MUSIC, SOCIAL ENGAGEMENT, AND EMPATHIC DECISION MAKING

By

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To the hope that humans will respect one another and the Earth more holistically through the multi-modal engagement of musical stimuli

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LIST OF ABBREVIATIONS

ANS	Autonomic Nervous System
BFI-10	Big-Five Inventory 10
BSIM	Bowed-Stringed Instrument Music
CNS	Central Nervous System
GSR	Galvanic Skin Response
HRV	Heart Rate Variability
IRI	Interpersonal Reactivity Index
LPP	Listening Project Protocol
mini-PROMS	mini-Profile of Music Perception Skills
PIM	Percussive Instrumental Music
PNS	Parasympathetic Nervous System
RSA	Respiratory Sinus Arrhythmia
SNS	Sympathetic Nervous System
STOMP-R	Short Test of Music Preferences - revised

Abstract of Thesis Presented to the Graduate School
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MUSIC, SOCIAL ENGAGEMENT, AND EMPATHIC DECISION MAKING

By

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Chair: Larry Crook
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The purpose of this research is to determine linkages between music and human social engagement by investigating music's effects upon neurophysiology in social settings. Although it is known that music is widely used in social settings, the neurophysiological underpinnings of impacts of certain musical types (qualitative musical features) on empathic decision making in healthy adults is unknown. Previous anthropological research has demonstrated important relationships between music and social behavior, specifically music's roles in social communication (Mithen, '06). I hypothesize that certain attributes of music will facilitate greater empathic decision making as compared to a control group, due to changes in the social engagement system as described by Polyvagal Theory (Porges, 1995). This study is designed to examine the effects of differences in musical content specific to rhythm, tempo, instrumentation, and articulation upon empathic decision making. We will employ a multi-modal approach including psychophysiological (HRV/RSA and skin conductance) and self-report data to evaluate the impact of these qualitative aspects of musical compositions on empathic decision making. Music and emotion are fundamental components of the human condition. Neurophysiological understanding of musical experimentation and empathy will contribute to our knowledge of this human condition and provide utility in designing better environments for people.

CHAPTER 1
INTRODUCTION

Music exists in a constantly circulating continuum of active/passive and/or participatory/presentational contexts (Turino 2008) within every human culture on Earth, often accompanying social functions in some capacity (Hargreaves and North 1999). This suggests that a deeper understanding into why this accompaniment exists may yield knowledge into why humans have and/or engage in/with music in groups at all and what outcomes may come from such knowledge. In the context of this project, two contrasting selections of music were used to identify certain of music's psychological (i.e. music preference and dispositional skills) and physiological (i.e. heart rate variability, galvanic skin response, and respiratory sinus arrhythmia) roles in social functions: Western-European bowed-stringed instrument music and Brazilian Carnival percussion music.[1] These styles differ quite drastically via their respective rhythms, tempi, instrumentation, and articulations, with the former selection exemplifying a smooth, walking-like tempo, with connected sounds and the latter exemplifying choppy, quick, and disconnected sounds. Furthermore, the differences in instrumentation accentuate the dissimilarities in sound between these two styles of music.

This project has taken place over a period of four years, beginning with an independent study within the Neurophysiology laboratory of Dr. Evangelos Christou at the University of Florida College of Health and Human Performance. Literature review and orientation to the potential for this work to take place were accomplished over this period of time, at which point the direction turned to a music-centered perspective in the Spring semester of 2016. The

[1] The choice of this music is inspired by the work of my thesis adviser, Dr. Larry Crook, whose research is focused on Brazilian culture.

evolution of this orientation period concluded with a rather simple research question to pursue: why is music present at a party?

Several subtexts exist within the context of this question and to tackle it, simultaneously addressing certain of the biological and psychological foundations (a field called psychophysiology, which focuses on the behavior of the autonomic nervous system, e.g. fight/flight or rest/digest) behind individual experiences of social situations builds upon existing literature tackling similar questions from slightly, if not entirely, different angles (see Porges et al 2014; Kirschner and Tomasello 2010; and Rabinowitch et al. 2013). Particularly, combining methodological approaches from the fields of psychophysiology and ethnomusicology to address effects of musical style upon empathic decision making (i.e. prosocial perspective taking and/or concern for others) has not been done.

Can fusing these methodologies form a deeper understanding of what roles music plays at parties and social gatherings? In part, inevitably yes, as ample evidence exists that music and social interaction goes hand in hand. However, empirical evidence of such a fusion is lacking and this project intends to address some of the underlying issues. My work is grounded in Stephen Porges' Polyvagal theory (1995), which addresses these concepts from a thorough conceptual background blending numerous methods from the neurosciences, particularly the integration and interaction of/between the autonomic nervous system, heart, lungs, digestive organs, and face. Underlying issues involved in the complexity of interaction between autonomic processes (e.g. fight/flight or rest/digest) and voluntary activities (e.g. cognitive behaviors), leaves much to be discovered on numerous fronts, particularly involving music's accompanying role(s) in human social interactions.

To briefly illustrate the Polyvagal theory, our bodies are constantly interpreting and reinterpreting potential threats to our existence, without conscious knowledge of this activity occurring at all. When we act upon a particular stimulus that our brains consider to be dangerous, a flurry of autonomic activity occurs to prepare our conscious mind for voluntary actions, fighting/fleeing for example. A similar level of autonomic preparation occurs in states of calm and/or relaxed states, though under the pretense that our perception of threat is low enough to allow our body to undergo actions of digestion and also, social engagement. Social engagement, then, at least from this stance, is not possible if the body tells the mind that it must protect itself. If we feel scared or afraid, interaction between two or more individuals is, for the most part, impossible. Therefore, we must establish a common ground between one another to feel comfortable in the presence of one another, in order for a voluntary willingness to engage in social behaviors with one another, to occur.

Social engagement via music offers this common ground. Literature on the synchronizing effects of music suggests that music provides the common ground for individuals to link-in to one another's mood-states and behave accordingly context by context, in part via the common autonomic processes briefly aforementioned. Conscious choices to behave in certain ways (e.g. empathic decision making) follow suit, as we are biologically inclined to share in commonly interpretable emotional experiences offered through music: happiness, anger and/or sadness, as examples. However, the psychological experiences of music are vastly individualized.

Individual psychological differences alter the potential for the simplicity of primary emotional experience to remain simple: introverts and extroverts, for example, will interpret and/or extend initially happy feelings in various directions, some maintaining the primary elements of happiness, where others might experience secondary emotions, melancholy for example. Secondary emotional experiences are inherent to music and social engagement. Therefore, the potential for common ground to exist between two or more strangers in a social setting while some form of music is present in the same space is arguably like quick sand - aspects of this ground will indeed be and remain solid (the potential for mutual primary emotional experiences, for example), but other aspects will constantly shift.

One area of knowledge to address such shifts is the arguably innumerably disparate aspects of human culture. Learned cultural practices affect the potential for prosocial decision making, even if one's autonomic state communicates safety to the conscious, voluntary mind. Even if the potential to extend compassion or kindness to someone needing it happens, via feelings of safety and security communicated by the autonomic nervous system to the conscious mind, one's decision to act in such a manner may shift due to previously witnessed and/or mimicked behavior of their elders, mentors, and/or peers. Furthermore, the genetic inheritance of previous generations' cultural practices, influenced via individualized and/or collective genetic predispositions, affect(s) one's experience of emotions and thus, the potential to connect, link-in, and behave accordingly in response to another individual of seemingly disparate background.

The methodologies of psychophysiology and ethnomusicology, collectively, offer the potential to address these issues at least in part, and perhaps, shed some light onto the complexity of interactions between music, the autonomic nervous system, and social experience. The potential to apply principles of this project into research and development areas of human miscommunication, conference facilitation, and/or conflict resolution is highly suggestive of the need to engage in this project and others with similar intent. It is within these contexts that the basis for this project exists.

CHAPTER 2
REVIEW OF LITERATURE

Preface

This chapter is primarily a literature review of the core elements of this project. It starts with a brief overview of the beginning and evolution of the study of empathy. The following section is devoted to the social science literature on social engagement. Following this section is a paragraph devoted to considering empathy and social engagement in unison, from a musical perspective. Following is a paragraph devoted to the processes involved with empathy and social engagement, introducing the phrase *empathic decision making.* The Polyvagal theory (i.e. background of vagus nerve and methodology to measure and analyze the vagus' role in human social engagement) is then introduced and briefly discussed to correlate biological considerations of social engagement with aforementioned social science approaches.

Empathy

Empathy is a core component of social experience. Empathy as a construct has been refined over time. Mark Davis' work (1980) presents several historical accounts, considering Adam Smith's (1759) account of sympathy, as differing from *instinctive* sympathy (which Davis refers to as empathy), with the latter described as "a quick, involuntary, seemingly emotional reaction to the experiences of others, and intellectualized sympathy . . . the ability to recognize the emotional experiences of others without any vicarious experiencing of that state." Contemporary ideas of the split between cognitive (Mead 1934; Piaget 1932) and affective empathy (McDougall 1908; Lipps 1926) may be important distinctions for targets of environmental manipulation. German philosopher Robert Vischer's term *einfühlung*, translated to *feeling into,* offers an example of applied empathy, via the art enthusiast feeling into the artist's work. In this context, empathy was applied to 19th century European aesthetics of art, as corroborated by Wilhelm Worringer (1908) and Vernon Lee (1913), respectively. Further corroboration and adoption of Vischer's term comes through Theodor Lipps (1903-13). Lauren Wisp (1987) considered multiple psychological approaches to researching empathy, including *einfühlung*, empathy in personality theory, therapy, social and developmental psychology, and Titchener's (1924) translation of the former German into empathy, itself. These studies of empathy are most germane to the proposed research, as they offer insights into the social engagement of music.

Social Engagement

Social engagement literature includes many sub-topics.[1] The study of social group activity for example, a primary focus of social engagement literature to date, differentiates the topic of social engagement from civic and/or community engagement. Studies on elderly populations and health/quality of life promotion (Mor et al. 1995; Carstensen and Hartel 2006; Prohaska, Anderson, and Binstock 2012), mental health (Avison, McLeod, and Pescosolido 2007), and online social networking (Zhang, Jiang, and Carroll 2011) are some examples of sub-topics to social engagement research. Further sub-topics to the study of social engagement include social identity (Ashforth and Mael 1989), social relations (Fiske 1992) interpersonal attachment (Baumeister and Leary 1995), interpersonal communication (Berger and Calabrese 1975), interpersonal behavior (Schutz 1958), and social support (Cohen and Willis 1985). These topics of inquiry associate individual identity with group belonging, indicating a fundamental human tendency toward social engagement across socio-cultural boundaries. Lastly, social

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[1] For the proposed research, social engagement will be defined in detail later in this document, specifically pertaining to the state of one's autonomic nervous system (see Porges 1995).

bonding relates to social engagement regarding social group activity, as exhibited through music and dance (Freeman 1998).

Considering empathy and social engagement together, *musicking* is the process of group music making (Blacking 1974; Laurence 1999; Small 2011). The expression and mutually recognizable element of emotion (pending one's health) in this social group format suggests the root of how and why group music making elicits empathy, as feeling into one another's emotional state (a common definition of affective empathy, in particular) is accomplished through the act of making music together (Kirschner and Tomasello 2010; Rabinowitch et al. 2013). These authors provide fundamental approaches from which the proposed study is in part built upon, with adaptations described in detail later in this document.

Empathic Decision Making

Empathic decision making involves interaction between the processes of empathy and social engagement. The author is unaware of any studies using the specific phrase empathic decision making. However, research in game theory (Sanfey 2007) and the neuroscientific investigation therein (Rilling and Sanfey 2011), offers insights into empathic decision making via the study of the interaction between the processes of empathy, decision making, and social engagement. Terminology with a similar intent to empathic decision making includes and is not limited to ethical decision making (Ferrell and Gresham 1985; Treviño 1986; Bommer et al. 1987; Jones 1991; Wood 2001; O'Fallon and Butterfield 2005; Detert et al. 2008); moral decision making (Weber 1996; Heekeren et al. 2005; Glenn et al. 2009); compassionate decision making (Simpson et al. 2014); and egalitarian decision making (Deere and Twyman 2012).

The Polyvagal Theory

Building upon the background literature of empathy and social engagement listed from a predominantly social science perspective, the author of the Polyvagal theory (Porges 1995) presents a psychophysiological approach to understanding human social engagement. Specifically, the competitive relationship between the two-medullary source nuclei of the vagal nerve: the NA (nucleus ambiguous) and DMNX (dorsal motor nucleus) are responsible for heart-rate variability. The theory highlights vagal control of the sino-atrial node of the heart, in which bidirectional communication between it and the brain determines social disposition through shifts in autonomic state: higher parasympathetic nervous system activity (of the NA and linked to respiratory sinus arrhythmia) is associated with positive social engagement (i.e. reciprocal behavior between two or more individuals), whereas parasympathetic withdrawal and sympathetic dominance is associated with defensive dispositional states (i.e. fight or flight).

The human social engagement system is hierarchically organized and reflects dynamic traits of the nervous system such that emotional and cognitive brain systems are influenced by and influence social disposition, respectively; this disposition is reflected by autonomic state. Physiological measurement of previously mentioned studies' subjects through their respective research methods was not undertaken and the behavior of these systems may be critical in understanding the relationship of musical experience in facilitating social engagement. Further, and specific to the Kirschner and Tomasello (2010), and Rabinowitch, Cross, and Bernard (2013) studies, respectively, subjects were solely children, indicating a need to test adult populations. Further still, music making in groups was the prioritized focus for both studies, suggesting music listening with an associated empathy task as an addition to present literature on the topic. Including physiological measurement will add to the conclusions drawn from these studies, offering further means to quantify empathy as related to social engagement.

Addressing phylogeny (i.e. evolutionary inheritance) of the human social engagement system, Porges hypothesized (1995, 2001, and 2003) it to initially have evolved from ancient autonomic nervous systems (ANS) responsible for survival in vertebrates. Immobilization behaviors mediated by unmyelinated vagal pathways, common to responses to danger in reptilian and amphibious life forms transitioned into the so-called "fight or flight" response, associated with mammals. As the neurobiological complexity of these systems co-evolved with mammalian socialization systems, more elaborate biological development occurred, allowing for greater complexity in interpersonal relationships and social bonds to occur. Specifically, Porges focused parts of his research on the evolution of the physiology of the middle ear (i.e. small bones of the ossicular chain connecting the eardrum with the cochlea) allowing humans to discern frequency ranges present within the human voice when these ranges are competing with sounds sourced from other audible frequency ranges - an attentional advantage for language sounds (see figure 1 below).

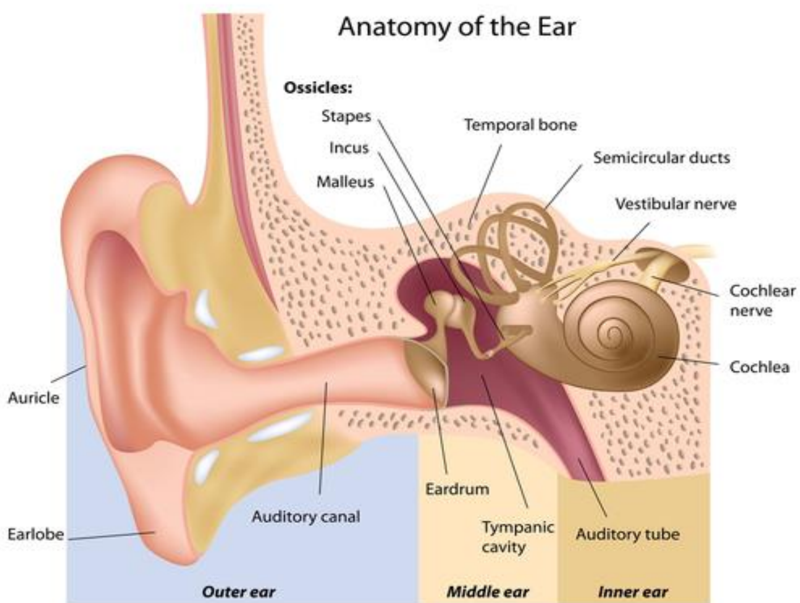
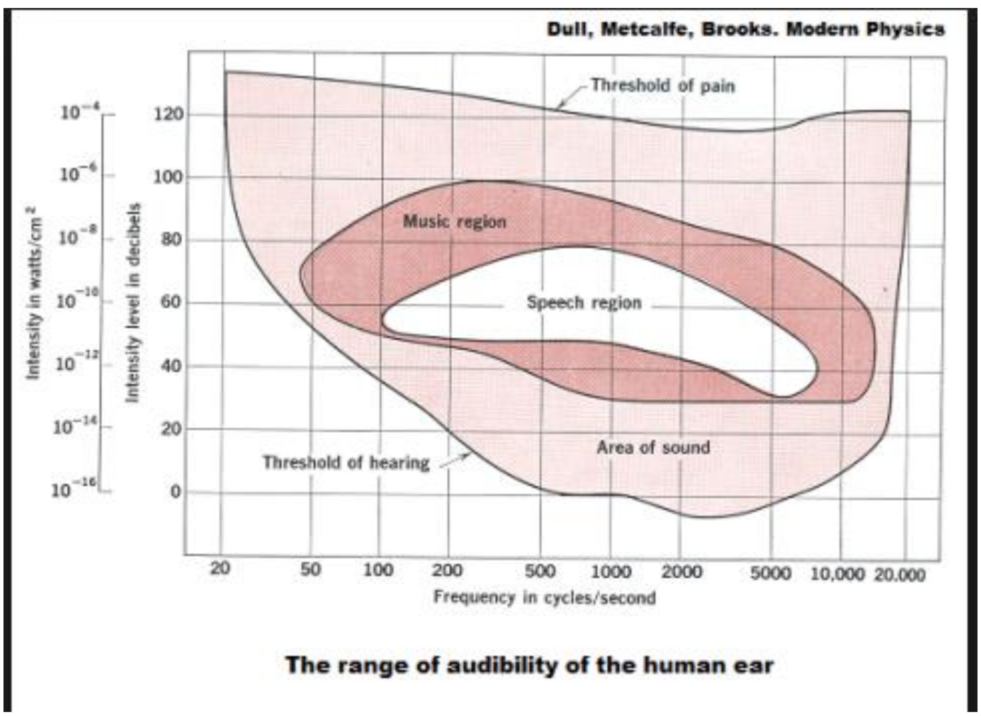


Figure 2-1. This figure displays the anatomy of the human ear. (Source: The New York Otolaryngology Group).

As part of the Listening Project Protocol (LPP: Porges et al. 2014), an explanation of the ossicular chain detailed the functional role of the middle ear muscles of the inner ear in filtering certain frequency ranges for the purposes of social engagement. Subjects of the LPP included children with autism, particularly those who displayed deficiencies in these filtering capabilities. Certain attenuated frequency ranges through computer-generated music positively influenced these children's ability to socially engage within particular activities following the music treatment. Manipulation of these frequency ranges was specifically designed to assist in facilitating an increase in the subjects' ability to filter out sounds irrespective of the human voice, such that focus on the human voice was improved. This evolved ability to hone in on the frequency ranges of the human voice contributes to our ability to socially engage.



The range of audibility of the human ear

Figure 2-2. The above figure displays the range of audibility of the human ear. (Source: SolitaryRoad.com).

The proposed study adapts this strategy, with intent to build upon findings of the LPP and develop knowledge around how certain kinds of music may or may not contribute to human social engagement. Derived from the Polyvagal theory and expanding upon the LPP, an interdisciplinary approach involving ethnomusicology and neuroscience is being taken to determine if these functional state changes in the ANS may be modifiable in healthy people through exposure to music. To illustrate a component of an ANS state-change in subjects associated with social engagement, empathy is a quantifiable indicator through social inclusion/exclusion activities. Cyberball (Williams et al. 2006) has been used for such purposes (Masten et al. 2011; Nordgren et al. 2011; Meyer et al. 2012; Riem et al. 2013) and was used in this study to measure empathic decision making through a control-treatment design.

From a psychophysiological perspective, empathy (Robert W. Levenson and Anna M. Ruef's (1992) work related to physiological state is most pertinent to highlight amidst the plethora literature on empathy) is a complex construct neurobiologically with multiple directions of inquiry into its component cognitive and affective parts being undertaken (Lamm et al. 2007; Shirtcliff et al. 2009). Levenson and Ruef used respiratory sinus arrhythmia (RSA) as a predictor for empathy between subjects of their study, noting that high parasympathetic tone (RSA) indicated positive emotion between subject and task conditions. This correlation further influences the design of the proposed study regarding physiological state as an indicator of social engagement equal to Porges' work.

CHAPTER 3
THEORETICAL BACKGROUND

Preface

This chapter is devoted to the fields from which this project draws its theoretical background. It offers a theoretical explanation of how and why the fields of ethnomusicology and neuroscience were used to explain music's roles in human social engagement. The first section includes information from formative scholars in ethnomusicology, with a focus on the universal traits of music humans experience across all cultures. Highlighted scholars include John Blacking, Bruno Nettl, Christopher Small, anthropologist Steven Mithen, Olivier Urbain and Felicity Laurence, Larry Crook, Jeff Todd Titon and Linda Fujie, and Steven Feld. The second section includes information on neuroscience, particularly a subfield called psychophysiology, with a focus on Stephen Porges' Polyvagal theory. The theory stresses the role of the human autonomic nervous system in social interaction, with fight/flight and rest/digest behaviors explained through evolutionary inheritance and modifications. Finally, in the third section I highlight Judith Becker's work regarding the combination of ethnomusicology and neuroscience: neuro-ethnomusicology.

Ethnomusicology

In *How Musical is Man*, author John Blacking defines ethnomusicology as "a comparatively new word which is widely used to refer to the study of the different musical systems of the world" (Blacking 1974, 3). In the era in which this definition was given, Blacking's thoughts were deserving of merit. However, the field has now evolved in numerous directions. The study of folk music traditions, for example, particularly differentiates the study of ethnomusicology from musicology, with the latter highlighting the study of Western European art music traditions. Furthermore, the emphasis upon ethnographic fieldwork and the use of such work to frame one's professional identity as an ethnomusicologist, contributes to the differentiation between the two fields.

At the time of his book's publication, Blacking was particularly interested in humanity's physical production and participation in the act of making music, and evaluating the human capacity to do so across socio-cultural hierarchies:

> if . . . all members of an African society are able to perform and listen intelligently to their own indigenous music . . . based on intellectual and musical processes that are found in the so-called 'art' music of Europe, we must ask why apparently general musical abilities should be restricted to a chosen few in societies supposed to be culturally more advanced. Does cultural development represent a real advance in human sensitivity and technical ability, or is it chiefly a diversion for elites and a weapon of class exploitation? (Blacking 1974, 4)

Ethnocentrism is an element of human biology and one's preferences for music (in whatever capacities) maintain its practice (De Dreu et al. 2011).[1] However, Blacking's thoughts divert away from the perceivably negative connotations of ethnocentrism to the roots by which we as humans display our abilities to understand and interact with music, either alone or in social settings. Particularly within multi-culturally diverse social settings, humans in general display common traits in their interactions with one another when music is present. Dancing, for example, though culturally unique in its numerous forms, genres, displays, purposes, and meanings remains a common method of expression by which all humans represent their reactions to musical stimuli, specifically within social settings. Considering Darwin's theory of evolution in conjunction with Blacking's thoughts, humanity has inherited "essential physiological and cognitive processes that generate musical composition and performance" (Blacking 1974, 7),

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[1] De Dreu et al. studied the role of oxytocin in facilitating in-group bias for and/or between its members. The results indicate the possibility that individuals of a group (defined by its musical preference(s), for example) will favor interaction with members of the group over those from outside.

providing for the argument that humans' musical abilities are not limited to ethnic, nor socio-cultural constructs.

Whether written or aural, composed or improvised, sung or played, listened-to or performed, humans maintain the ability to interpret aural stimuli through a network of environmentally affected cognitive and emotional systems culminating in the communication of meaning. To highlight this capacity, Blacking used the term "sonic order" (Blacking 1974, 12) referring to music as organized patterns of sound that form meaning through the processes of our inherited aural cognitive and emotional processing mechanisms. Elements that contribute to this perceived organization are hierarchically organized into categories, and together, they operate as a complete aural stimuli. Volume (amplitude) and pitch (frequency) exemplify some of these fundamental elements of an aural stimuli, and when combined with articulations, rhythms, durations, and tempi, they form meanings that one perceives with or without language involved. These fundamentals of an aural stimuli pertaining to potential meaning are arguable, however, as Blacking describes that "even though the meaning of music rests ultimately 'in the notes' that human ears perceive, there can be several possible structural interpretations of any pattern of sound, and an almost infinite number of individual responses to its structure depending on cultural background and current emotional state of its listeners" (Blacking 1974, 19-21).

Regarding music's potential to facilitate social engagement, then, as suggested in my project, variability in dispositional musical skill and musical preferences coupled with one's personality at a given moment in time will affect their willingness to behave in a certain way, specifically in social settings. Developing a deeper understanding of these phenomena through inclusion of Blacking's thoughts into the previously proposed design will offer another perspective into the potential meanings behind why music is part of human life. Furthermore, analysis and explanation of these phenomena through the proposed design's hypothesized results will direct future lines of inquiry into the question of how musical humans are, rather than solely man, specifically pertaining to Blacking's focus on the effects of socio-cultural constructs upon potential universal perceptions all humans may experience through music.

Bruno Nettl, an equally formative scholar in the field of ethnomusicology to Blacking, develops Blacking's thoughts on universals in music perception through his chapter in Wallin, Merker, and Brown's (respectively) *The Origins of Music* (2000). Nettl states "it may be helpful to consider various levels of universals—those extant in music at all times, those present in each musical utterance, others present in some sense in each musical system or musical culture . . ." (Nettl 2000, 463), to begin to understand music universals. However, "identification of universals depends on definitions of music, of musical units analogous to culture units, and on an inter-culturally valid concept of music . . ." (Nettl 2000, 463), to which Nettl clearly focuses on cultural perceptions. Furthermore, his focus on cognitive and/or voluntary choice of a particular group of people proliferating a particular style based upon preference for any given reason limits the conception of musical universals perhaps existing at all. This supports Blacking's thoughts of culture affecting the perception of music universals, though a deeper layer for investigation into music universals exists regarding their construction.

Music universals defining Nettl's statement of 'those extant in music at all times' suggest that qualities and/or fundamental building blocks of music stretch across cultural practices. Considering music universals in the form of music's fundamental building blocks is a necessary step here, to highlight elements of music that are truly 'extant in music at all times.' Otherwise, Nettl's thoughts on definitions of music representative of a particular culture's practices suggest a different perspective on definitions of music universals. Every culture to our knowledge does indeed possess some form of music by which that culture expresses, interacts, celebrates, mourns, etc. Therefore, the uses of music are myriad. However, particularly the auditory components of music are built on foundations that stretch across cultural practices. [2]

Stretching across cultural practices of music to connect to another's music requires some level and/or form of appreciation, respect, and/or tolerance of the qualities of the fundamental building blocks of music. One could use different terms, but the essence of music appreciation ties intimately into the essence of musical experience. Individual preferences (Nettl discusses bi-musicality and multi-musicality) for music due to the interplay of one's personality and cultural upbringing may limit willingness and/or ability to connect to another's culturally-based music, but this is not directly related to music's building blocks, specifically regarding the previous thought process. The essence of musical experience involves "a set of concentric circles" (Nettl 2000, 466), to which Christopher Small offers a valuable perspective.

Christopher Small's book *Musicking: The Meanings of Performing and Listening* builds on Blacking's and Nettl's respective thoughts of music as a universal human phenomenon. However, Small uniquely suggests that "there is no such thing as music . . . music is not a thing at all but an activity, something that people do" (Small 2011, 2), or *musicking*. Small agrees with Blacking on the ethnocentrism associated with certain Western European art music scholars and supports Blacking's thoughts through a brief discourse on the challenge of ascribing meaning to a musical work (as similar to a work of visual art or poem). The performance of that work, however, allows the perceiver to conceptualize the composer(s') and/or performer(s') respective

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[2] Examples of some of the auditory components of music, excluding Nettl's discussion of the North American Blackfoot Indians' term saapup defining the process of "singing, dancing, and ceremony all rolled into one," (Nettl, 466, '00) for example, include elements of rhythm, tempo, articulation, volume, tone, etc. Though the effects of culture upon one's perception of these elements as well as how to define these elements may differ, these fundamental building blocks of the auditory components of music exist as music universals.

intent(s) regardless of cultural context(s), tying in to Nettl's thoughts on extant musical universals. This is achieved via cognitive and emotional mechanisms discussed by Blacking, yielding "an explicit will" (Small 2011, 4) all parties involved with the consumption of that music can connect to and unravel in their own biologically and environmentally influenced ways.

Small suggests musicking as "an activity in which all those present are involved and for whose nature and quality, success or failure, everyone present bears some responsibility" (Small 2011, 10). Whether performer or composer, listener or audience member, concert hall staff or cleaning crew, the setting in which the organized sound we call music takes place envelops all involved and supplies a role for each of us to play. Small is arguing for the belief that music is not strictly presentational nor participatory, but rather a hybridized version of the two, in which all present to experience its effects contribute to the overall path the music travels. The emotional effects, for example, may not solely occur by a change in the auditory component of the music itself. Rather, one's perceptions of the visual, olfactory, and/or tactile sensory stimulations via one's physical presence in a performance space combine with one's perception of auditory stimulation to form the essence of the experience of music.

Small's use of the word responsibility further suggests some level of one's obligation to the experience of music. In whichever musical setting, concert hall or backyard house party, grocery store or elevator, mutual physical presence in that setting alters the perceptions of the auditory stimuli from one to another - performer, composer, and/or audience. If role playing as the performer, for example, the audience's and/or composer's perceptions of the stimuli (visual, auditory, tactile, gustatory, and/or olfactory) within the performance space may alter the behavior of the performer in some capacity, further altering initial intentions of that performer. Similarly, the composer's perceptions of the stimuli present at the time in which she composed the work also affects the composition. All of these elements contribute to Small's conception of musicking.

The musical event and work, then, is presented as one in the same. This challenges Carl Dahlhaus' belief that the unification of musical work and event "does not exist" (Small 2016, 105). Small's theory of musicking encapsulates "all human musicking, no matter how strange, primitive, or even antipathetic . . . to our perceptions" (Small 2011, 11), fundamentally shifting a common belief that music is only one experience. The Western European Classical music tradition, for example, has long been privileged in Western thought as the singularly true musical experience for many people, with the concert hall as the predominant space in which one goes to experience music. Perhaps thankfully, additions in appreciation for music of others' cultures to one's established music preferences have limited the hegemonic influence of Western European Classical music upon its many audiences. Small mentions the effects of hip-hop and African American blues as examples, while laying out his "theory of musicking":

> Everyone, whether aware of it or not, has what we can loosely call a theory of musicking, which is to say, an idea of what musicking is, what it is not, and what role it plays in our lives. . . . A theory of musicking, like the act itself, is not just an affair for intellectuals and 'cultured' people but an important component of our understanding of ourselves and of our relationships with other people and the other creatures with which we share our planet (Small 2011, 13).

Music appreciation is a class elementary school students in the United States often take as a prerequisite towards graduation into middle school courses. Select individuals grasp and favor the offered material within the particular setting of each individual school environment, where others are not offered the nurturing they need to embrace their subjective theory of musicking. However, "if everyone is born musical, then everyone's musical experience is valid" (Small 2011, 13) and honoring this idea contributes to a unifying theory of musicking, as all who engage in musical experience share in its common stimuli. Being born musical, then, yields the idea that humans are born with innate capacities to both perceive qualities of sound defining musical stimuli, as well as engage in social activities promoting the acts of making and/or producing musical stimuli in groups. The validity of this assertion offers the possibility for assessing ways and means to nurture these capacities and promote intra and inter-cultural musical aptitudes and appreciations.

That said, one's preference(s) for culturally oriented environments via the interaction of enculturation and genetic predispositions wholly contributes to one's comfort level within those environments and the potential for such aptitude and/or development of appreciation to perhaps occur at all. Small takes care to point out his negative bias towards the Western European Classical music tradition and his associated personal discomfort in those settings, such as the symphony concert. Similarly, he mentions individuals who favor WECM to inevitably feel some level of discomfort at a rock or blues concert, due to their preference for certain different acculturated settings. Preference for acculturated musical environments is a strong indicator of one's involvement in musicking and contributes to Small's principal interest in writing his book, "what's really going on here?" (Small 2011, 17).

Small devotes an entire chapter to this question and focuses on the relationships people develop among one another and with the cosmos through musicking. He describes one's encounter with musicking in social settings as exploratory, affirmatory, and lastly celebratory. These characteristics are described as the relationships one develops within themselves to the music itself, and between themselves and other people (Small 2011, 183). According to Small, musical settings offer non-familiar people the opportunity to interact through socially stimulating means, creating an atmosphere of exploration, affirmation, and celebration:

> The relationships that are created in a musical performance are of two kinds: first, those among the sounds that the musicians are making, whether on their own

> initiative or following directions, and second, those among the people who are taking part. . . . Although the sounds that the musicians are making do not constitute the whole of the experience, they are nonetheless the catalyst that makes the experience take place, and their nature and their relationships are therefore a crucial part of the nature of the experience as a whole (Small 2011,184).

One last thought to include from Small's *Musicking* is his brief discussion on Homo sapiens perceptions of aural language being an evolved adaptation from perceptions of earlier hominid species' gesture-based communication. Small describes musicking as wholly gestural, with meaning from one's experience of a musical setting encapsulating multiple dimensions of purpose and intent, communicated and interpreted by each member within the musical setting via their personal biases, filters, and perceptions. In contrast to the gesture-based communication of musicking, Small describes aural language - with its intent for direct and explicit meaning - as reductive, "reducing the many-layered, multidimensional experience [of musicking] to a one-dimensional discursive stream" (Small 2011, 185).

The use of aural language as critique, for example, is designed to describe a musical event in specific terms. A professional music critic describes a musical event with the intent in mind that their audience will want to hear about the event within the style of which the critic is known. Small's thoughts provide for an interpretation of the significance of a musical setting as more than "a one-dimensional discursive stream," through embodied perceptions of emotion - Small's "multidimensional experience" of musicking - perhaps impossible to wholly capture through descriptive language. The existence of music's cross-cultural gestural communication indicates how and why one's physical experience of music in social groups contributes to interpersonal understanding, regardless of language barriers.

Adding to Small's work, Thomas Turino provides insight into how the associated signs and indices of objects, sounds, smells and other sensory stimuli contribute to interpersonal understanding in his "Signs of Imagination, Identity, and Experience: A Peircian Semiotic

Theory for Music." Gestural communication is therefore not limited to vocalized utterances and/or guttural sounds according to Turino's take on Peircian semiosis.[3] Furthermore, a limitless stream of consciousness both informed by sensory cues (visual, auditory, olfactory, etc.) from one's environment and their inherited traits is constant, and constantly transforming through one's life experiences. Specific to music, Turino's discussion of Peirce's semiosis highlights iconicity - the sounds one identifies with characteristics of something they've previously heard:

> we . . . recognize a new song as belonging to a particular style or genre because it *sounds like* other songs we have heard; the sound of the steel guitar and a particular type of "twangy" vocal quality (**timbre*) and ornamentation allow North Americans to immediately identify a new piece encountered as country music because it sounds like the country songs they have heard before. (Turino 2008, 6)

Turino's example suggests that a human's perception, recognition, and associated reaction(s) of/to a previously heard auditory stimuli is based upon a chain of cognitive and emotional events that culminate in a form of meaning particularly salient to that individual. The gestures of a musical sound (rhythm, harmony, melody, articulations, tempo, volume, etc.) and physical gestures of a performer only make sense to someone when they've encountered some version of those gestures in their past, such that their individualized responses to those gestures meshes with their understanding of what those gestures mean. Collectively, however, humans all (pending one's physical and/or psychological ability to perceive these gestures) respond to sound stimuli (in particular) because of common experiences we all share at some point in our lives that formed semiosis in the first place.

Turino's thoughts on the role of emotional associations to semiosis via auditory stimulation are helpful here, due to the effect that a sound has upon one's reaction to it. Sounds

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[3] This expands the initial definition of gestural communication offered by Small, considering gestures as more than vocalizations produced by one human for the purposes of social interaction with another.

that are not readily recognizable, a "scary noise" (Turino 2008, 6) for example, is categorized as such due to a missing cue between common sounds – those that are recognizable to an individual – and uncommon ones. Though basic and/or perhaps somewhat overtly self-explanatory, this thought adds to the developing argument for why people react in certain ways to timbres of sounds that don't register with their bank of previously heard sounds. Their memory of a sound that sounds like this newly experienced auditory stimulus is slightly different, and consequently, startling and/or fear-inducing, leading to a chain of autonomic events in the body to facilitate fight-flight responses.

All people experience these moments at some point in their lives and the development of aural language has only complicated the amount of information within the bank of both unrecognizable sounds and emotional reactions to those sounds. Furthermore, the effect of the ability of language to direct both cognitive and emotional activity in us connects the essence of our gestural communications, tying the human experience together through its common mechanisms. However, human evolution has created individualized cultural identities, formed in part by psychological diversity, which limits our innate gestural communication and interpretation skills from wholly functioning across cultures.

These areas of inquiry involve multiple methodologies and considering ethnomusicology from an evolutionarily-anthropological perspective, human perception of gestural communication is an innate skill formed before acculturation and one that has evolved through humanity's pedigree. In *The Singing Neanderthals*, author Steven Mithen (2006) theorized multiple forms of gestural communication as the first means of humans (Homo sapiens) to indicate common goals to one another - goals that would ultimately lead to our successes over our predecessors, the Neanderthals. From auditory gestures - grunts, snorts, coughs, and laughs, for example - to silent gestures including smiles and/or pointing in a particular direction, Mithen explains the significance of these cues as the predecessors to aural language development. Mithen also highlights the evolution of bipedalism as a (if not the) catalyst for homo sapiens' capacity and development of aural language, for example, as increases in communicative capacity through this evolutionary development influenced our understanding of collective intents and actions (e.g. scouting new territory, hunting and gathering, etc.), ultimately leading to the need for more explicit and/or direct auditory communication, such as the use of words and phrases with specific meanings.

The evolution of audition in human communication is an essential element of most people's perceptions of musical experience. Without the capacity to understand gestures, particularly the prosody (musical elements of speech, i.e. rhythms, dynamics, articulations, intonations, etc.) of one's intent, verbal gestural cues would lack value and limit the extent to coordinate common goals and/or actions. The fundamentals of musical communication are these prosodic cues and the multi-dimensional experience one may engage in through music (suggested by Small) directly correlates to Mithen's discussion. How does empathy fit into this mix? How and/or why did the evolution of human interaction through gestural cues lead to the capacity for a conscience?

Olivier Urbain and Felicity Laurence consider these thoughts from the perspective of music. Particularly, Laurence discusses how music nurtures one's capacity for empathy, via the work of Edith Stein and Christopher Small. Through a framework, Laurence deduced key points of Stein's, and outlined how empathy is a realization of one's own interpretation of another's emotional and/or cognitive state. Furthermore, Laurence discusses Stein's distinction between emotional contagion and empathy, with the former being an automatic, collective consciousness of emotional and/or cognitive reaction(s), rather than an individual experience prompted by one's background (Laurence 2015, 19).

An example of emotional contagion and music is highly rhythmic music that evokes groups of people to dance. The individual(s) that initiate(s) dance facilitate(s) an emotionally contagious response in the/a group. The tempo, rhythms, articulations and other auditory characteristics of the music coupled with the visual cues of the dance stimulate the followers to move like the initiate. Culture plays a significant role in the transitional process from one's stillness to physical engagement, as similarities in preference for music and dance instigated by one's upbringing contribute to an understanding of how and why moving to music in a particular way is socially accepted.

Laurence takes note of Stein's discussion in reference to culture somewhat outside of this example of highly rhythmic music, more generally suggesting that intra-group cohesion is perhaps debilitating to inter-group cohesion. Intra-group cohesion strengthens often to a point of increased exclusionary tendencies to out-groups, despite music and dance acting as a social lubricant (Laurence 2015, 21). However, when observing another's emotional expressions of joy and pleasure through culturally-specific gestural cues of their forms of music and dance, empathy for that joy stimulates outside members of that culture to similarly experience joy. Implicit affiliation for another individual's culture is facilitated via collective actions and/or synchronized activity, like music and dance, with empathy playing a key role in this process (Vuoskoski et al. 2016). Smiles, laughs, and other gestural communication expressed via the emotionally contagious music and dance evokes emotional responses within all involved, regardless of cultural affiliation.

Building on this, Laurence discusses Mothe's thoughts to support both Small's and Stein's ideas, particularly to "draw an explicit distinction between the noun *empathy* and the verb *empathize*" (Laurence 2016, 22). In the process of empathizing, particularly in the context of highly rhythmic music facilitating groups of individuals to dance, Laurence notes the ability of these stimuli to enact a common intent between those involved. Individual goals may differ, regarding particular movements to the music to impress another in the group, for example, though an overall goal to participate in the communal activity of the dance exists. This overall goal is facilitated by the common ability of humans to empathize with one another, experience a common feeling, and share in the intent of others through music and dance.

Music associated with Carnival celebrations in Brazil is an example of this, particularly considering the amount of international participation. Individuals and groups from across the globe congregate for the annual 4-day event, coming from diverse sets of cultural backgrounds. Common gestural cues - honest smiles and laughter, for example - exhibit recognizable characteristics defining joy that outsiders to Brazilian culture are able to empathize with and share. Joy spreads throughout the participants like a contagious virus, as empathy for another's emotional state is mutually felt and proliferated via innate mirroring activity. To this extent, a hybridization of empathy and emotional contagion exist in Brazil's Carnival, countering Stein's and building upon Laurence's thoughts. Music and dance play significant roles in the facilitation of this culturally diverse participation, with an interplay of empathy and emotional contagion at the core of the experience.

Larry Crook's work in Brazil accounts for this supposition, with ethnographic data of Brazil's carnival pointing to the mutual joy people experience when taking part in the celebrations. In the northeast of Brazil, residents of Recife celebrate Carnival with music emphasizing "the unrelenting, driving pulse" (Crook 2010, 3) of the *Maracatu de Baque Virado* (turned around beat) percussion, as part of their numerous celebratory styles. Another of these styles, *Bloco Carnavalesco* celebrates and emphasizes instruments like mandolins, guitars, and flutes, rather than percussion, and *Caboclinho* highlights the flute, a small drum, and metal shakers (Crook 2010, 7). All three styles originate from Recife, with groups from each tradition sometimes convening simultaneously in the street at the time of Carnival to share in the overall celebration. One's preference for the elements of any or all of these Recife traditions significantly contributes to their physical participation. However, the drive to physically express and participate in the group activity is something each individual can account for, empathize with, and share with members of other groups, regardless of cultural influence and/or preference.

Embedded influences from African, European, and indigenous traditions upon Brazilian music and culture promote intercultural engagement between Recife's Carnival group members, despite stylistic differences and individual preferences. Broadening the scope, one style of Brazilian music that has evolved from these influences into a nationally and internationally celebrated style is the *samba.* The samba contains elements of music practiced and appreciated across the globe, including diverse instrumentation, virtuosic performance, complex compositions and arrangements, and a similarly 'unrelenting, driving pulse.' To briefly give an idea of the significance of the samba on Carnival, the percussion, dance, and costuming sections from Rio de Janeiro's Carnival scene alone (particularly considering the competitions in the *Sambadrome* between Rio's many *escolas de samba* (samba schools)), include hundreds of members each: dancers compete for attention as the best in movement; costume designers hone their crafting skills of color and texture in various fabrics to accentuate the dancers' movements and prove their deft touch at fashion. Collectively, a superorganism of individual contributions produce Rio's annual Carnival, with empathy for the intended outcome of the big picture playing a dominant role.

Jeff Todd Titon and Linda Fujie provide further ethnomusicological thought towards music and empathy in their *Worlds of Music*: "we must 'get out of our cultural skins' as much as possible in order to view music from more than one point of view" (Titon and Fujie 2005, 3). Perspective and awareness of one's bias and/or cultural background is an essential part of at least beginning to understand the significance of another's music, particularly the numerous contexts involved. But, Titon and Fujie's wording of 'cultural skins' is truly significant, particularly considering the train of thought to follow.

They approach this thought from a scientific bent considering what, if any, common traits of music exist. To analyze these common traits, they ask how music is different than sound, stating music as human-created phrases and all other auditory stimuli as sound. Pivoting, Titon and Fujie exemplify common elements of all auditory stimuli found within their chosen example of bird song, to which scholars of music argue for and against relating specifically to the aforementioned thought of music being human-created phrases. To 'get out of our cultural skins,' Titon and Fujie follow suit with Blacking and Small in stating that rhythms, tempi, articulations, dynamics, etc. define all auditory stimuli collected by the human ear, no matter the auditory source (human or otherwise). With a balanced perspective, one can appreciate the similarities of music and sound as culturally (and/or species-related) nondescript.

Building on Titon and Fujie's thoughts, Steven Feld similarly discusses music and culture from the perspective of bird song in his *Sound and Sentiment*. Feld lived with the Kaluli people of Papua New Guinea and experienced the relationship these people shared with the wildlife, particularly the significance of bird song to their spiritual beliefs. While documenting elements of this relationship, Feld asked a question to his guide (Jubi) regarding the imitative calls Jubi was making, to which Jubi "blurted back, 'Listen – to you they are birds, to me they are voices in the forest" (Feld 2012, 45).

Feld's experience taught him the importance of removing himself from his cultural skin to fully understand the relationship Jubi and the Kaluli have with others in their version of reality. All auditory stimuli are arguably perceived in acculturated terms due to the nature of humanity's disposition to form and associate with cultural groups. However, sensitivity to ethnocentric biases allows us to appreciate and experience different versions of reality, particularly considering what music is or is not. Pathways to understanding between cultures through music must include deeper appreciation for cultural values, with elements that all humans perceive, i.e. rhythms, tempi, articulations, etc., at the forefront of constructive discussions.

To expand upon these ideas, I turn now to the role of neuroscience, particularly psychophysiology, in broadening our understanding of music and empathy. However, the overall topic is too broad to consider in detail for the purposes of this study. Therefore, I will focus on one approach to the field geared towards the study of the autonomic nervous system and human social engagement.

Neuroscience

In 1995, Stephen Porges introduced a new approach to the field of psychophysiology. Coined the Polyvagal Theory, Porges argues that the 10^{th} cranial nerve of a human's brain stem, the vagus, is divided into two separate sources with competitive functions. According to the theory, the first of the two sources, the nucleus ambiguus (NA)[4], is responsible for numerous social functions in mammals, including respiratory sinus arrhythmia (RSA), "a naturally occurring correspondence between respiratory phase and heart rate" (Jennings and McKnight 1994). The second, the dorsal motor nucleus (DMNX)[5], is responsible for regulation of digestive and alimentary processes in subdiaphragmatic organs, as well as neurogenic bradycardia (Porges 1995, 305). These nuclei respectively communicate with the body's cardiopulmonary and digestive systems via autonomic nervous system tissues. Particularly, the NA is comprised of myelinated nerves and the DMNX predominantly unmyelinated nerves (Porges 1995, 308). The process of nerve myelination is complex, but the purpose is simple: expedited communication of information from one location to another.

Porges argued this expedited communication as an inherited trait of mammals over millennia of evolution from mammals' distant ancestors, reptiles. In reptiles, there are similar distinctions in vagal construction and function. Both NA and DMNX constructions and functions are present within multiple reptilian species, including crocodiles and lizards (Barbas-Henry and Lohman 1984). However, reptilian vagi do not exhibit the same behavioral outcomes as mammalian vagi, particularly regarding orienting reflexes. Reptiles orient themselves to their environments via immobilization behaviors at moments of perceived threat, for example. Mammals inherited the autonomic roots of the reptilian response, but our orienting reflex includes complex interactions between emotions and social communication at moments of perceived threat and otherwise.

[4] The NA is part of the ventral vagal complex, including the trigeminal and facial nerves. In conjunction, this complex of nerves contributes to social communication in mammals with the NA playing a predominant role.

[5] The DMNX is part of the dorsal vagal complex, including the NTS (nucleus tractus solitarius). In conjunction, these nerves contribute to rest/digest behaviors in mammals.

To foster social communication in mammals, the NA innervates muscle tissues in the face and throat that contribute to the uniquely mammalian capacities for complex social communication. These nerves originate at the NA and operate in conjunction with the other nerves of the ventral vagal complex (VVC), innervating the muscles of our faces, larynges, pharynges, soft palates, and esophagi (Porges 1995, 309). The functional expressions of these innervations will differ from individual to individual pending psychological traits, particularly pertaining to social communication. However, the culmination of these nerves originating at the VVC indicates a phylogenetic inheritance from reptiles suggested by Porges in Polyvagal theory. Furthermore, a means to study psychophysiological characteristics of mammalian social communication is offered through Polyvagal theory, including, for example, musicking.

The expression and comprehension of primary emotions are a key component of Porges' discussion on mammalian social communication. The NA's role in facilitating the expression and comprehension of primary emotions: happiness, sadness, anger, fear, surprise, interest, disgust, and panic, is highlighted. To facilitate these expressions and in conjunction with its innervations of facial and throat muscle tissue, the NA innervates heart and lung muscle tissue, "organs that are assumed to be sensitive to emotion and stress" (Porges 1995, 313). The NA's innervations of both sets of tissues (facial/throat and cardiopulmonary) produces a unified behavior from these parts of the body, contributing to both the expression and comprehension of primary emotions to occur. Across human cultures, these primary emotions are shown to be universally expressed and understood (Ross et al. 1994). In conjunction with Vuoskoski, Clarke, and DeNora (2016), this suggests the primary emotional components of music to promote intercultural understanding via polyvagal activity.

The Polyvagal theory has evolved from Porges' initial 1995 publication. In 2011, Porges published the book *The Polyvagal Theory: Neurophysiological Foundations of Emotions, Attachment, Communication and Self-Regulation* as a culmination of works that include detailed discussions relating the roles of the NA and DMNX to the roles of the sympathetic (fight/flight) and parasympathetic (rest/digest) nervous systems. Together, the ventral and dorsal vagal and sympathetic and parasympathetic systems form our autonomic nervous system (ANS), with interactions between them at the core of mammalian social interaction. Porges' first chapter of the book highlights the term *neuroception* to describe the complex interactions of these systems "continually evaluating risk" (Porges 2011, 11) from our surrounding environments. Mammals will not feel comfortable to socially interact with one another if they perceive the situation to be risky and/or threatening. This activity is subconscious, with automatic preparations for potentially risky and/or threatening situations acting upon a mammal's conscious or voluntary behaviors. If we feel threatened, we will disengage from social interaction because of fight/flight preparations by the sympathetic system. In contrast, if we feel safe, our parasympathetic system inhibits fight/flight behaviors and automatically prepares our body for positive social interactions.

The vagal (NA and DMNX) innervations of sub and supradiaphragmatic organs (guts and throat/face, respectively) contribute to this inhibition of the sympathetic nervous system's autonomic responses to perceived risks or threats. In parasympathetic activity, the NA serves a predominant role in inhibiting the sympathetic system's preparations of the body for fight/flight responses; the body is calmed via slowed heart-rate, relaxed muscles, and slowed breathing. The DMNX also engages the rest/digest characteristics of the parasympathetic system through its subdiaphragmatic innervations, and both the NA and DMNX act upon the heart's sino-atrial node to inhibit sympathetic preparations for fight/flight. These actions produce the physiological state required of humans to socially engage with one another; neuroception produces the physiological states required for us to listen to one another, be respectful, kind, and empathetic.

Porges elaborates on these ideas through a deeper discussion of the vagal and peripheral autonomic (PNS and SNS) systems' involvement in the expression and reception of emotion. True to its name, the *sympathetic* "reflects the historical identity of this system as a nervous system 'with feelings' and contrasts it with the parasympathetic nervous system, a label that reflects a nervous system that 'guards against feelings'" (Porges 2011, 160). These descriptions particularly pertain to the body's sympathetic responses to perceived threats, with feelings for the survival of the individual outweighing the "metabolically costly gastrointestinal" (Porges 2011, 160) activity of the parasympathetic system. However, to achieve the appropriate physiological state for civil behavior to occur between two or more individuals in social settings, the parasympathetic system must regulate sympathetic activity.

Transitions in autonomic state reflected by positive expressions of emotion in human social engagement are directly linked to the activity of the NA and its associated ventral vagal complex. Neuroception by the VVC inhibits sympathetic perceptions of threat, promoting parasympathetic expressions through its numerous supradiaphragmatic innervations: the larynx, pharynx, and facial tissues. Porges' coined the term *social engagement system* (Porges 2011, 269) to refer to the behavior and interactions between these two competing systems, with the VVC supplying the necessary "vagal brake" (Porges 2011, 268)[6] required for prosocial

[6] Dr. Porges refers to the vagal brake at numerous points through his book. This particular reference point highlights mammalian advances in autonomic regulation of perceptions of threat promoting prosocial behavioral interaction in healthy individuals. Earlier in the book, chapter 7 contains information on the development of this capacity human infants.

engagement to occur between two or more people. Characteristic emotional expressions of positive social engagement via these innervations include smiling, laughter, and eye contact. More complex expressions of positive social engagement include curiosity through active listening and questions, pertaining to another's spoken and/or physically gestured train of thought.

The ability to express and perceive emotions is essential for positive social engagement between two or more individuals to occur. Psychophysiologically, empathy for another cannot occur unless the sympathetic nervous system is inhibited and parasympathetic states of rest/digest are activated. Levenson and Ruef (1992) endeavored to study affective empathy from this psychophysiological perspective. Briefly, they concluded from their study that subjects in states of low cardiovascular arousal (i.e. parasympathetic states) detected positive emotion between spouses in a marital interaction better than when in states of high cardiovascular arousal. Contrastingly, negative emotion was detected better when cardiovascular arousal was high and subjects experienced a greater physiological linkage with target spouses across time when their respective heart-rates were higher.

Of key importance in their discussion is the inclusion of empathy stimulating both physiological arousal and withdrawal. Regarding the Polyvagal theory, the ability of the human social engagement system to autonomically perceive threats/risks limiting one's ability to interact with another is a survival mechanism. However, the interactions between the sympathetic and parasympathetic systems are constantly occurring, indicating the potential for perceptions of threat to occur at any moment during social interactions. The perception of threat inhibits prosocial behaviors from occurring and stimulates fight/flight reflexes, deterring positive social engagement. Furthermore, when social and/or emotional cues are misread due to psychophysiological imbalances, miscommunication is possible and the ability to correct that miscommunication is difficult.

Individuals with an inability to detect social and/or emotional cues relating to positive social engagement (i.e. expressions of joy or laughter) lack the proper functionality of vagal mechanisms responsible for transitions from fight/flight to rest/digest. Autism exemplifies a neuropsychological condition with such characteristics, to which Porges conducted a study on autistic children using "computer altered acoustic stimulation" (Porges et al. 2014) to facilitate positive social engagement. The Listening Project Protocol (2014) was a team effort involving individuals from multiple disciplines and designed to expose autistic subjects to auditory stimulation comprised of frequencies emulating the human voice. The Polyvagal theory states that the construction of the middle-ear muscles is designed to filter out frequencies irrespective of the human voice to facilitate social engagement between two or more people. Autistic individuals do not have this capacity according to the LPP study, yielding the need to design a study to better understand this particular aspect of autism-spectrum disorders. Porges and his team concluded that auditory stimulation of this type did facilitate positive social engagement between the autistic subjects and their parents during a post-listening activity.

The potential for music to positively affect the psychophysiology of groups of people is an intriguing thought. Judith Becker has approached similar thoughts from a neuro-ethnomusicological direction in her work, to which the following section of this chapter is devoted. Articles and chapters of books from authors interested in similar topics are included to support Becker's thoughts.

Neuro-Ethnomusicology

Judith Becker discusses the neurobiological roots of emotion responsible for human response to auditory stimuli in her book *Deep Listener's: Music, Emotion, and Trancing*, (2004).

These neurobiological roots form the human capacity for emotion perception and embodiment, with embodiment involving both neurobiological and cultural/environmental influences. Becker highlights two facets of the relationship between emotion perception and embodiment, through her discussion of emotion and the physical embodiment of emotional experience. These include: "1) the body as a physical structure in which emotion happens, and 2) the body as a site of first-person experience" (Becker 2004, 45).

These facets of emotion and emotional experience are derived from Becker's discussion of William James' seminal theory of emotion, in which feeling states (emotions) occur after physical stimulation in some manner. Anger for example, according to James, is felt after the physical effects of anger are expressed through the body: an impatient increase in volume while speaking or a shift in tone of voice directed to/at another individual. Becker states "anger, the emotion, *is*, according to James, what one *feels* when enacting this display" (2004, 47). Contrasting this theory, Becker supplies psychologist Randolph Cornelius' "common sense" (2004, 46) account of emotion and emotional experience, suggesting that the physical expressions of emotions (anger and otherwise) occur after the perception of a stimuli prompts an emotion.

To build upon James' and Cornelius' theories, Becker supplies Antonio Damasio's "more sophisticated knowledge of the neurophysiology of emotion . . . a more nuanced and inclusive theory of emotion" (2004, 47). Damasio focuses on the autonomic nervous system's role in facilitating emotion and emotional experience, distinguishing primary from secondary and/or "'background emotions' or moods" (Becker 2004, 51).[7] Secondary emotions account for the

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7 In the previous section on Porges' Polyvagal theory, primary emotions are labeled as happiness, sadness, anger, fear, etc. These emotions are neurobiologically wired in humans. Regardless of cultural influence, primary emotions are both felt and embodied, pending psychophysiological and/or neurobiological health of an individual.

more complex emotional experiences humans undergo during deep listening in musical settings, for example. Cultural and/or environmental influences act in tandem with a human's neurobiological roots to affect their capacity for emotion and emotional experience. In discussing emotion and music, Becker takes care to emphasize the nuance involved with human perception and cognition of emotion:

> Musical emotions in this study narrowly refer to emotions aroused in deep listeners or performers, not necessarily those the listener believes are *expressed* by the music. The studies discussed below were focused on the strong emotional reactions of the listener, the physiology of musical listening. . . . For all the differences from other kinds of emotion that may have evolved as a strategy for survival, musical emotion is still rooted in basic physiological arousal felt in the body and displayed by tears, chills/shivers, goosebumps, palpitation of the heart, and perspiration (Sloboda 1991; Panksepp 1995; Gabrielsson and Lindstrom Wik 2000: 103; Blood and Zatorre 2001) (Becker 2004, 52).

Arousal is both positive and negative, linking back to the previous section on the Polyvagal theory and discussion of competition between the sympathetic and parasympathetic systems. Perceived threats to survival stimulate the fight/flight response regardless of the nature of the stimulation. Well-intending stimuli perceived as a threat will trigger subconsciously aroused emotional responses, based upon the combination of one's neurobiological and cultural/environmental influences. However, Becker suggests musical emotions to facilitate feeling states based on physiological arousal from primary emotions often triggering pleasure, rather than pain – "we tend to feel good when we are musically aroused and excited. Notably, musical emotions tend to be positive, whereas primary emotions tend to be negative" (2004, 52).

To support this, Becker discusses the roles of arousing emotions like "joy, fear, and rage" (2004, 52) in facilitating trance-states within deep listeners. She distinguishes these arousing emotions from secondary emotions like "solace, humility, and peace" (2004, 54) suggesting that to achieve trance-states, primary emotions are aroused first and secondary emotions follow. Becker believes that high arousal primary emotions are essential for trance-states to occur, with deep listeners arguably not experiencing the level of emotional arousal when compared to those in trance. That said, Becker supplies multiple seminal studies of researchers interested in chill responses and goosebumps caused from deep music listening, including Blood and Zatorre (2001):

> Blood and Zatorre (2001) conducted and experiment in which the subjects selected music that predictably invoked intensely pleasurable responses (chills). Changes in heart and breathing as well as changes in the electrical activity of skeletal muscles were significant when the subjects were listening to their self-selected, pleasure-inducing musical examples. . . . That "music recruits neural systems of reward" (Blood and Zatorre 2001) is a scientific finding that only confirms a phenomenal truism: Pleasure motivates deep musical listening. (Becker 2004, 53)

Self-selection of music appears to have promoted (if not caused) the intensely pleasurable responses of the subjects in Blood and Zatorre's study. Stimulation from fulfilling expectations of one's musical preferences is therefore a key element in instilling arousing emotional responses, at least in deep listeners. Reward centers in the brain (as discussed in Blood and Zatorre's study) responsible for these intensely pleasurable responses in deep listeners appear stimulated greatest via fulfilled expectations from the musical stimuli. David Huron's work in cognitive ethnomusicology promotes this argument, wherein music listening involving fulfilled expectations elicits stronger pleasurable responses than from musical stimuli outside of one's musical preferences:

> If a nominally unpleasant sound is not expected by a listener, then the sound will be perceived as even more unpleasant or annoying. Conversely, if a nominally pleasant sound is not expected by a listener, it will tend to be perceived as more pleasant. A lengthy dissonant passage is likely to lead listeners to expect further dissonant sonorities. If the music shifts toward a more consonant texture, then the resulting contrast will tend to evoke a pleasing effect that can be greater than experiencing only the consonant passage. (Huron 2007, 22).

Huron's use of the word *nominally* points to previous discussions of Becker's and Porges' regarding subconscious arousal of primary emotions via the autonomic nervous system, from sound stimuli or otherwise. Stressing the combined influence of one's neurobiological roots and cultural upbringing forming their dispositional primary emotional response to both expected and unexpected sound stimuli is of significant importance here. Humans across cultures express primary emotional responses. However, how, when, and/or why an individual expresses their particular version of a primary emotional response is exclusively individualized. Becker discusses William James' theory (aka the James-Lange theory) for this purpose, to distinguish between subconscious emotional arousal and voluntary emotional responses.

According to Huron, subconscious primary emotional arousal from unexpected sound stimuli directly relate to an accentuated feeling state of unpleasantness. Whereas, the opposite accentuated feeling state occurs if an unexpected pleasant sound stimuli is processed. Strengthening the sound-evoked emotional responses to pleasant and unpleasant emotions includes a level of cross-cultural understanding; happiness and sadness are indeed universally human emotions. Common neurobiological hardware responsible for the human ability to empathize with another human allows us (healthy individuals with no psychological illness) to understand the behavioral characteristics associated with primary emotions, happiness and sadness as examples. However, the complexity associated with emotional responses to sound-stimuli particularly arises with discussion of secondary emotions and inclusion of cultural influence upon socially acceptable emotional behaviors.

Secondary emotions significantly define the interaction between subconscious arousal and conscious emotional expression from/of sound-evoked emotions. Complex emotional responses - like those Becker mentioned previously of solace, humility, and peace - particularly in the context of musicking are indeed initially formed through subconscious arousal. But, culturally-distinct musical expressions spurred by conscious, voluntary responses to initial subconscious emotional stimulation instigating the feeling states of solace, humility, peace, and/or otherwise, are unique to a given culture. Every culture has its own distinct music, with the complexity of secondary emotions significantly contributing to these distinctions.

This limits the potential for cross-cultural understanding through musical interaction. The nature of human emotions function off-of a hierarchically organized system as described earlier via discussion of the Polyvagal theory. How could music stimulate positive understanding between culturally distinct emotional expressions, if psychophysiologically, one feels threatened by another's expressions?

To supply a brief answer, Becker gives accounts of deep listeners and trancers who experienced arguably similar feeling states through music, regardless of their respective cultures. Firstly, Becker compares accounts of Gabrielsson and Lindstrom (1993 and 2000) with Pentecostal worshippers Wood (1965), Wacker (2001), and Blumhofer (1993), to highlight their "deep listen[ing] and transcendental experience[s]" (2004, 54-55). She then outlines conclusions of Panskepp (1995, 1998), Krumhansl (1997), and Nyklicek et al. (1997), to emphasize the power of emotions in facilitating deep listening and trance. These authors highlight autonomic arousal similar to Porges' work, strengthening the argument for certain universal human experiences. Finally, through discussion of Balinese *bebuten* trance and particularly Indian *rasa* theory, Becker proposes that regardless of culture, humans entertain common emotional experiences to auditory stimuli and/or otherwise.

Becker focuses on "involuntary states" in *rasa* theory and "strong emotions" from Panskepp, Krumhansl, and Nyklicek et al.'s respective works, to both compare and contrast the two concepts specifically relative to deep listening and autonomic arousal. She states that "many of these ancient 'involuntary states' closely parallel the physiological responses of deep listeners" (2004, 59). One element of *rasa* theory relative to Becker's thought on parallelism between physiological responses and deep listening regarding emotional arousal is germane to my study. That element is disinterestedness and its particular association with achieving impersonal emotional experience, or selflessness. Becker's inclusion of Gnoli's (1956) account regarding its power to turn pain into pleasure is valuable:

> Aesthetic experience, being characterized by disinterested and impersonal pleasure is a modality *sui generis* of the unbounded beatitude that appears to the yogin in his ecstasy and, in his eyes, transforms *samsara* into *nirvana*. The mysterious conversion of pain into pleasure, which accompanies the full realization of one's own Self, is to be found equally in aesthetic experience, which possesses the magical power of transfiguring the greatest sadness into the disinterested pleasure of contemplation. Pain, which is mobility, inquietude, has no place in aesthetic experience, which is rest, lysis, and the fulfilment of all desires—unless it is converted magically into pleasure. (Becker 2004, 59-60).

Aesthetic experience in this regard is music, or other transcendent experiences lifting one away from their bodily prisons into the heavenly realm. However, one's intent is deeply associated with this practice. To define inherent individual differences in intent, Becker contrasts Gnoli's account of deep listening with trance and its goal to "not mentally distance [one's self] from the inducer of her arousal" (2004, 60). Trance (according to further inclusion of Gnoli's work) is applied through group activity, rather than individual, disinterested and impersonal activity, as suggested by Gnoli and his discussion of samsara (suffering) and nirvana. Furthermore, individual vs. collective intent inherently includes a level of both particularly within practices involving collective activity, as individuals comprise a group and always maintain at least some level of individual autonomy (i.e. free will and decision making to act upon certain stimuli in ways they see fit at that particular moment in time). The level of individual autonomy (pending power structures and social hierarchies of interactions) acts upon collective intent, suggesting that the role of individual intent supersedes the potential for positive collective intent.

The complexity of disinterestedness regarding the autonomic process of one's individualized transitional sequences from primary emotional arousal to secondary emotional experiences is a daunting task to quantify and attempt explanation of. Cultural influence upon individual choice of how to either attach or dis-attach (relative to Gnoli's thoughts) to particular stimuli (auditory or otherwise) exempt of autonomic arousal stresses this complexity. But, the long-term goal of contributing to knowledge on the significance of these emotional experiences universally impacting all cultural groups via multidisciplinary experimentation and discussion as posed through neuro-ethnomusicology is necessary and requires deeper attention. Particularly linked to Gnoli's account, the potential for mergers between the humanities and neurosciences to offer developed, updated strategies into the communication of similarities between emotional experiences across humanity is an impersonal means to continued prophetic ends, pending individual intent.

Conclusion

Common neurobiological roots implant capacities for emotional experiences in all humans. Common psychological effects of emotion take place within all humans (pending health), particularly regarding primary emotions. As we are currently aware, one's culture does not alter their initial autonomic responses to auditory stimuli, at least pertaining to primary emotions. Becker's and others studies' arguments yield an awareness of this potential human universal through their accounts and efforts to supply meaty details of such thoughts. However, the inclusion of psychology into physiological studies on music and emotion limits the opportunity to universally compare the vast differences in individual experiences of music and emotion.

Music is an element of culture and secondary emotions are complex psychophysiological realities of human life. But the majority of us all experience secondary emotional behavior and share in musical expressions. This points to the reasoning behind attempting to understand what is going on in a public/social setting when music is present. Why do similar secondary emotional processes occur between individuals of different cultural backgrounds/influences? Why do primary emotional experiences, fight/flight in particular, shift during musical encounters, especially in social settings?

Common neurobiological roots allow for common experiences of emotional responses to auditory stimuli to occur, and furthermore, social behavior across cultures includes musical experience perhaps everywhere in the human world. This suggests that an overarching goal of this project - to understand how two non-familiar individuals placed into a common space may elicit similar secondary emotional processes through musical stimulation - will occur. After initial primary emotional cues of potential threats are subdued, secondary emotional processes may ensue, promoting prosocial behavior. The music serves as a social lubricant, limiting fight/flight and promoting rest/digest in the parasympathetically-driven social engagement system.

CHAPTER 4
METHODS

Design

This study addressed the effects of one of two distinct music selections (Percussive Instrumental Music – PIM; and, Bowed-String Instrument Music – BSIM) and a non-music control setting upon the human social engagement system in healthy young adults in social settings, as evidenced by empathic decision-making.

Hypotheses

1. Music will increase parasympathetic activity (RSA) and empathic decision making as compared to the non-music control setting.
2. The BSIM setting will increase empathic decision making, as compared to PIM and the non-music control setting.
3. Parasympathetic activity (RSA) will predict the degree of empathic decision making.

Music Selections and Administration

The choice for the PIM selection came from influence of the author's thesis adviser whose work has focused on the music and culture of Brazil (Crook 1993, 1999, and 2010). Brazil's cultural history includes music as playing a significant role in the socialization of its citizenry, as seen in Brazil's carnival. Carnival is the apex annual event of Brazil's diverse cultural groups, as people from across the country gather in droves over a near week-long period to celebrate and contest the country's history through music, dance, food, and other artistic portrayals of culture. Several urban centers of Brazil host their own versions of Carnival with unique music and dance traditions as seen in Rio de Janeiro, Salvador da Bahia, São Paulo, Recife, Pernambuco, and others. The cultural history and modern life of certain communities in Brazil were a focus of Dr. Larry Crook's work, and greatly influence the choice of this music for this study.

Brazilian carnival samba (the style representative of the PIM selection) is polyrhythmic, combining cultural influences primarily from Africa and Europe developed over the course of Brazil's history. Samba contains multiple percussive, melodic, and harmonic elements that define its polyrhythmic nature. The low surdo bass drums, pandeiro (hand drums), caixa (snare drums), tamborim (small frame drum struck with sticks), agogo (metal bells), ganzás (cylindrical metal percussive instrument scraped with a metal scraper), and repinique (double-headed frame drum struck with sticks and hands) all represent this complex combination of rhythm and further represent the influence of the West African musical traditions brought to Brazil through European-based slave trading. The polyrhythmic nature of samba percussion alone produces a rich musical texture that is often amplified through combination of string, wind, and vocal timbres. These latter sounds represent the associated/construed melodies and harmonies of the music, which in conjunction with the percussion provide a complex and intense amount of energy.

People come in droves from around the world to participate in the Brazilian Carnival, and the polyrhythmic nature of the music provides them with the opportunity to entrain to one another's responses to the music. The fast-tempo pulse of the rhythms defining samba are continuous, providing the means for participants to align to one another in their movements. Prediction of musical events after a certain amount of listening (depending upon the individual's musical capacity) is a strong indicator of one's entraining to pulse-based music (Zentner and Eerola 2010). Entrainment to the music is therefore suggestive of a potential function the music serves in engaging individuals socially. Alternatively, cultural pride, music preference, and cultural expectancy to participate in Carnival are involved in some capacity (Crook 1993). Contributing to the discussion of what music does to instigate social engagement via an understanding of nervous system activity will broaden this perspective.

Within participatory music settings (Brazilian carnival celebrations and associated samba music, for example), ethnomusicologist Thomas Turino would associate the musical events with "a special type of artistic practice in which there are no artist-audience distinctions, only participants and potential participants performing different roles . . . *presentational performance*, in contrast, refers to situations where one group of people, the artists, prepare and provide music for another group, the audience, who do not participate in making the music sounds or in dancing (Turino 2008)." This distinction defines the fundamental role for the use of Brazilian samba for this project as indicative of its participatory nature, and ascribes the function of the autonomic activity of the heart in response to its up-tempo nature (Bernardi et al. 2009). Contrasting the Brazilian samba with a piece from the Western European classical music repertoire as exhibitory of Turino's definition for presentational performance provides necessary perspective into these two categories of music.

Turino's discussion continues with a brief analysis of how to further consider participation with music: "sitting in silent contemplation of sounds emanating from a concert stage is certainly a type of musical participation, as is walking in the woods or down a city street to the soundtrack of music coming through the headphones of an iPod (2008)." The performance of music, Turino distinguishes, is described via active participation in the making of music, rather than active participation in listening to music. Lastly, Turino discusses the expectation of participants to socially engage with others associated with the event they intend to attend and the role in which music is anticipated to play in their social engagement with one another.

This expectation is potentially an essential component to understanding the role music plays in facilitating social engagement between two or more individuals (conversation/dancing and eye-contact/reciprocity of the polyvagal theory). Participants are socialized in advance to the characteristics of the music they will hear at the event, preferentially affecting their engagement with that music in social settings, and potentially affecting their social engagement with other people. Developing Turino's thoughts with a deeper investigation into the effects of different types of music upon social engagement will add to the available literature specifically on the effects of expectancy and/or anticipation of music as related to social engagement.

To contrast the PIM selection, Johann Pachelbel's *Canon in D Major* will represent the BSIM selection and provide a significant dissimilarity in effect upon subjects compared with the PIM selection. Previous research has indicated the variety of effects differing styles of music have upon the nervous systems of individuals, including: exercise physiology, the ANS, and music (Yamashita et al. 2006); ANS dysfunction and music (Ellis and Thayer 2010); music therapy and the ANS (Okada et al. 2009); cardiac autonomic regulation (Roque et al. 2013); and skin-conductance response, emotion, and music (Khalfa et al. 2002). Amidst other search criteria with similar outcomes, these previously listed studies briefly outline existing studies on the topic combining these elements. Bibliographies within this list of studies offer further information on available studies following these lines of inquiry, but the addition of social activity is necessary to develop future inquiry.

The PIM and BSIM selections differ through the sound of their respective rhythms, tempi, instrumentation, and articulations. In contrast to the polyrhythmic nature of the PIM selection, the BSIM selection represents temporally sequenced rhythm exclusive of complex syncopations. Furthermore, the tempi (dominant pulse level; meter) of the two selections differ by ~50 bpm. The *Canon's* rhythm involves temporal sequences of interlocking subdivisions of the main pulse at four beats per measure, including whole, half, quarter, eighth, and sixteenth note subdivisions. The phase-locked characteristic of these subdivisions differs from the syncopated nature of the PIM selection, indicating significant contrast in rhythm between the two selections. The instrumentation of Pachelbel's *Canon* is comprised of bowed-stringed instruments: violins, violas, and cellos that are primarily articulated in a legato (smooth) style without percussive (staccato) attack, indicating the significant difference in articulations. These differences indicate the opposing characteristics of these two musical selections regarding these particular criteria and the subsequent choice of their use in this study.

I suggest that the PIM setting will induce a different physiological state than the BSIM setting, based on previous physiological research involving excitatory and relaxant music (Roque et al. 2013). Aforementioned descriptions of the two music conditions proposed for this study suggest PEM to represent excitatory and BSIM relaxant. Regarding previously outlined research in social engagement and germane to the predicted contrasting effects of these musical settings upon the sample of the overall population used in this study, the PIM setting will increase norepinephrine release (Gerraa et al. 1998) and its associated stimulation of attentional output of subjects during the empathic decision making task. In contrast, the BSIM setting's relaxant qualities will not stimulate attentional benefits from increased norepinephrine release, as similar to the non-music control. This is particularly significant regarding the average age of the demographic used in this study (18-22 year old males and females), as social engagement practices for this age group contrast with differing age groups and accompany the potential qualities of response (i.e. decisions made within the empathic decision making task) from this particular age demographic.

Effects of preferred music over music selections outside subjects' preferences have been shown to elicit greater reduction in pain perception (Mitchell and MacDonald 2006), state anxiety (Smith 2008) and pain management (Bernatzky et al. 2011), with discussions of increases in empathy included, respectively, in these studies. Inclusion of the methods of the here proposed study to the methods of the aforementioned studies within this paragraph would offer further conclusive results comparing the effects of potentially non-preferential music upon RSA and associated empathy.

Higher empathy is associated with relaxing music, particularly in medical environments involving music therapy (Tansik and Routhieaux 1999; Kemper and Danhauer 2005), suggesting a positive correlation between exposure to Pachelbel's *Canon in D Major* and an increase in empathic decision making in social settings. The hypothesized shifts in physiological state from exposure to either of the two music conditions will elicit varying empathic decision making. Comparing/Contrasting the effects of the PIM and BSIM conditions upon physiological state of study subjects will determine the role music plays in facilitating social engagement as determined by empathic decision making.

Administration of Music Selections. The two music settings (BSIM and PIM) were prerecorded and administered via an Apple iPod and headphones. The recordings were played once the subject was comfortably ready to begin, as approved by their verbal agreement to begin. Each music setting was played for five minutes, or until the Cyberball task ended after the preset number of 60 ball-tosses. In the non-music setting, subjects played Cyberball for the same amount of total completed time in each of the music settings to limit cross-condition variability pertaining to timeframe.

The PIM selection was a track from a percussion-based compact-disc of Brazilian samba music titled *Batucada: The Sound of the Favelas*. The track includes polyphonic and polyrhythmic music as previously described. The instrumentation of the track is exclusive to percussion instruments, including: struck metal bells (agogô), hand drums with jingles (pandeiro), struck low-bass drums (surdo), medium to higher pitched drums also struck with sticks and hands (repinique and tamborim), and scraped metal cylinders (ganzás).

The BSIM selection (Pachelbel's *Canon in D* Major) was a single MP3 track downloaded for the experiment. As previously described, the temporal organization of rhythm, slower tempo, instrumentation, and articulations exemplified in this selection significantly differ to the PIM selection.

After the five-minute period (or completion of 60-ball tosses in Cyberball) was completed for each of the music settings and non-music control setting, subjects completed a short survey of their subjective experience of the experiment.

Descriptions of Tools used

Empatica e4 wristband

For the purposes of this study, three principal components of the watch were used as advertised on the Empatica website (https://www.empatica.com/en-eu/research/e4/): the PPG (photoplethysmograph) sensor, the EDA (electro-dermal activity) sensor, and the event-mark button.[1] The PPG sensor measures blood-volume pulse (BVP), from which

[1] For further technical specifications of the Empatica E4 wristband, please see Appendix F.

the data for each subject specific to parasympathetic activity - respiratory-sinus arrhythmia (RSA) - was derived. The EDA sensor measures galvanic skin response (GSR), from which the data specific to sympathetic nervous system activity was derived. The event-marker button allows the user to specify moments in time regarding when a component part of their experiment began and ended.

Software

Seven separate software programs were used to store and analyze all components to the data set of this experiment: Limesurvey (https://www.limesurvey.org/), Microsoft excel (https://products.office.com/en-us/excel), Matlab (https://www.mathworks.com/products/matlab.html), Ledalab (http://www.ledalab.de/), Cardio edit and Cardio batch (https://www.med.unc.edu/psych/research/brainbody/training-workshops), and the Statistical Package for the Social Sciences (SPSS - https://www.ibm.com/analytics/data-science/predictive-analytics/spss-statistical-software).

Limesurvey is an online survey construction and administration website through which all psychological assessments were stored and administered to all subjects. Each subject took the psychological assessments in the same order: BFI-10, IRI, PROMS, STOMP-R, and Post-experiment survey. Data for all subject responses were stored on both the Limesurvey server and the University of Florida student dropbox account. Microsoft excel was used as an intermediary between both Limesurvey and SPSS and Ledalab and SPSS. Microsoft excel translates the output information from Limesurvey into a format which SPSS understands.

Matlab was used as the base for Ledalab, "a Matlab-based software for the analysis of skin conductance data."[2] Continuous decomposition analysis (CDA) of event-specific time frames within each trial of the experiment was used to decompose skin conductance data into continuous phasic and tonic activity. CDA "takes advantage from retrieving the signal characteristics of the underlying sudomotor nerve activity."[3] The opposing methodology associated with the analysis of skin conductance data, discrete decomposition analysis, was not used for the purposes of this experiment.

Upon completion of CDA analysis, all outputs were exported to Microsoft excel and saved. Detailed maintenance of event-markers specific to all component parts of the experiment were individually inputted into the excel outputs from Ledalab by visually comparing recorded events through the E4 wristband with the Ledalab files. These events were then manually imported into the excel files for cross-program validity between Empatica connect (https://www.empatica.com/connect/login.php), Ledalab, and Microsoft excel, specific to the event markers.

Cardio edit and Cardio batch were used to analyze and calculate output values for all RSA data. Parametric and non-parametric statistical analysis upon these data were run in SPSS. Inter-beat interval (IBI) data recorded from the E4 wristband and displayed via Microsoft Excel was imported into the Cardio edit software program. These IBI data were then individually edited on a subject-by-subject basis, using the editing tools provided through the Cardio edit software program (e.g. addition, averaging, and cropping tools) to produce suitable input data for the Cardio batch software program to read and interpret. Once entered, the Cardio batch software program ran an algorithm and

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[2] "Ledalab" Google, accessed 1/25/2018, http://www.ledalab.de/.

[3] Ibid, 1/25/18.

displayed 10 separate outputs (output_no_epoch, output_30, HRmeanBS, HRmeanAS, HRSDBS, HRSDAS, HPmeanBS, HPmeanAS, HPSDBS, HPSDAS) related to RSA.

Event Markers

Each event marker represents the start and end of a specific task, to which each subject of the experiment undertook (see Table 4-1).

Subject Grouping

Specific to the order of the administration of the three principal components to the experiment: baseline period, psychological assessment surveys, and empathic decision making task, the subjects were grouped via the order in which they were exposed to the musical settings and non-music control setting associated with the empathic decision making task previously described.

Post experiment survey and debrief

Upon completion of all Cyberball games and final recovery period (1-minute of rest), each subject completed the short 8-question post experiment survey. This battery of questions was created by the principal investigators of this experiment explicitly for the use of it within this experiment.[4] This battery of questions was designed to assess the personal experiences of each of the 60 participating subjects, through their subjective responses. The first five questions are short response questions addressing the subjects' favorability of and potential transitions in mood state within each of the two music settings previously described (questions 1-4), as well as their subjective response to their willingness to evenly distribute their ball-tossing choices within the Cyberball game to both computer-based players, or not (question 5). The following three questions are numerical response questions (Likert format on a scale from 1-10) indicating subjects'

4. See Appendix E for full details.

subjective empathic disposition (question 1) and their feelings of relaxation within the BSIM (question 2) and PEM (question 3) settings.

SPSS was used for all parametric and non-parametric statistical assessment. Data from the Limesurvey server, Ledalab, Microsoft excel and Cardio batch outputs were all imported into SPSS for parametric and non-parametric analyses to occur.

Procedure

The experiment included two stages: 1) recruitment and randomization of dyad-pairs from the University of Florida undergraduate community; and 2) the in-lab assessment.

Stage 1: Recruitment

Recruiting tactics involved e-mail and in-person communication between the examiner and his colleagues. Two recruitment pools were used to recruit subjects for the experiment from two separate courses offered at the University of Florida's School of Music: MUH 3025, History of American Popular Music and MUL 2010, Experiencing Music. One hundred-twenty subjects were recruited and randomly paired into dyad-pairs.

Stage 2: In-Lab Assessment

After recruitment, the in-lab assessment proceeded as follows: 1) invitation of each subject within the randomized dyad-pair to the testing location; 2) orientation to lab-testing space, which included the subjects' visual overview of the contents of the testing space: table and chairs, MP3 audio player, and laptop computer; 3) request by the examiner for the subjects to sign the informed consent documents; 4) administration of deception; 5) measurement of baseline ANS activity from randomly selected subject on trial-by-trial basis via E4 wristband;[5] 6) psychological assessments (personality via the

[5] See Appendix H.

Big Five Inventory-10: Rammstedt and John 2007; dispositional empathy via the Interpersonal Reactivity Index: Davis 1983; music preference via the Short Test Of Music Preferences revised: Gosling and Rentfrow 2003; and dispositional musical skill via the mini-Profile Of Musical Skills: Law and Zentner 2012);[6] 7) administration of the empathic decision making task, accompanied by each of the three music settings (1: non-music setting as control; 2: PIM setting; and 3: BSIM setting); 8) post experiment survey;[7] and 9) post experiment debrief. A period of rest and recovery (1 minute) took place between each of the three non-music and music settings, to allow for the subject to prepare for each of the subsequent settings and for the examiner to record the recovery period for later analysis. A representation of the above description is available in Figure 4-1.

The order of presentation of stages 5-7 of the experimental protocol (as described in Figure 4-1) changed depending upon the subjects' date and time of participation. Four separate groups were randomly created based upon these criteria and exposed to the empathic decision making task within the two music settings and non-music control in the following orders: Group 1 - non-music control, PIM, and BSIM; Group 2 - non-music control, BSIM, PIM; Group 3 – PIM, BSIM, non-music control; and Group 4 – BSIM, PIM, and non-music control. Based upon this ordering, we established the use of the four separate groups to compare/contrast any order effect both within and between groups.

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[6] Copies for all psychological assessments are displayed within the appendices. See Appendix A for BFI-10, Appendix B for the STOMP-R, Appendix C for the IRI, and Appendix D for the PROMS. However, the PROMS is only available in an electronic format. Therefore, the authors' explanation of the PROMS is provided in Appendix D.

[7] See Appendix E.

The measurement of the baseline autonomic activity (stage 5 of the in-lab assessment procedure) serves to help understand the significance of the relationship between tonic and phasic activity in heart-rate variability, as well as the significance of staging the analysis of this relationship within these three distinct stages. See Figure 4-3.

Empathic Decision Making Task

The empathic decision making task was Cyberball (Williams et al. 2012), a computer-based ball tossing game, used to measure empathic decision making and define social engagement as similar to Crowley et al. 2010 and Riem et al. 2013. Cyberball involves three or more participants (one real player and *n* number of computer-based players) electronically tossing a ball back and forth. The real player decides which computer-based player to toss to at a given moment. Inclusion/Exclusion of an individual (i.e. ostracism) is the primary purpose of the game, with several menu options available to alter the decisions of the computer-based players, at the experimenter's discretion. For the purposes of this study, the "exclude other" function was used, wherein one computer-based player is preprogrammed (through the available menu options) not to toss to the other computer-based player. According to our hypotheses, the BSIM music setting was intended to promote the real player (subject wearing the E4 wristband) to toss to the excluded computer-based player more often than the non-excluded computer-based player, indicating the degree of their empathic decision making via correlation to parasympathetic (i.e. RSA) activity by E4 wristband measurement. Time interval (approximately 5-minutes and/or completion of 60-total ball tosses) and number of players (3-total players: one real and two computer-based players) by which the ball may be tossed to were the only customized options used in the experiment. See Figure 4-2.

The randomly selected subject of the dyad-pair chosen to wear the E4 wristband was also assigned to participate in the empathic decision making task, prepped and ready to begin in advance of the subjects' convening in the testing location. Each of the three music settings accompanied the subject's playing of three separate empathic decision making tasks, with the rest and recovery period taking place between each of the three music settings.

Deception

The other member of the dyad-pair, unbeknownst-to-them, was randomly selected to deceive the subject randomly selected to complete the empathic decision making task previously described. This deception began upon arrival of both participants. Participants were consented together. The process involved the early dismissal of the subject randomly chosen as the deceiver from the testing space, while the subject randomly selected to complete the tasks waited patiently. The examiner accompanied the confederate out of the testing space and verbally explained to both the confederate and subject randomly chosen to complete the empathic decision making tasks that the confederate would complete the experiment tasks in another testing space. The examiner then led the confederate out of the testing space and dismissed them for their participation up that point. The examiner then returned to the testing space to carry out the aforementioned protocol upon the subject waiting in the testing space.

Table 4-1. Displays the sequential order of all event markers taken within the experiment. After the five-minute baseline period was complete and before the start of proceeding part of the protocol for the experiment, each subject was instructed to push the event-marker button to indicate the end of the baseline-gathering period and beginning of the BFI-10 survey. Upon completion of the survey, the subject was instructed to push the event-marker again to signify the end of that particular component part of the overall experiment. This process was repeated for all component parts of the experiment for each subject that participated.

Event marker	Significance	Event marker	Significance
1	Baseline_end/Big Five Inventory-10_during	8	STOMP-R_end
2	BFI-10_end	9	Cyberball during
3	Interpersonal Reactivity Index during	10	Cyberball end
4	IRI end	11	Cyberball during
5	Profile Of Music Skills during	12	Cyberball end
6	PROMS_end	13	Cyberball during
7	Short Test Of Music Preference revised during	14	Cyberball end

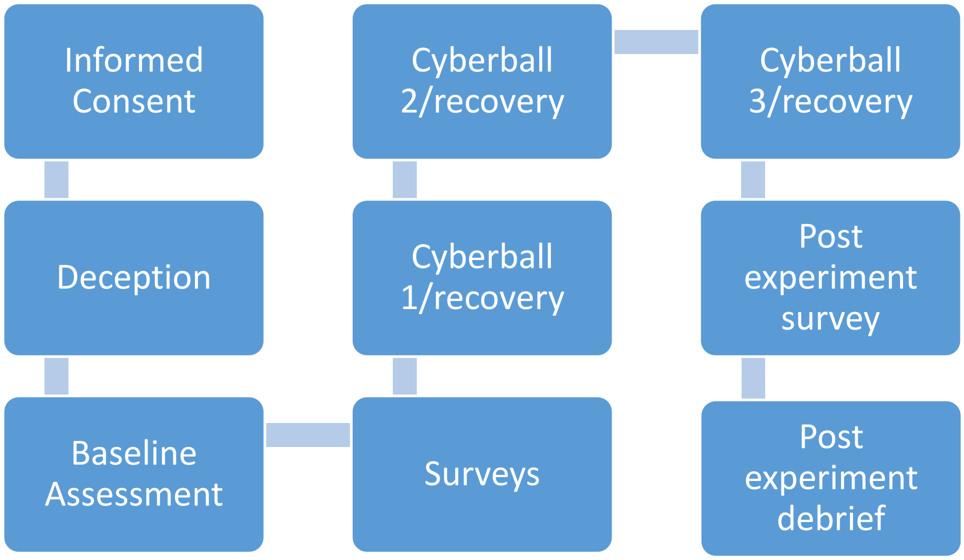

Figure 4-1. Visual representation of experiment protocol. After invitation of subjects into lab-testing space, subjects were instructed to read and fill out the informed consent documents. Upon completion of the informed consent, one subject was deceived into believing the experiment would indeed be a paired experiment and the deceiver was dismissed. The assessment of baseline autonomic activity then took place, followed by administration of all psychological assessments. Each of the three Cyberball games then commenced, with order of music-setting administration determined by the subject's date of participation. The post-experiment survey and debrief were administered following the completion of the final Cyberball game

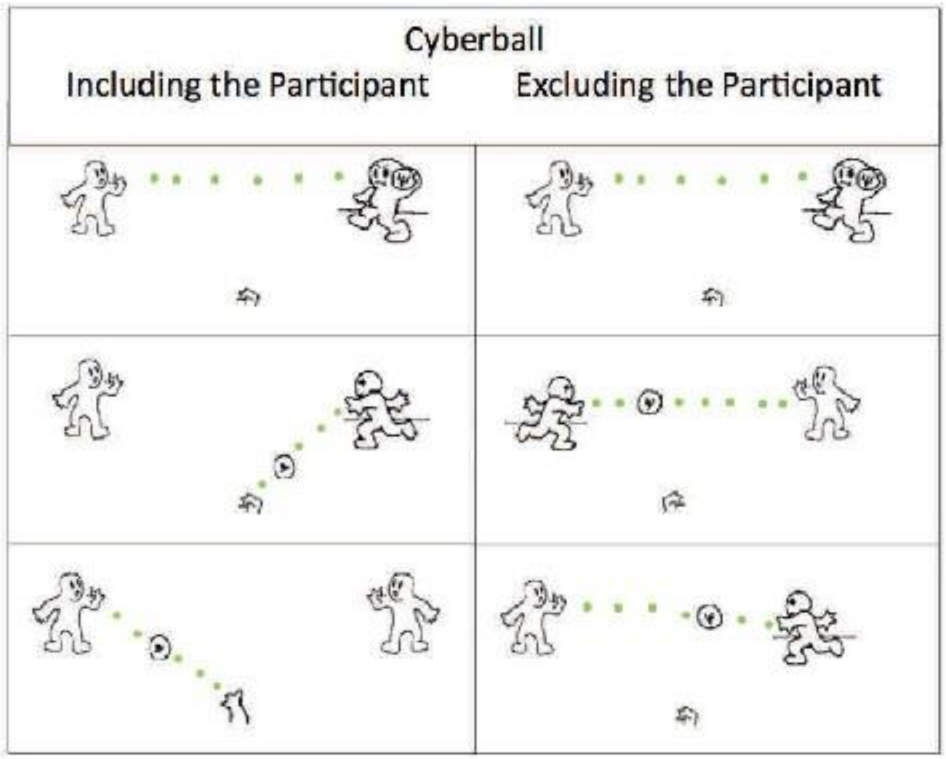

Figure 4-2. Visual representation of Cyberball. The exclude other feature of Cyberball is portrayed here, wherein one computer player is pre-programmed to ostracize another player (computer or real). In the above portrayal, the real player is not included in the visualization of real-game play, taking place between two computer-based players, instead.

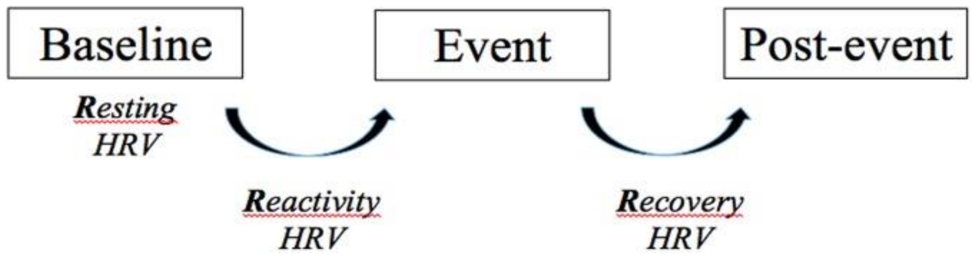

Figure 4-3. The figure above displays the three R's of HRV (resting, reactivity, and recovery) as detailed in Laborde, Mosley, and Thayer ('17). This model visually suggests the significance of ordering the measurement of the relationship between tonic and phasic activity in heart-rate variability, to accurately represent changes that occur within the autonomic nervous system throughout stages of executive function. The interaction between the ANS and CNS is both constant and fluid, and the use of this model to explain the measurement of tonic and phasic activity is intended to provide clarity into the reasoning behind how the measurement of this interaction is best accomplished through this practice.

CHAPTER 5
STATISTICAL ANALYSIS PLAN

This experiment was designed to predict the effects of two separate music settings upon the empathic decision making of healthy young adults. Both parametric and non-parametric statistics were used to assess the predictive power of the degree of difference between subjects' respiratory sinus arrhythmia (RSA) and galvanic skin response (GSR) within each of the two music settings (BSIM and PIM) and non-music control setting upon subjects' empathic decision making. SPSS (Statistical Package for the Social Sciences) was used for the statistical analysis of all data within the data set.

Our statistical analysis model included several components: 1) descriptive statistics of all dependent variables (i.e. Cyberball within the music and non-music settings) and independent variables (i.e. autonomic and questionnaire results); 2) correlations between the dependent and independent variables were used to assess the degrees of variance and significance between the dependent and independent variables, specific to answering the hypotheses; 3) multiple regressions were used to produce unstandardized residuals of the interactions between the baseline autonomic results (specific to RSA) and during task (i.e. Cyberball) autonomic results; and 4) general linear models (repeated measures ANOVAs) were used to analyze variance between the dependent and certain of the independent variables.

Descriptives

Descriptive statistics (minimum, maximum, mean, and standard deviations) were prepared for all variables (i.e. Cyberball results) along with visual inspection in order to assess normalcy of the distributions for each variable as well as to present degree of differences amongst variables of interest (i.e., empathic decision making during music conditions, RSA, GSR, musical experience, etc. . .).

Correlations

Parametric correlations (i.e. Pearson's correlation coefficients) were prepared to compare and contrast variance between and within the dependent and independent variables. Correlations within the dependent variables (i.e. Cyberball data) alone did not produce any significant Pearson's correlation coefficients. However, several correlations between the dependent and independent variables did produce statistically significant values as described in the results section and as displayed in the tables at the end of the results section.

Unstandardized Residual Difference Metrics

Specific to Hypothesis 3 (i.e. parasympathetic activity (RSA) will predict the degree of empathic decision making), we regressed the predicted effects of RSA with the BSIM and PIM settings upon the baseline autonomic assessments within SPSS, saved the unstandardized residuals, and used them within repeated measures ANOVAs.

Repeated Measures ANOVAs

Repeated measures ANOVAs using three and four levels were used to assess any significant effect(s) of the independent variables upon the dependent variables. A three-level repeated measures ANOVA (i.e. RSA during Cyberball without music regressed onto baseline RSA - unstandardized residuals; RSA-PIM; and RSA-BSIM) was used to determine any significant effects of music setting upon RSA and a four-level repeated measures ANOVA (i.e. GSR baselines, GSR-BSIM, PIM, and non) was used to determine any significant effects of music setting upon GSR. A three-level repeated measures ANOVA (i.e. Cyberball BSIM and PIM, non-music) was also used to determine any significant effect(s) of music setting upon empathic decision making. A three-level repeated measures ANOVA (i.e. Cyberball BSIM, Cyberball PIM, and

Cyberball non) with covariates (i.e. RSA-BSIM, RSA-PIM, and RSA-non; and log transformed GSR for BSIM, PIM, and non-music settings), was used to determine any significant predictive effects of autonomic response to music upon empathic decision making. Lastly, four separate models of three-level repeated measures ANOVAs were used to determine any potential effects of individual differences in autonomic response to music influencing empathic decision making.

CHAPTER 6
RESULTS

A within-subjects design was used to test the effects of music condition on autonomic response and empathic decision making (no music, percussive instrumental music: PIM, and bowed string instrument music: BSIM).

Participant Characteristics

All subjects were neurologically and psychiatrically healthy by self-report. All subjects were between the ages of 18 and 22 and both female (N = 33) and male (N = 27) subjects were used. Ethnicities varied, including Caucasians (N = 37), African Americans (N = 5), Latinos (N = 6), Asians (N = 6), Asian Americans, (N = 4) and subjects that identified as mixed ethnicity (N = 2). Additional sample information is displayed in Table 6-1.

All subjects were high school graduates and currently undergraduate students at University of Florida. Compensation for each subject was extra-credit not to exceed 1% of their total grade within the courses listed within the Procedure section. All subjects signed informed consent documents approved by the University of Florida Institutional Review Board.

Response Characteristics of Measures Used

Cyberball results

Cyberball results (i.e. during music setting: BSIM, PIM, and non-music control) were visually inspected. The data were normally distributed and used in subsequent models. The descriptive statistical results for the empathic decision making task included the non-music control setting (N = 58; min = 1.00; max = 20.00; mean = 11.77; SD = 5.34), PIM setting (N = 58; min = 2.00; max = 22.00; mean = 13.03; SD = 4.89) and

BSIM setting (N = 55; min = 5.00; max = 36.00; mean = 13.91; SD = 5.19). See Table 6-3.

Baseline Personality (Big Five Inventory-10) Results

The BFI-10 (Rammstedt and John 2007) is a shortened version of the full inventory (i.e. BFI-44). Four categories define the questions for both the BFI-10 and BFI-44 including: extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience. Results from the Big Five Inventory-10 (BFI-10) were divided into two groups: high and low. The data were visually inspected for normal distribution and used in the subsequent models. See Appendix A for the BFI-10.

Dispositional Empathy (Interpersonal Reactivity Index) Results

The IRI (Davis 1980) is a 28-item survey assessing subjects' dispositional empathy. Four categories define the 28-questions of the IRI including: perspective taking (i.e. the tendency to spontaneously adopt the psychological point of view of others), fantasy (i.e. taps respondents' tendencies to transpose themselves imaginatively into the feelings and actions of fictitious characters in books, movies, and plays), empathic concern (i.e. assesses "other-oriented" feelings of sympathy and concern for unfortunate others), and personal distress (i.e. measures "self-oriented" feelings of personal anxiety and unease in tense interpersonal settings). Results from the IRI were divided into two groups: high and low. The data were visually inspected for normal distribution and used in the subsequent models. See Appendix C for the IRI.

Dispositional Music Preference (STOMP-R) and Music Skill (mini-PROMS) Results

The STOMP-R is a 23-item version of the original Short Test of Music Preferences (Rentfrow and Gosling 2003). This test contains questions assessing subjects' music preferences via four dimensions: reflective and complex, intense and rebellious, upbeat and conventional, and energetic and rhythmic. Each of these dimensions were created via factor analysis. Furthermore, one of the concomitant purposes of the aforementioned publication was to determine the validity of these four dimensions, with a follow-up study (Rentfrow et al. 2011) converting these four dimensions into five: mellow, unpretentious, sophisticated, intense, and contemporary.

Question 4 (i.e. preference for Classical music) and Question 11 (i.e. preference for International/Foreign music) of the STOMP-R were particularly pertinent to this study due to their respective auditory-qualities and were divided into two groups: high and low. Descriptive statistical scores of subjects' responses to Questions 4 & 11 of the STOMP-R are displayed below (see Table 6-4). The data were visually inspected for normal distribution and used in the subsequent models. See Appendix B for the STOMP-R.

Mini-Profile of Music Skills: The mini-PROMS is a music-skills assessment test containing questions divided into four categories: melody, tuning, speed, and accent (Law and Zentner 2012). Subjects' overall results from these four categories were compiled and divided into two groups: high and low. The data were visually inspected for normal distribution and used in the subsequent models. See Appendix D for the mini-PROMS.

Correlations between Dispositional Music Preference, Music Skill, and Empathic Decision Making

To correlate music preference, skill, and empathic decision making, two separate correlations were calculated specific to the relationships of music style (i.e. Classical and International/Foreign, as defined by the STOMP-R criteria), musical skill (as assessed by the mini-PROMS) and empathic decisions (as assessed by Cyberball). Tables 6-5 and 6-6 display these correlations. Table 6-5 displays the Cyberball results within the BSIM-setting correlated with subjects' overall results in the mini-PROMS and subjects' preference for Classical music (as defined by the STOMP-R). Table 6-6 displays the Cyberball results within the PIM setting correlated with mini-PROMS results and preference for International/Foreign music (as defined by the STOMP-R).[1]

The overlay-scatter plot (see Figure 6-1) portrays the relationship between subjects' performance in the mini-PROMS and their preference for either Classical or International/Foreign music, with a strong linear relationship displayed between subject-performance in the mini-PROMS, overall, and their preference for either Classical or International/Foreign music.

Considering subjects' performance in the mini-PROMS and subjects' reported preferences for Classical and International/Foreign music in the STOMP-R from the reported mean scores, a favor in preference for Classical music confirms the stronger linear relationship displayed in Figure 6-1.

No statistically significant correlations between subjects' empathic decision making within the BSIM setting, overall performance in the mini-PROMS, and preference for Classical music were reported. There was, however, a statistically significant correlation ($p < 0.05$) between subjects' empathic decision making in the PIM setting and their overall performance in the PROMS (see Table 6-6). No statistically significant correlation was reported between subjects' empathic decision making within the PIM setting and their preference for International/Foreign music.

[1] No other category of music identified within the STOMP-R closely related to the qualities of the PIM setting as similar to the description used to define these qualities (i.e. International/Foreign). Depending upon one's perspective and/or musical background, the qualities of the PIM setting may be described differently and regarded not as foreign, but domestic.

Hypothesis Testing: Autonomic response to music

Autonomic variables (i.e. RSA and GSR) were visually inspected. The autonomic data specific to GSR were non-normally distributed and a log transform was performed. These data appeared normal and were used in the subsequent models. The autonomic data specific to RSA were non-normally distributed within the music settings (i.e. BSIM Kurtosis = 1.81; PIM Kurtosis = 5.08; and non-music Kurtosis = -0.23), but not within the baseline assessment (Kurtosis = 0.66). Linear regression of music setting (i.e. BSIM, PIM, and non-music) upon subjects' baseline autonomic data were performed. Visual inspection of the unstandardized residuals of these regressions were normal (BSIM Kurtosis = 0.65; PIM Kurtosis = 0.34; Non-music Kurtosis = 0.57) and these data were used in subsequent models.

Does music selection affect autonomic behavior?

To assess whether music setting affected parasympathetic response (i.e. RSA), we used a repeated measures ANOVA with three levels (RSA during Cyberball without music regressed onto baseline RSA, unstandardized residual; RSA PIM; and RSA BSIM), there was no significant effect between music setting and mean RSA: $f(2, 86) = 0.88$, $p = 0.42$.

To assess whether music setting affected sympathetic response (i.e. GSR), we performed a log transform and analyzed each music setting and baseline measurement using a repeated measures ANOVA with four levels (GSR baselines; GSR non music setting; GSR PIM; and GSR BSIM). There was a significant effect of music setting on GSR (sympathetic nervous system response amplitude): $f(3, 132) = 8.20$; $p = 0.00$. The log transformed baseline GSR (N = 59; mean = -1.44; SD = 0.32), compared to music setting BSIM (N = 53; mean = -1.62; SD = 0.28), PEM (N = 54; mean = -1.58; SD

=0.29), and non-music control (N = 53; mean = -1.61; SD = 0.31), shows that music setting reduced average initial GSR response.

Pairwise comparisons across the conditions show that music (PIM and BSIM) related GSR is significantly lower than non-music related GSR relative to baseline during Cyberball ($p<0.05$), but there was no significant difference between the music conditions in GSR.

Does music selection affect empathic decision making?

To assess whether music affected empathic decision making, we computed a new variable combining the overall empathic decisions made within the BSIM and PIM settings. Using a repeated-measures ANOVA with two levels (i.e. Cyberball music and Cyberball non-music), there was a significant within-subjects effect of music upon empathic decision making: $f(1, 51) = 4.90$, $p = 0.03$ (N = 52; mean of music = 13.30; mean of non-music = 11.77; SD music = 3.18; SD non music = 5.35). This suggests music positively influenced subjects' overall empathic decision making.

To assess whether music setting affected empathic decision making, we analyzed each music setting (i.e. Cyberball BSIM and PIM, non-music) using a repeated measures ANOVA with three levels (Cyberball non-music setting; Cyberball PIM setting; and Cyberball BSIM setting). A trend was evident regarding music selection's effect upon empathic decision making: $f(2, 102) = 2.23$, $p = 0.11$, and the raw results of empathic decisions made were in the predicted direction: BSIM > PIM > Non music (N = 52; mean of BSIM = 13.52; mean of PIM = 13.08; mean of non-music = 11.77; SD BSIM = 4.30; SD PIM = 4.87; SD non music = 5.35). This suggests that subjects' autonomic response to the BSIM setting predicted their empathic decision making in a positive direction.

Does autonomic response to music predict empathic decision making?

Respiratory Sinus Arrhythmia: To assess whether subjects' RSA response to music predicts empathic decision making, we computed a new variable from the unstandardized residual RSA values of the music settings (i.e. unstandardized residual RSA: BSIM and PIM). Using a repeated measures ANOVA with two levels (i.e. Cyberball music and Cyberball non) and covariates (i.e. unstandardized residual RSA: music and non), a significant within-subjects effect was reported: $f(1, 37) = 5.51$, $p = 0.02$, suggesting that as subjects' parasympathetic response to music increased, so did their empathic decision making.

To assess whether subjects' RSA response to music setting predicts empathic decision making, we used the unstandardized RSA residuals as covariates (i.e. unstandardized residual RSA: BSIM, PIM, and non-music). Using a repeated measures ANOVA with three levels (i.e. Cyberball BSIM, Cyberball PIM, and Cyberball non) and covariates (i.e. RSA-BSIM, RSA-PIM, and RSA-non), the effect of autonomic response to music did not predict empathic decision making: $f(2, 72) = 1.16$, $p = 0.32$. However, autonomic response to the PIM music setting was significant: $f(2, 72) = 3.32$, $p = 0.04$. This suggests that subjects' parasympathetic response specifically to the PIM music setting predicted their empathic decision making in a positive direction.

Galvanic Skin Response: To assess whether subjects' GSR to music predicts empathic decision making, we computed a new variable from the log transformed GSR values of the music settings (i.e. log transformed GSR: BSIM and PIM). Using a repeated measures ANOVA with two levels (i.e. Cyberball music and Cyberball non) and covariates (i.e. log transformed GSR: music and non), a positive trend was evident for the within-subjects interaction effect: f(1, 39) = 2.94, p = 0.09, such that as subjects' sympathetic response to music decreased, their empathic decision making increased.

To assess whether subjects' GSR to music setting predicts empathic decision, we performed a log transform on the raw GSR values from each music setting and used these values as covariates. Using a repeated measures ANOVA with three levels (i.e. Cyberball BSIM, Cyberball PIM, and Cyberball non) and covariates (i.e. log transform GSR: BSIM, PIM, and non), a positive trend was evident for the within-subjects interaction effect of music setting and GSR upon empathic decision making (f(2, 76) = 2.62, p = 0.08), such that as subjects' sympathetic response to each music setting decreased, their empathic decision making increased. No statistically significant between-subjects interaction effects specific to music setting and GSR were reported.

Do individual differences in autonomic response to music influence empathic decision making?

To assess whether individual differences in autonomic response to music influenced empathic decision making, we designed several models to assess interaction effects between dispositional musical skill (i.e. mini-PROMS), music preference (i.e. STOMP-R), personality (i.e. BFI-10), and empathy (i.e. IRI) using repeated measures ANOVAs with three levels (i.e. Cyberball non-music, Cyberball BSIM, and Cyberball PIM), a between-subjects factor (i.e. high and low scores), and covariates (i.e. RSA-baseline and log transformed GSR-baseline).

Model 1: mini-Profile of Music Skills (mini-PROMS)

Using a repeated measures ANOVA with the between-subjects factor of high/low scores in the mini-PROMS and two levels (Cyberball music and Cyberball non music), a significant within-subjects effect was reported: f(1, 47) = 4.24, p = 0.05. Furthermore, a positive trend was evident for the between-subjects interaction effect: f(1, 47) = 3.52, p =

0.07, such that as subjects' overall performance in the mini-PROMS increased, their empathic decisions made also increased.

Using a repeated measures ANOVA with a between-subjects factor (i.e. high and low scores) and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM), a trend was evident for the within-subjects effect: $f(2, 94) = 2.05$, $p = 0.13$. Furthermore, a significant between-subjects effect was reported: $f(1, 47) = 4.69$, $p = 0.04$. Subjects scoring lower on the mini-PROMS had higher average empathic decisions as contrasted to subjects scoring higher on the mini-PROMS (empathic decisions made during BSIM associated with low-score mini-PROMS = 14.08, SD = 3.79; empathic decisions made during BSIM associated with high-score mini-PROMS = 12.44, SD = 4.51; empathic decisions made during PIM associated with low-score mini-PROMS= 14.79, SD = 4.22; empathic decisions made during PIM associated with high-score mini-PROMS = 12.16, SD = 4.84).

Using a repeated measures ANOVA with a between-subjects factor (i.e. high and low scores), covariates (i.e. baseline-RSA and log transformed baseline-GSR), and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM), a positive trend was evident for the within-subjects interaction effect between subjects' empathic decisions made and their log transformed baseline-GSR scores: $f(2, 80) = 2.97$, $p = 0.06$. A positive trend was also evident for the between-subjects interaction effect of subjects' empathic decisions made and their log transformed baseline-GSR scores: $f(1, 40) = 1.93$, $p = 0.17$. These trends suggest that as subjects' overall empathic decisions made increased, their log transformed baseline-GSR scores decreased. Lastly, a significant between-subjects interaction effect between subjects' empathic decisions made and their mini-PROMS performance was reported: $f(1, 40) = 4.61$, $p = 0.04$, such that as subjects' empathic decisions made increased within the music settings, their mini-PROMS performance also increased.

Model 2: Short Test of Music Preferences revised (STOMP-R)

Reflective and Complex: To assess whether subjects' responses to the reflective and complex category affected their empathic decision making, we used a repeated measures ANOVA with a between-subjects factor (i.e. high and low scores) and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM). No significant within-subjects interaction effect was reported: $f(2, 100) = 0.74$, $p = 0.48$. However, a positive trend was evident for the between-subjects interaction effect: $f(1, 50) = 3.86$, $p = 0.06$, such that as subjects' empathic decisions made increased, so did their preferences for music categorized as reflective and complex.

Intense and Rebellious: To assess whether subjects' responses to the intense and rebellious category affected their empathic decision making, we used a repeated measures ANOVA with a between-subjects factor (i.e. high and low scores) and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM). A trend was evident for the within-subjects interaction effect: $f(2, 100) = 1.76$, $p = 0.18$, such that as subjects' empathic decisions increased, so did their preference for music defined as intense and rebellious. No significant between-subjects interaction effect was reported: $f(1, 50) = 0.32$, $p = 0.57$.

Upbeat and Conventional: To assess whether subjects' responses to the upbeat and conventional category affected their empathic decision making, we used a repeated measures ANOVA with a between-subjects factor (i.e. high and low scores) and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM). No significant within-subjects interaction effect was reported: f(2, 100) = 0.78, p = 0.47. No significant between-subjects interaction effect was reported: f(1, 50) = 0.14, p = 0.71.

Energetic and Rhythmic: To assess whether subjects' responses to the energetic and rhythmic category (questions 6, 8, 18, 19, and 22) affected their empathic decision making, we used a repeated measures ANOVA with a between-subjects factor (i.e. high and low scores) and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM). No significant within-subjects interaction effect was reported: f(2, 100) = 0.17, p = 0.84. No significant between-subjects interaction effect was reported: f(1, 50) = 1.29, p = 0.26.

Question 4: Classical music. Using a repeated measures ANOVA with a between-subjects factor (i.e. high and low scores) and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM), no significant within-subjects interaction effect was reported: f(2, 96) = 1.64, p = 0.20. However, a trend was evident for the between-subjects factor: f(1, 48) = 3.35, p = 0.07, such that as subjects' music preference for Classical music as defined by the STOMP-R increased, so did their overall empathic decision making to the ostracized player.

Using a repeated measures ANOVA with a between-subjects factor (i.e. high and low scores), covariates (i.e. RSA-baseline and log transformed GSR-baseline), and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM), a trend was evident for the within-subjects interaction effect: f(2, 80) = 2.76, p = 0.07. Furthermore, a trend was evident for the between-subjects interaction effect: f(1, 40) = 2.55, p = 0.12. These trends corroborate positive directions for both the within-subjects and between-subjects interactions, such that as subjects' overall empathic decisions made increased and preferences for Classical music increased, their baseline-RSA increased and log transformed baseline-GSR decreased.

Question 11: International/Foreign music. Using a repeated measures ANOVA with a between-subjects factor specific to question 11 (i.e. high and low scores) and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM), a trend was evident for the within-subjects effect: $f(2, 100) = 1.82$, $p = 0.17$. A trend was also evident for the between-subjects effect: $f(1, 50) = 1.75$, $p = 0.11$. These trends corroborate positive directions for both the within-subjects and between-subjects interactions, such that as subjects' empathic decisions made increased, so did their preferences for International/Foreign music.

Using a repeated measures ANOVA with a between-subjects factor (i.e. high and low scores), covariates (i.e. RSA-baseline and log transformed GSR-baseline), and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM), a trend was evident for the within-subjects effect: $f(2, 84) = 1.95$, $p = 0.15$. A trend was also evident for the between-subjects effect: $f(1, 42) = 2.43$, $p = 0.13$. These trends corroborate positive directions for both the within-subjects and between-subjects interactions, such that as subjects' empathic decisions made and preferences for International/Foreign music increased, their baseline-RSA increased and log transformed baseline-GSR decreased.

Model 3: Big Five Inventory-10 (BFI-10).

To assess whether subjects' responses to the extraversion category (questions 1 and 6) affected their empathic decision making, we used a repeated measures ANOVA with a between-subjects factor (i.e. high and low scores) and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM). No significant within-subjects interaction effect was reported: f(2, 100) = 0.01, p = 0.99. No significant between-subjects interaction effect was reported: f(1, 50) = 0.64, p = 0.91.

To assess whether subjects' responses to the agreeableness category (questions 2 and 7) affected their empathic decision making, we used a repeated measures ANOVA with a between-subjects factor (i.e. high and low scores) and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM). No significant within-subjects interaction effect was reported: f(2, 100) = 0.59, p = 0.56. No significant between-subjects interaction effect was reported: f(1, 50) = 0.00, p = 0.98.

To assess whether subjects' responses to the conscientiousness category (questions 3 and 8) affected their empathic decision making, we used a repeated measures ANOVA with a between-subjects factor (i.e. high and low scores) and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM). No significant within-subjects interaction effect was reported: f(2, 100) = 0.47, p = 0.63. No significant between-subjects interaction effect was reported: f(1, 50) = 0.69, p = 0.41.

To assess whether subjects' responses to the neuroticism category (questions 4 and 9) affected their empathic decision making, we used a repeated measures ANOVA with a between-subjects factor (i.e. high and low scores) and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM). No significant within-subjects interaction effect was reported: f(2, 100) = 0.68, p = 0.51. No significant between-subjects interaction effect was reported: f(1, 50) = 0.69, p = 0.41.

To assess whether subjects' responses to the openness to experience category (questions 5 and 10) affected their empathic decision making, we used a repeated measures ANOVA with a between-subjects factor (i.e. high and low scores) and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM). No significant within-subjects interaction effect was reported: f(2, 100) = 1.43, p = 0.24. No significant between-subjects interaction effect was reported: f(1, 50) = 0.04, p = 0.85.

Model 4: Interpersonal Reactivity Index.

To assess whether subjects' responses to the perspective taking category (questions 3, 8, 11, 15, 21, 25 and 28) affected their empathic decision making, we used a repeated measures ANOVA with a between-subjects factor (i.e. high and low scores) and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM). No significant within-subjects interaction effect was reported: f(2, 98) = 1.48, p = 0.23. No significant between-subjects interaction effect was reported: f(1, 49) = 0.03, p = 0.86.

To assess whether subjects' responses to the fantasy scale category (questions 1, 5, 7, 12, 16, 23 and 26) affected their empathic decision making, we used a repeated measures ANOVA with a between-subjects factor (i.e. high and low scores) and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM). A trend was evident in the within-subjects interaction effect: f(2, 98) = 2.69, p = 0.07, such that as subjects' empathic decisions made increased, so did their responses to the questions within the fantasy scale category. No significant between-subjects interaction effect was reported: f(1, 49) = 0.01, p = 0.91.

To assess whether subjects' responses to the empathic concern category (questions 2, 4, 9, 14, 18, 20 and 22) affected their empathic decision making, we used a repeated measures ANOVA with a between-subjects factor (i.e. high and low scores) and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM). A trend was evident in the within-subjects interaction effect: f(2, 98) = 1.89, p = 0.16. A trend was also evident in the between-subjects interaction effect: f(1, 49) = 2.05, p = 0.16. These trends corroborate a positive direction in these interactions, such that as subjects' empathic decisions made increased, so did their responses to the empathic concern category of the IRI.

To assess whether subjects' responses to the personal distress category affected their empathic decision making, we used a repeated measures ANOVA with a between-subjects factor (i.e. high and low scores) and three levels (Cyberball non-music, Cyberball BSIM, and Cyberball PIM). A significant within-subjects interaction effect was reported: $f(2, 98) = 4.45$, $p = 0.01$, such that as subjects' feelings of personal anxiety and unease in tense interpersonal settings decreased, their empathic decisions made increased. No significant between-subjects interaction effect was reported: $f(1, 49) = 1.10$, $p = 0.30$.

Table 6-1. Descriptive statistical demographic information for all subjects. A legend for all values displayed in this table is provided below the table.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Age	60	18.00	21.00	18.5500	.69927
education	60	3.00	5.00	4.4000	.61617
gender	60	1.00	2.00	1.4500	.50169
ethnicity	60	1.00	6.00	2.0167	1.51257
play_instrument	60	1.00	2.00	1.6000	.49403
read_western_music_notation	60	1.00	2.00	1.6167	.49030
music_skill	60	1.00	3.00	1.3000	.56148
music_in_family	60	1.00	3.00	1.4333	.59280
Valid N (listwise)	60				

Legend:	Education	Sex	Ethnicity	Play Instrument	Read Western Music Notation	Musical Skill	Music in Family
	1 = elementary school education	1 = female	1 = Caucasian	1 = yes	1 = yes	1 = non-musician	1 = no
	2= middle school education	2 = male	2 = African American	2 = no	2 = no	2 = amateur	2 = yes (amateurs
	3 = vocational school/ high school diploma		3 = Latino		3 = semi-pro	3 = yes (pros)	3 = other
	4 = academic high school/ grammar school		4 = Asian			4 = pro	
	5 = university/college		5 = Asian American				
			6=mixed				

Table 6-2. Descriptive statistics of subjects' self-reported nationality and dispositional musical skill, as collected from the mini-PROMS (Law and Zentner 2012), and music preferences for classical and international/foreign music styles, as collected from the STOMP-R (Rentfrow and Gosling 2003). The legend below the table describes the numerical significance of each categorical variable within the table.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Nationality	60	1.00	6.00	2.0167	1.51257	1.248	.309	.277	.608
STOMP-R_Q4_classical	60	.00	7.00	4.2833	1.77641	-.577	.309	.071	.608
STOMP-R_Q11_international_foreign	60	.00	7.00	3.5833	1.93357	-.342	.309	-.318	.608
Mini-PROMS_Results	60	.00	60.00	34.1167	12.94590	-.435	.309	.890	.608
Valid N (list wise)	60								

Legend:	
Nationality:	Music Preference:
1 = Caucasian	1 = strongly dislike
2 = African American	2 = dislike
3 = Latino	3= slightly dislike
4 = Asian	4= neutral
5 = Asian American	5 = slightly like
6=mixed	6 = like
	7 = strongly like

Table 6-3. Descriptive statistics of all empathic decisions made between the non-music control and music settings (BSIM and PIM).

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Cyberball_non_music	58	1.000000000000000	20.000000000000000	11.775862070000000	5.337859166000000
Cyberball_PIM	58	2.000000000000000	22.000000000000000	13.034482760000000	4.888100543000000
Cyberball_BSIM	54	5.000000000000000	24.000000000000000	13.500000000000000	4.254852945000001
Valid N (list wise)	52				

Table 6-4. Descriptive statistics of subjects' overall performance in the mini-PROMS and subjects' music preferences for Classical music (question 4) and International/Foreign music (question 11).

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Mini-PROMS_Results	60	.00	60.00	34.1167	12.94590
STOMP-R_Q4_classical	60	.00	7.00	4.2833	1.77641
STOMP-R_Q11_international_foreign	60	.00	7.00	3.5833	1.93357
Valid N (list wise)	60				

Table 6-5. Correlation coefficients between subjects' empathic decision-making choices during the BSIM setting, overall performance in the PROMS, and preference for Classical music.

Correlations

		Cyberball_BSIM	PROMS_Results	STOMP-R_Q4_classical
Cyball_BSIM	Pearson Correlation	1	-.123	-.121
	Sig. (2-tailed)		.350	.358
	N	60	60	60
PROMS_Results	Pearson Correlation	-.123	1	.223
	Sig. (2-tailed)	.350		.086
	N	60	60	60
STOMP-R_Q4_classical	Pearson Correlation	-.121	.223	1
	Sig. (2-tailed)	.358	.086	
	N	60	60	60

Table 6-6. Correlation coefficients between subjects' empathic decision-making choices during the PIM setting, overall performance in the mini-PROMS, and preference for International/Foreign music.

Correlations

		Cyberball_PIM	Mini-PROMS_Result	STOMP-R_Q11_international_foreign
Cyberball_PIM	Pearson Correlation	1	.010	-.098
	Sig. (2-tailed)		.941	.455
	N	60	60	60
Mini-PROMS_Results	Pearson Correlation	.010	1	-.297*
	Sig. (2-tailed)	.941		.021
	N	60	60	60
STOMP-R_Q11_international_foreign	Pearson Correlation	-.098	-.297*	1
	Sig. (2-tailed)	.455	.021	
	N	60	60	60

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

Table 6-7. Descriptive statistics of subjects' responses to the post-experiment survey.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
PES_Q1_PIM_favorability	44	1.00	5.00	3.9318	1.53104
PES_Q2_PIM_Cyberball_feeling_state	44	1.00	6.00	4.9318	1.10806
PES_Q3_BSIM_favorability	44	1.00	6.00	4.5682	1.30112
PES_Q4_BSIM_Cyberball_feeling_state	44	1.00	6.00	2.1136	2.08222
PES_Q5_Y_N_O_ostracized_player_even_distribution	44	1.00	3.00	1.8182	.75553
PES_Q6_empathy_likert	44	2.00	10.00	7.1818	1.72900
PES_Q7_BSIM_feeling_of_relaxation_likert	44	3.00	10.00	8.2500	1.71349
PES_Q8_PIM_feeling_of_relaxation_likert	44	1.00	9.00	4.6818	2.12157
Valid N (list wise)	44				

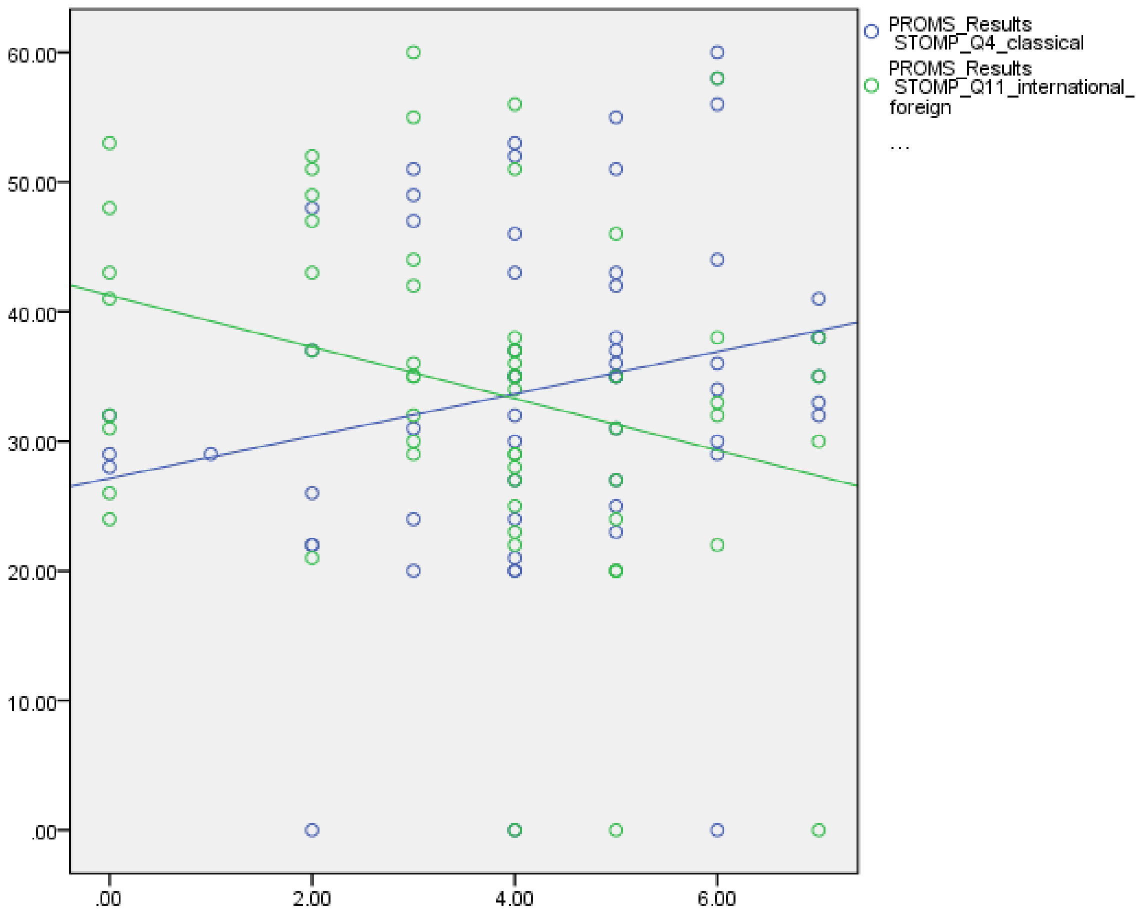

Figure 6-1. Overlay scatter-plot of overall subject-performance in the musical skills-assessment survey, the mini-PROMS, and subject responses to questions 4 (Classical music) and 11 (International/Foreign music) of the music preference survey, the STOMP-R.

CHAPTER 7
DISCUSSION

Primary Findings

The primary findings of this study are that music affected empathic decision making as well as autonomic function. Music increased empathic decision making compared to the non-music setting. Further, music affected sympathetic function, reducing it as compared to the non-music control setting (see Bernardi et al. 2009). However, music setting did not influence parasympathetic function. Though there were effects of music on both empathic decision making and autonomic function, there was no association between the two.

Specific to effects of music upon parasympathetic response, Perez-Lloret et al. 2014, found that in subjects (N = 25) who preferred certain relaxing music, their high frequency heart rate variability reduced. This was specific to music categorized as new age (i.e. Enya's "Only Time"), involving a slow-to-medium tempo (i.e. 80-85 bpm) and a predictable rhythm. Furthermore, though not statistically significant, classical music yielded the highest high frequency heart rate variability result when compared to three other music settings. In our study, music (regardless of content: BSIM or PIM) reduced sympathetic nervous system response, but did not significantly affect heart rate variability derived indices of parasympathetic function.

Specific to effects of music upon sympathetic response, Iwanaga et al. 2005, found that music setting (i.e. sedative, excitatory, and non-music control) affected subjects' (N =13) overall autonomic nervous system activity on four separate timed occasions. The excitatory setting (i.e. Igor Stravinsky's *Rite of Spring*), defined by its "dynamic, rhythmic, and wild . . ." modified autonomic response as measured by the low-frequency component of heart-rate variability and the low-high frequency ratio, suggesting decreased parasympathetic response to the excitatory music condition. Music preference was not an element of this study and each subject was exposed to each of the two music settings and non-music control at different scheduled times.

Individual Differences

Although aspects of the primary hypotheses were falsified, there were some intriguing trends in the results specific to individual differences. Specifically, when music was present as compared to the non-music control, subjects' empathic decisions were higher. This corroborates the results from Kirschner and Tomasello 2010 and Rabinowitch et al.'s 2013 respective studies, regarding the overall effects of music upon prosocial engagement. Furthermore, regarding, John Blacking 1974, Felicity Laurence 1999, and Christopher Small 2011, the physical element of social engagement through music-making promotes empathy, as similar to the physical element of empathic decision making defined in this study via Cyberball. Freeman 1998 further corroborates these results, particularly from a neurobiological perspective, as music and physical activity promote social bonding between non-familiar individuals.

Developing upon these thoughts, research in the interaction effects of music preference and human behavior is proving to provide for significant results regarding the study of the use of music to promote social engagement, as defined by the Polyvagal theory. In Dunn et al. 2012, for example, the authors discuss the significant interactions between subjects' self-reported personality traits as defined by the Big-Five Inventory (John and Srivastava 1999) and music preferences. Interestingly, higher preference for Western European Classical music was strongly correlated with higher reports of neuroticism, in contrast to higher preference for the general categorization of Jazz music and its strong correlation to openness to experience.

Though Dunn et al. 2012 did not include a physiological component, Lundqvist et al. 2008 corroborate the idea that a mixed-method approach involving self-report and physiological data specific to primary emotional content of music (i.e. happy, sad, fearful, and/or angry) contributes to a more comprehensive understanding of musical stimuli, preference, and human behavior. Furthermore, and specific to the cultural implications behind the use of genre labels to define characteristics of music, Dunn et al.'s (2012) uses of Classical and Jazz music within their experimental protocol suggests these particular genres to maintain certain cultural assumptions, levying the possibility for multiple angles of criticism. However, findings within these studies involving multiple demographics highlight the interaction effects these particular styles and characteristics of music have upon human behavior, in general. Studying these parameters will develop the understanding and perhaps value-judgements of music's significances in society at large, at least from the methodological angles of psychophysiology and ethnomusicology.

Limitations

Cyberball: Cyberball contains a large number of variable programming options across several domains to perhaps induce different levels of participation from subjects (Hartgerink et al. 2015). Within this experiment, the use of arguably the simplest form of the game (i.e. no background image, minimum number of players, no real-player faces portrayed on top of original avatar facial features, and no real-player names included) may have provided for subjects' habituation to the experimental procedure and limited their overall participation, and thus, limited statistical significance displayed in the results particular to the hypotheses.

Altering the parameters of the game to include greater customized elements available to the game is a necessary follow-up step to accurately display the effects of this particular potential change to the experimental protocol. Combining these potential changes to the experimental protocol with shifts in the music used and variations in the psychophysiological outcome measures may offer a very different perspective into the intent of this project's goals.

To the author's knowledge, no studies exist testing outcome measures of Cyberball with music present. Therefore, further research particular to the relationships between Cyberball game play (i.e. available outcome measures supplied by the current version of Cyberball) and exposure to music is necessary to find further conclusions as to what role(s) music may play in facilitating empathic decision making, as evidenced by Cyberball game play. Transitioning somewhat, the use of a different empathic decision making task may have provided for differences in overall effect of the music settings (i.e. BSIM and PIM) upon physiological state and consequently, statistical outcomes from the empathic decision making task(s), itself.

Future directions

Empathic decision making and behavior is historically a major area of study in the psychological sciences. This was strongly the case after World War II as the field attempted to understand the holocaust (i.e. Stanley Milgram 1963). In his seminal work, Milgram discusses the "study of destructive obedience," particularly to highlight that human willingness to administer punishment is often linked to the likelihood that we self-regulate empathic concern for another human when an authoritative figure is present. Furthermore, in a similar vein, the Stanford Prison Experiment (Zimbardo 1971) demonstrated that role-playing links preconceived notions of expected behavior to actual behavior, despite potential negative effects of that behavior. Contemporary IRB-approved studies on human subjects will not allow such methodologies to be reproduced. Consequently, and particular to the study of empathy and its correlates (i.e. altruistic and/or compassionate empathy), the development of acceptable and/or agreed upon methods to measure empathy are needed for a variety of contexts in order to understand contributors to variance in empathic behavior.

Measuring empathic decision making in laboratory contexts in an ecologically valid manner is a challenge. How does one achieve the necessary stakes or emotional investment to elicit an empathic decision that is reliable and valid and psychometrically of good quality? We chose Cyberball, which is an experimental computer task designed to measure elements of empathy, but specifically ostracism. This task is appealing because it has substantial configurability and has good measurement properties. But, it is not perfect in that there is no personal interaction and the task may be perceived as boring, which could affect engagement in the task and thus diminish the degree that empathy may play a role in decisions. Furthermore, cognitive versus affective empathy appeared a common trend across trials perhaps due to the human-computer, rather than human-human interaction. To mitigate these issues to some extent, we introduced a confederate to make it seem that the participant was playing with real humans, rather than unreal characters.

In our empathic decision making data, there is evidence that ostracism does validly associate with aspects of empathic traits. Specifically, we found relationships between self-report of empathic traits and behavioral choices in Cyberball. For example, individual differences in response to the Interpersonal Reactivity Index (Davis 1980) indicated a significant within-subjects interaction effect between their empathic decisions and personal distress, such that as subjects' feelings of personal anxiety and unease in tense interpersonal settings decreased, their empathic decisions made increased. This suggests a fundamental relationship between self-other interaction in the contexts of empathy, specifically empathic decisions, and one's perception(s) of personal distress.

As attempted by this experiment, the effects of music upon empathic decision making altered subjects' physiological states compared with the non-music control setting, suggesting the qualities of the musical selections used in this project to have provided their intended and respective purposes. The selections, in terms of their musical qualities did not differentiate from one another. This is not consistent with the prior literature. However, the sample sizes in the prior literature have, thus far, been relatively small. Thus, more research is needed with larger samples to flesh out the contexts in which different music selection may impact these systems.

Music, therefore, does provide for a greater level of social engagement, at least as evidenced by participation in an empathic decision making task. Results from the autonomic measures taken in this experiment (i.e. baseline assessment, GSR, and RSA outcome measures) confirm the conclusion that compared with the average GSR scores of the baseline assessments and non-music control setting for all subjects, the average GSR scores of the during-task music settings (BSIM and PIM) were reduced. This presents several potential conclusions and possibilities for future inquiry, and to first address certain of the conclusions: 1) the qualities of the music settings (as defined in the methods section of this document) were significantly relevant and/or preferential to the average subject (as confirmed by their self-reports within the STOMP-R), enough to confirm their increased participation in the empathic decision making task as evidenced by overall throw count to the ostracized player, compared with the non-music control setting; 2) particular to reported GSR scores, the music settings reduced subjects' overall perceptions of threat as compared with the non-music control setting.

These results arguably provide for a conundrum, such that the excitative music setting (as defined by Iwanaga and Tsukamoto 1997; Yamashita et al. 2006; and Bernardi et al. 2009), rather than providing for a higher sympathetic nervous system response (i.e. increased heart rate over a given period of time), was not different in this particular regard to the sedative music setting. Several factors may have contributed to this result: 1) overall length of exposure both within and between-subjects per music setting; 2) habituation effects to the empathic decision making task and potential cognitive regulation of inter-beat interval variability across the two music settings due to cognitive attentional demands; and 3) perhaps most interestingly, a fundamental challenge to the association of high-tempo music to increased sympathetic activity when social factors are involved (i.e. empathic decision making and/or other socially engaging activities). The lack of parasympathetic difference as a function of music or in relationship to empathic decision making may reflect context in regard to the type of empathic decision being made and the strength of the manipulation (Cyberball). A more emotionally engaging empathy task may better address this element of autonomic/empathy relationships.

To further address certain of the possibilities for future inquiry, this particular study of the interactions of music, social engagement, and empathic decision making has yielded possibilities for changes to the existing experimental protocol in a variety of areas: 1) changes in elements of musical characteristics used as foci for the/an experiment (i.e. rather than rhythm, tempo, instrumentation, and articulation, one might focus on timbre, dynamics, or key signature, as examples) and/or changes in style(s) – indicating the potential of using only one style of music versus multiple, and incorporating artificially attenuated qualities previously mentioned (timbre, dynamics, etc.) to differentiate between versions of the hypothetically-devised style - of music used within the context of this existing experimental protocol (i.e. configurations of musical characteristics yielding perceptions of specific musical genres: funk, rock, blues, or folk, as examples of primarily Western-music oriented styles/genres); 2) change(s) in the execution of the steps of the current experimental protocol, within the confines of how the current protocol already exists (i.e. assessing the baseline autonomic assessment period thru only certain allowable body postures and/or only one allowable body posture; changing the deception to allow for greater variance in the execution of how the deception affects the subject who participates in the entire experiment, particularly considering the configurations used within the empathic decision making task; altering the administration of the duration of the music settings; altering the duration of the recovery settings; etc.); 3) a fundamental change in the use of a different empathic decision making task and/or social engagement outcome to define social engagement, perhaps with greater social interaction between two (or more) non-familiar subjects; 4) changes in musical skills assessment (i.e. using a different battery of questions than the mini-PROMS to assess dispositional musical skill).

The above suggestions for potential changes and/or future directions of this project take into account only a few of the possible adaptations this project may endure as the concept behind the study of the interactions of music, social engagement, and empathic decision making is developed. Furthermore, the interactions between the future of the methodologies of ethnomusicology and psychophysiology continue to evolve as projects such as this one engage multi-modal and interdisciplinary discussion of human behavior from a combined socio-cultural and biological perspective.

APPENDIX A
BIG FIVE INVENTORY (BFI-10)

A Brief Version of the Big Five Personality Inventory.

Big Five Inventory-10 (BFI-10)

Adapted from Rammstedt, B. & John, O. P. (2007). Measuring personality in one minute or less: A 10 item short version of the Big Five Inventory in English and German. *Journal of Research in Personality, 41*, 203-212.

Instructions: How well do the following statements describe your personality?

I see myself as someone who …	Disagree strongly	Disagree a little	Neither agree nor disagree	Agree a little	Agree strongly
1. … is reserved	(1)	(2)	(3)	(4)	(5)
2. … is generally trusting	(1)	(2)	(3)	(4)	(5)
3. … tends to be lazy	(1)	(2)	(3)	(4)	(5)
4. … is relaxed, handles stress well	(1)	(2)	(3)	(4)	(5)
5. … has few artistic interests	(1)	(2)	(3)	(4)	(5)
6. … is outgoing, sociable	(1)	(2)	(3)	(4)	(5)
7. … tends to find fault with others	(1)	(2)	(3)	(4)	(5)
8. … does a thorough job	(1)	(2)	(3)	(4)	(5)
9. … gets nervous easily	(1)	(2)	(3)	(4)	(5)
10. … has an active imagination	(1)	(2)	(3)	(4)	(5)

Scoring the BFI-10 scales (R = item is reverse-scored):

Extraversion: 1R, 5

Agreeableness: 2, 7R

Conscientiousness: 3R, 8

Neuroticism: 4R, 9

Openness to Experience: 5R, 10

(Retrieved 7/31/10 from http://www.ocf.berkeley.edu/~johnlab/pdfs/BFI-10.doc)

APPENDIX B
SHORT TEST OF MUSIC PREFERENCES (STOMP-R revised)

STOMP-Revised

Please indicate your basic preference for each of the following genres using the scale provided.

1	2	3	4	5	6	7
Dislike Strongly	Dislike Moderately	Dislike a Little	Neither like nor dislike	Like a Little	Like Moderately	Like Strongly

1. _____ Alternative
2. _____ Bluegrass
3. _____ Blues
4. _____ Classical
5. _____ Country
6. _____ Dance/Electronica
7. _____ Folk
8. _____ Funk
9. _____ Gospel
10. _____ Heavy Metal
11. _____ International/Foreign
12. _____ Jazz
13. _____ New Age
14. _____ Oldies
15. _____ Opera
16. _____ Pop
17. _____ Punk
18. _____ Rap/hip-hop
19. _____ Reggae
20. _____ Religious
21. _____ Rock
22. _____ Soul/R&B
23. _____ Soundtracks/theme song

Music preference dimensions scoring:

Reflective & Complex: 2, 3, 4, 7, 11, 12, 13, 15

Intense & Rebellious: 1, 10, 17, 21

Upbeat & Conventional: 5, 9, 14, 16, 20, 23

Energetic & Rhythmic: 6, 8, 18, 19, 22

APPENDIX C
INTERPERSONAL REACTIVITY INDEX

INTERPERSONAL REACTIVITY INDEX (IRI)

Reference:

Davis, M. H. (1980). A multidimensional approach to individual differences in empathy. *JSAS Catalog of Selected Documents in Psychology, 10*, 85.

Description of Measure:

Defines empathy as the "reactions of one individual to the observed experiences of another (Davis, 1983)."

28-items answered on a 5-point Likert scale ranging from "Does not describe me well" to "Describes me very well". The measure has 4 subscales, each made up of 7 different items. These subscales are (taken directly from Davis, 1983):

Perspective Taking – the tendency to spontaneously adopt the psychological point of view of others

Fantasy – taps respondents' tendencies to transpose themselves imaginatively into the feelings and actions of fictitious characters in books, movies, and plays

Empathic Concern – assesses "other-oriented" feelings of sympathy and concern for unfortunate others

Personal Distress – measures "self-oriented" feelings of personal anxiety and unease in tense interpersonal settings

Abstracts of Selected Related Articles:

Davis, M. H. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. *Journal of Personality and Social Psychology, 44*, 113–126.

The past decade has seen growing movement toward a view of empathy as a multidimensional construct. The Interpersonal Reactivity Index (IRI; Davis, 1980), which taps four separate aspects of empathy, is described, and its relationships with measures of social functioning, self-esteem, emotionality, and sensitivity to others is assessed. As expected, each of the four subscales displays a distinctive and predictable pattern of relationships with these measures, as well as with previous unidimensional empathy measures. These findings, coupled with the theoretically important relationships existing among the four subscales themselves, provide considerable evidence for a multidimensional approach to empathy in general and for the use of the IRI in particular.

Pulos, S., Elison, J., & Lennon, R. (2004). Hierarchical structure of the Interpersonal Reactivity Index. *Social Behavior and Personality, 32*, 355-360.

The hierarchical factor structure of the Interpersonal Reactivity Index (IRI) (Davis, 1980) inventory was investigated with the Schmid-Leiman orthogonalization procedure (Schmid & Leiman, 1957). The sample consisted of 409 college students. The analysis found that the IRI could be factored into four first-order factors, corresponding to the four scales of the IRI, and two second-order orthogonal factors, a general empathy factor and an emotional control factor.

Scale (taken from mailer.fsu.edu/~cfigley/Tests/**IRI**.RTF)**:**

INTERPERSONAL REACTIVITY INDEX

The following statements inquire about your thoughts and feelings in a variety of situations. For each item, indicate how well it describes you by choosing the appropriate letter on the scale at the top of the page: A, B, C, D, or E. When you have decided on your answer, fill in the letter next to the item number. READ EACH ITEM CAREFULLY BEFORE RESPONDING. Answer as honestly as you can. Thank you.

ANSWER SCALE:

A	B	C	D	E
DOES NOT DESCRIBE ME ME WELL				DESCRIBES VERY WELL

1. I daydream and fantasize, with some regularity, about things that might happen to me. (FS)

2. I often have tender, concerned feelings for people less fortunate than me. (EC)

3. I sometimes find it difficult to see things from the "other guy's" point of view. (PT) (-)

4. Sometimes I don't feel very sorry for other people when they are having problems. (EC) (-)

5. I really get involved with the feelings of the characters in a novel. (FS)

6. In emergency situations, I feel apprehensive and ill-at-ease. (PD)

7. I am usually objective when I watch a movie or play, and I don't often get completely caught up in it. (FS) (-)

8. I try to look at everybody's side of a disagreement before I make a decision. (PT)

9. When I see someone being taken advantage of, I feel kind of protective towards them. (EC)

10. I sometimes feel helpless when I am in the middle of a very emotional situation. (PD)

11. I sometimes try to understand my friends better by imagining how things look from their perspective. (PT)

12. Becoming extremely involved in a good book or movie is somewhat rare for me. (FS) (-)

13. When I see someone get hurt, I tend to remain calm. (PD) (-)

14. Other people's misfortunes do not usually disturb me a great deal. (EC) (-)

15. If I'm sure I'm right about something, I don't waste much time listening to other people's arguments. (PT) (-)

16. After seeing a play or movie, I have felt as though I were one of the characters. (FS)

17. Being in a tense emotional situation scares me. (PD)

18. When I see someone being treated unfairly, I sometimes don't feel very much pity for them. (EC) (-)

19. I am usually pretty effective in dealing with emergencies. (PD) (-)

20. I am often quite touched by things that I see happen. (EC)

21. I believe that there are two sides to every question and try to look at them both. (PT)

22. I would describe myself as a pretty soft-hearted person. (EC)

23. When I watch a good movie, I can very easily put myself in the place of a leading character. (FS)

24. I tend to lose control during emergencies. (PD)

25. When I'm upset at someone, I usually try to "put myself in his shoes" for a while. (PT)

26. When I am reading an interesting story or novel, I imagine how I would feel if the events in the story were happening to me. (FS)

27. When I see someone who badly needs help in an emergency, I go to pieces. (PD)

28. Before criticizing somebody, I try to imagine how I would feel if I were in their place. (PT)

NOTE:(-) denotes item to be scored in reverse fashion

PT = perspective-taking scale
FS = fantasy scale
EC = empathic concern scale
PD = personal distress scale

A = 0
B = 1
C = 2
D = 3
E = 4

Except for reversed-scored items, which are scored:

A = 4
B = 3
C = 2
D = 1
E = 0

APPENDIX D

DESCRIPTION OF THE PROMS (Profile of Music Perception Skills)

The Profile of Music Perception Skills (PROMS), informally "Music-Quotient Test", was used to measure perceptual musical skills across multiple domains: melody, pitch, timbre, tuning, rhythm, rhythm-in-melody, metric accent, and tempo. The PROMS has satisfactory psychometric properties for the composite score (internal consistency and test-retest >.85) and fair to good coefficients for the individual subtests (.56 to .85). Convergent validity was established with relevant dimensions of Gordon's Advanced Measures of Music Audiation and Musical Aptitude Profile and with the Musical Ear Test. Criterion validity was evidenced by significant relationships between test performance and external musical proficiency indicators. A nonmusical auditory discrimination was unrelated to the test supporting its discriminant validity. Brief versions of the full PROMS, the Short PROMS (taking about 25 minutes to complete) and the mini-PROMS (taking about 15 minutes to complete), have been introduced as time-efficient web-based versions of the full version of the PROMS.

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APPENDIX E
POST EXPERIMENT SURVEY QUESTIONS

Short response questions

1. Did you like listening to the Brazilian music?

2. How did the Brazilian music make you feel during Cyberball?

3. Did you like listening to the Classical music?

4. How did the Classical music make you feel during Cyberball?

5. Did you try to evenly distribute which player you threw the ball to?

Numerical response questions

6. On a scale from 1-10, how empathetic do you think you are?
   (1 – Not empathetic . . . 10 – most empathetic)

7. On a scale from 1-10, how relaxed did you feel during the classical music?
   (1 – Not relaxed . . . 10 – most relaxed)

8. On a scale from 1-10, how relaxed did you feel during the Brazilian music?
   (1 – Not relaxed . . . 10 – most relaxed)

APPENDIX F
POST EXPERIMENT DEBRIEF

Study ID:IRB201701231 Date Approved: 6/29/2017 Expiration Date: 6/29/2018

Post Experiment Debrief

Thank you for your participation!

There are a few pieces of information we would like to share with you now that you have completed the experiment:

1. Please read the below description.
   - In the Cyberball task, the other players in the game were in fact computer players. The other person you met before starting to play Cyberball was not playing the game. Instead of also playing Cyberball, the other person was recruited to act as another real player, but their physical participation did not actually occur. After you two met, the other person was dismissed from the experiment.

The purpose of this design was to limit dialogue between the two of you while the experiment took place. Dialogue can be distracting and it is a difficult thing to measure. In future experiments, we intend to understand the role of music upon group cooperation with dialogue playing a role.

If you have any questions or concerns, please don't hesitate to contact the co-investigator Aaron Colverson for further information. He can be reached at acolverson@ufl.edu.

Thank you again for your participation

APPENDIX G
INFORMED CONSENT

Study ID:IRB201701231 Date Approved: 6/29/2017 Expiration Date: 6/29/2018

Informed Consent

Protocol Title

Social engagement in a multiplayer computer game

Please read this consent document carefully before you decide to participate in this study.

Purpose of the research study

The purpose of this study is to determine linkages between autonomic activity and social engagement during a multiplayer computer game.

Who are we looking for?

We are looking for healthy people between the ages of 18-22 who do not have history of psychiatric, neurological, or heart disease.

What you will be asked to do in the study

There are four surveys that you are required to take in order for the study to progress to following stages. This will take approximately half an hour.

After completing these pre-test surveys, you and your partner will participate in a computer-based ball tossing game called Cyberball.

You will be asked to wear a wristband that measures heart-rate.

Time required

1 hour

Risks and Benefits

There are no known benefits for participating in this study to you.

There are no known risks for participating in this study to you.

Compensation

Students will receive extra credit for participating in this study not to exceed 1% of the student's final grade. Faculty member in support of this project is Heather Bergseth (bergsehe@ufl.edu).

Confidentiality

Your identity will be kept confidential to the extent provided by law. Your information will be assigned a code number. The list connecting your name to this number will be kept in a locked file in my faculty supervisor's office. When the study is completed and the data have been analyzed, the list will be destroyed. Your name will not be used in any report.

Voluntary participation

Your participation in this study is completely voluntary. There is no penalty for not participating.

Right to withdraw from the study

You have the right to withdraw from the study at any time without consequence.

Who to contact if you have questions about the study

Aaron Colverson, Graduate Student, University of Florida, acolverson@ufl.edu

Who to contact about your rights as a research participant in the study

IRB02 Office
Box 112250
University of Florida
Gainesville, FL 32611-2250
phone 392-0433.

Agreement

I have read the procedure described above. I voluntarily agree to participate in the procedure and I have received a copy of this description.

Participant: ________________________________ Date: ______________

Principal Investigator: __________________________ Date: ______________

APPENDIX H
EMPATICA E4 WRISTBAND

Figure H-1. Technical specifications of the E4 wristband.

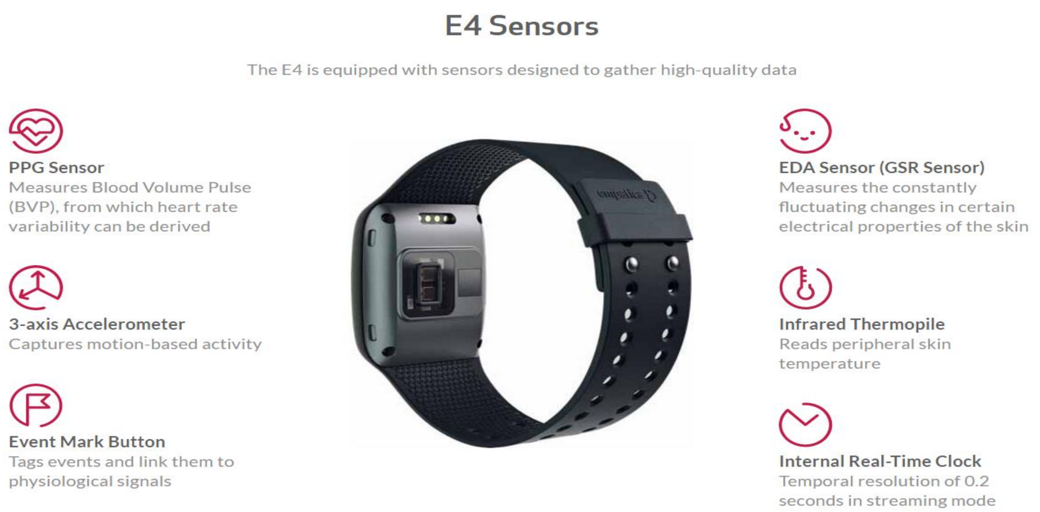

Figure H-2. All sensors and descriptions of the E4 wristband.

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BIOGRAPHICAL SKETCH

Aaron Colverson was born to Kathleen Earl Colverson and Peter James Colverson in Syracuse, NY in 1986. He began the study of music at age 8 beginning with private and group violin lessons focusing on the Western European Classical music tradition. This training also involved orchestral and small ensemble work, predominantly in routinized settings within his elementary and middle schools in Clinton, NY. Music has always been a significant element of his life, with the violin always at the core of his musical expression, perceptive capability, and experience.

At age 13 (after several years of shifting home base location), he and his family settled in Gainesville, FL where he still resides today. Through his parents, he gained access to a local band called *The Weeds of Eden,* a rock/soul/blues band whom he still plays with today. This band introduced Aaron to the option of improvising music on the violin, rather than maintaining his Western European Classical training and direction. He maintained an interest and passion for improvising through his high school years, continuing to play with *The Weeds*, as well as numerous other local musicians in Gainesville.

At age 18, after high school graduation, he attended Stetson University on a music scholarship for two years with a BA degree-track focus on Health Sciences/Biology. After this two-year period, he returned to Gainesville, FL for one year and enrolled at the University of Florida in an online course to earn credits before attending Santa Fe College to continue with his interest in biology. This yielded another change in degree-track focus when Aaron revitalized his passion for music and auditioned for Berklee College of Music in Boston, MA.

Berklee accepted his application and awarded Aaron a scholarship, to which Aaron maintained his attendance through May of 2009 upon graduation with a BA in Professional Music. Aaron remained in Boston for two years until he attended an informal exchange program to Kenya in June of 2011. In December of 2011, Aaron moved to Kenya for 6 months and lived with musicians he met while on the exchange program. This family opened up a new network of individuals to interact and work with, of whom Aaron remained in partnership/contact with for a two-year period.

In January of 2014, Aaron moved back to Gainesville, FL and began the process of acceptance into the University of Florida Graduate School. By the fall semester of 2014, Aaron was accepted to the UF Graduate School with a degree focus in Applied Physiology and Kinesiology under the guidance of Dr. Mark Tillman. Dr. Tillman took another position at Troy State University that same fall and Aaron was relocated to Dr. Evangelos Christou's Neurophysiology lab still within the College of Health and Human Performance at UF. The independent study Aaron took with Dr. Christou yielded further interest in reconnecting with music, though maintaining a bridge to the world of studying human performance. This led to a relationship with Dr. Yong-Jae Ko within the Sports Management Department.

For one year, Aaron studied with Dr. Ko, who was interested in the effects music may or may not have upon consumer behavior in various settings. Particularly, Dr. Ko was interested in investigating the effects of various types of music upon consumer behavior in college sporting events (i.e. football/basketball games, soccer, baseball, etc.). This field of study did not align with Aaron's developing interest in the roles music may or may not have in affecting empathy, rather than consumer behavior. Consequently, Aaron needed to jump ship again.

While attending classes in the College of Health and Human Performance, Aaron maintained connection with a fellow student of Berklee College of Music, Alexander Crook. Alex's recommended for Aaron to connect with his father, Dr. Larry Crook, Department Chair of the Department of Ethnomusicology in the College of Fine Arts at the University of Florida.

Aaron began playing music with Dr. Crook's co-run Brazilian music ensemble *Jacaré Brazil*. Furthermore, Aaron transferred from the College of Health and Human Performance into the College of Fine Arts, specifically the School of Music, where he continues his studies in Ethnomusicology today.

Outside of his studies, Aaron maintains an active role on campus building bridges between different departments and colleges associated with his research interests. Particularly, an event Aaron hosted in February of 2016 saw an interdisciplinary team of scientist and musicians called *the Crossroads Project* bring their performance and innovative climate change education to Gainesville, FL. This event required Aaron to raise a sum of $17,000, to which Aaron went door to door until raising the funds from 9 separate UF departments: UF IFAS, UF College of Journalism and Communications, UF Department of Biology, UF Center for Sustainability, UF Center for Humanities in the Public Sphere, UF Climate Change Institute, UF Bob Graham Center, UF School of Music, and UF Center for Adaptive Innovation.

Aaron is currently working towards his MM degree, with concentration in Ethnomusicology and partnering research in Neuroscience. His future goals involve his continuing of his studies at the University of Florida in pursuit of a PhD in Ethnomusicology under the guidance of Dr. Welson Tremura. Aaron intends to expand upon the work achieved through his MM thesis project in pursuit of his PhD, continuing the partnership with Dr. John Williamson. Furthermore, connections Aaron has made through email communication with numerous scientists in the fields of music perception and cognition will be developed through continued communication and collaboration.