance responses, faster heart and respiration rates relative to sad excerpts (((4b))). Etzel et al., 2006 found that heart rates of participants decelerated during the musical sad induction and accelerated during fear inductions, with slower respirations for sad musical inductions (((7e))). While there are many other studies corroborating the evidence found here, there are some mixed results when it comes towards neutral and sad excerpts. A growing number of studies have made statements encouraging future researchers to look into the 'multifaceted emotional experience which underlies sad music', (Ribeiro et al., 2019).

Within Ribeiro et al.'s 2019 study, they reference current studies that found that sad songs can evoke tears (followed by HR acceleration) and chills (increased EDA and subjective arousal), however sad songs can also be reported as unpleasant and not relaxing, which produces increases in SCL (Baumgartner et al., 2006). White & Rickard, 2015 is another study that measured emotional responses to 'happy' and 'sad' stimuli that yielded mixed results. While the "sad" music pieces induced self-reported emotional responses more frequently, the "sad" music induced a mixed response with moderate happiness induced as well (((12a))). This ability to cause pleasure and displeasure gives mixed results for specifically valenced emotions, posing a hurdle for new studies within the field.

Since research within the field is still relatively new, there aren't massive amounts of data on the effect of music on self-reported emotions over time, but there are some. In Ribeiro et al., 2019, the valenced adjectives within the valence-arousal self-report changed quickly to neutral ones after the second minute of the recovery phase, which is in accordance with results from Gomez et al. (2009) and Kuijsters et al. (2016). Skin conductance levels were reported as remaining increased for at least 4 minutes for positive and negative EIM's (Emotional Induction through Music) (((1e))). New studies also need to be careful to differentiate between induction of emotional states vs mood induction, which I will discuss in the criticism section.

Differences in Emotional States

While there are studies that have recorded various emotional states such as fear, anger, or tenderness, my claim only encapsulates *happy* and *sad* states specifically. While there are successful recordings of these other emotional inductions within studies, there is a sense of skepticism that should be taken when asserting the addition of other relatively similar emotional states. Limiting the claim to these two emotional states allows for some metaphoric 'breathing room', considering sad emotional states seem to be harder to fully capture already.

There are many possible reasons however why sadness has an increased affect on EDA, and just mixed responses as a whole. One masters thesis from Western Michigan University specifically studied electrodermal activity during dissonant music in musicians (High Experience Group) and non-musicians (Low experience group). The results found that those with high musical experience showed a more pronounced elevation in skin conductance response to dissonant music than the low experience group (((10a))). Another possible reason for the mixed results comes from a 2017 study that tested the effects of sad and happy music on mind wandering and the Default Mode Network. They state that,

> ‘During sad (vs. happy) music, listeners direct their attention inwards, engaging in spontaneous thoughts, which are related to the self and emotional aspects of life; during happy (vs. sad) music, listeners are more focused on the music itself and exhibit reduced mind wandering levels. Thus, our findings highlight the capability of music to trigger specific mental processes as a function of its emotional tone, opening a novel line of future research elucidating the impact of music on internally oriented cognition. This has crucial implications for the application of music in a variety of domains including education and psychotherapy,’ (((11c))).

While these studies referenced in both this section, and a paper as a whole, don’t necessarily directly support the embodied perspective, many of the warnings for future research seem to allude to embodied concepts. Deep mind wandering (Taruffi, 2017), exploring taboos such as dissonance and enjoyment of sad music (Chaplin, 2019; White & Rickard, 2015; Ribeiro et al., 2019), and framing music with social interaction (Dell ‘Anna et al., 2021), are all areas these researchers recommended future research focuses its attention. Some studies/projects have already started to explore more nuanced and implicit differences like cross-cultural comparisons (Bortz et al., 2019). Within this study, the over-a-decade long research project titled Emotion in Motion (EiM) is described and utilized for the purpose of the experiment. EiM was designed with two specific goals in mind: First, to address the concern of the generalizability of results when physiological responses are recorded within a laboratory setting, *data is collected outside of a lab, in more ecological environments*. Second, is the *need for a large sample size* in order to account for the vast differences in the participants age, sex, race, personality, and even the time of day (((2c))). All of the issues listed within this section; Cultural, environmental, and social, are able to be controlled under an embodied perspective.

Criticisms

Within the studies in this paper and this paper itself, there are a few limitations and possible criticisms. Some of the studies had limitations on their research design such as sample size (Ribeiro et al., 2019) or lack of HR recordings (Chaplin, 2019), however many of the limitations within the papers referenced

possible cultural or individual differences that weren't controlled for in one way or another. Ribeiro et al, mentions that one possible limitation in their study was that it is possible that individual differences linked to musical preferences and the impact of personality on EIM could influence outcomes, as both might be predictors of emotional elicitation through music. Khalfa et al, 2008, mentions that future research should focus on the effect of tempo entrainment while embedded in different musical contexts, as their study did not.

I encourage all of the studies listed within this paper, and any future studies within any field related to cognition or human behavior to strive to look at their research design with an embodied perspective. If the limitations and results from some of the most recent studies reveal anything it's that while positive and negative emotional states are possible to induce, a person's prior experiences, culture, and current musical context seem to be important determinants of one's enjoyment/discomfort of a certain musical excerpt. I recommend every study dealing with emotion/mood induction add Wilson & Golonka's four research tasks to their research design in order to control for more complex variables more accurately. While many extraneous variables are accounted for within these studies, *a full list of resources available to the agent* including minute changes in the environment over time are often not accounted for. If an exhaustive list of resources is made available, and if Arnie Cox's avenues of musical affect are accounted for to some extent, future studies will benefit and hopefully gain a better understanding of human music perception.

As for limitations or possible criticisms towards my claim or paper, there are a few. One clear limitation would be my lack of experience *actually* experimenting with these concepts and never actually conducting published research let alone any from an embodied perspective, because of my undergraduate status. While I haven't conducted research related to the field, and my youth may seem like a sign of incompetence towards fully understanding these concepts, I fully acknowledge there may be errors in my understanding of some concepts. However, I am confident that my current claim made in this paper isn't overzealous, and the work of many professionals already working within the field seem to be subtly pointing towards aspects of the embodied perspective. The embodied perspective itself is seen as controversial, which to some may be a criticism of my argument. My response to those reading that aren't sympathetic with the embodied perspective would be to at least keep Arnie Cox's avenues of musical

affect in mind when conducting research on music perception, and to control for any possible extraneous variables with your participants.

Conclusion

To sum up, in this paper I make the claim that carefully selected positive and negative excerpts can be effective in inducing *happy* and *sad* states, and that these states are dependent on the Eight Avenues of Musical Affect by Arnie Cox. The standard assumptions for behavior under Cognitivism are described and contrasted with the newer and more controversial embodied perspective of cognition. The Music Embodied Cognition field is introduced and describes music perception as being led by the paradigm of the *anticipation* of perceived structural components in music. Two sections are taken to describe the implicit and explicit properties of music according to Arnie Cox, those being (1) *Mimetic Participation*; (2) *Anticipation*; (3) *Expression*; (4) *Acoustic Impact (pitch height, ,duration, timbre, strength, location)*; (5) *Implicit and Explicit Analysis*; (6) *Associations*; (7) *Exploring Taboos*; and (8) *The Invisibility, Intangibility, and Ephemerality of Musical Sounds*.

Three main methods of recording emotional states within studies were given, those being *Electrodermal Activity* (Skin Conductance Level), *heartrate measurements*, and *valence-arousal self-report methods*. Through these three recording methods, and by using select musical excerpts, *happy* and *sad* emotional states can and have been induced through a number of studies (Khalfa et al., 2002; Taruffi et al., 2017; White & Rickard, 2015; Ribeiro et al., 2019; Khalfa et al., 2008). There are many other implications and limitations mentioned from the studies listed, especially about other possible extrinsic properties of music that need attention in future studies. Overall, I hope the reader takes away the importance of the Embodied Cognition movement towards current perception and music perception studies, and is hopefully closer to understanding something about how music affects a person's emotional states.

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