The Embodied Nature of Musical Experience:
Therapeutic Implications of Physical Performance

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Introduction

All sound comes into creation by the act of a physical motion. A force must be generated that displaces air molecules in the form of a wave. If a sonic force is generated near a human, the wave of air resonates with the human ear, which sends information about the wave through neural pathways for the brain to register as sound. What exactly happens once sound enters the body is an overwhelming, seemingly unpredictable process that largely remains a mystery. Music, especially, is a stimulus that vastly activates our perceptual network unlike other sensory experiences. Listening to music can revive the memory of Alzheimer patients, propel those with Parkinson’s disease to initiate movement, ease difficulties in speech caused by expressive aphasia, and encourage social interaction among autistic children. Music’s healing properties are undeniably real but the inner workings of these therapeutic effects are only moderately understood. What is certain is that the start of musical creation is consistently a bodily movement. Since physical motion is so integral to music, the movements that humans make to create sound must have an impact on the body. It is the job of a music psychologist/therapist to question how vibrating air molecules can cause bodily experiences of sound and how participating in music-making affects our health.

Music therapy practices in the United States as established by the American Music Therapy Association (AMTA) are mostly used to treat mental illnesses and/or are a supplement to a patient’s primary physical treatment. In health facilities across America, music therapists interact with their patients through music-making primarily to grow a therapeutic relationship. These parameters of American music therapy have been largely shaped by the reliability of empirical evidence. During the mid-20th century, when music therapy was being introduced to the medical field, music therapy researchers came across discrepancies in physiological results
but found that music participation always elevated mood. The homogeneity of research on music and mood simplified the establishment of music therapy as a behavioral science. The discrepancies in physiological studies, however, do not indicate that music has no physical effects, but merely that these effects are situationally dependent. One’s reaction to a musical experience is largely influenced by their current environment and cultural background. Music therapy has the potential to be effectively prescribed for physical conditions if therapists considered these situational factors and individualized their treatments accordingly.

The current field of American music therapy does important work in treating mental illness, but the field would expand its reach by additionally investigating the physicality of music-making. Music therapists could more commonly work alongside standard medicine practitioners to treat those with movement disorders, respiratory disorders, and cardiovascular diseases if detailed research was conducted on music’s bodily effects and awareness of these effects increased among the general public. Hesitancy towards this implementation may stem from a belief that the variability of music therapy makes it harder to control than standard medicine and too risky for the treatment of physical disorders. Firstly, I would argue that standard medicine, like all medicine, is not exempt from individual variability. Secondly, the risk associated with alternative medicine that is considered unsuitable for physical treatment is somehow not a concern for the treatment of mental illness. There is a false dichotomy in how American culture treats mental and physical illness. The duality that our culture ascribes to the mind and the body contributes to the stigma of alternative medicine and misinforms the reality of our sensory experiences.

The purpose of this thesis is to reveal that musical experience is embodied, more so than some may realize, and careful consideration of these bodily effects could transform the field of
music therapy. Embodiment can be thought of as visceral knowledge. Jazz pianist Vijay Iyer elaborates on embodiment and music cognition in his dissertation “Microstructures of Feel, Macrostructures of Sound: Embodied Cognition in West African and African-American Musics” (1998). Iyer claims that neural pathways throughout the body are involved in keeping rhythmic time and this temporal embodiment is a type of cognition complementary to abstract thought. Embodied cognition is then examined in the context of West African and African-American rhythmic structures, which require a different perceptual outlook on musical pulse than the European meter. Section I of this current work reiterates points about music cognition discussed in Iyer (1998) while adding insight on the historical development of mind-body dualism in Europe. Mind-body dualism has had a major influence on Western philosophies of music that are invalidated by contemporary neuroscience. By critiquing European philosophical history, I intend to contextualize the ignorance of the body in many Western music traditions.

Section II details the neuroscience behind how the body is used to develop musicality and questions the extent to which musicality is innate. I suggest that there is an innateness to musicality in that all humans exhibit a natural sensitivity to the musical structures of their culture with or without conscious effort. My position on innate musicality has been informed by music psychologist John Sloboda, whose theory of musical enculturation (1985) breaks down the typical musical development of Western children. I argue that the musical sensitivity displayed in enculturation most easily evolves into performative skill in educational environments that foster bodily movement. The embodiment of musical development is illustrated in two case studies on Dalcroze Eurhythmics and the trombone shout bands of The United House of Prayer for All People. Due to the time limitations and broad scope of this project, I did not conduct field research on these two educational traditions and, consequentially, this section unfortunately lacks
ethnographic detail. The strengths in these case studies lie more in the usage of Dalcroze Eurhythmic theory to explain musical motor development and the contextualization of trombone shout bands in a larger conversation of evangelical theology and musical enculturation.

Section III offers practical information about how the bodily effects of music performance can improve our health, specifically pertaining to the performance of wind instruments. As a trombonist myself, I believe that playing a wind instrument can benefit pulmonary health due to the forced, extended breathing that is required for its resonance. Research on the physiology of wind instrument performance was pioneered during the 1960s by Arend Bouhuys, who calculated lung volume, mouth pressure, and flow rate changes associated with playing each type of wind instrument.\(^3\) Bouhuys’ research has been scantly followed with few studies on the pulmonary health of wind instrumentalists that have produced contradictory results to one another. This section serves as a summary and reconciliation of these scattered findings as well as provides a unique perspective in comparing the breathing techniques of wind instrumentalists to the breathing exercises prescribed for the treatment of respiratory disorders. The comparison aims to show that wind instrument playing can be used as an exercise for treating non-severe respiratory conditions in the field of music therapy.

Section IV experiments with the idea that music can be composed in consideration of a performer’s physical health. This compositional project was inspired by the work of Milford Graves, a jazz drummer who composes music from the recordings of heart vibrations in order to facilitate heart cell development. In his article “Book of Tono-Rhythmology” (2007), Graves writes that the goal of a musician is, “to construct a music that initiates a biological process for greater flow of cellular energy for mind expansion and innovation.”\(^4\) Building off of Graves’ sentiment, I have written three pieces of music for wind instrumentalists and vocalists that
incorporate physiological concepts discussed in the previous sections. I include retrospectives describing my compositional process as an example for how other musicians could produce intentional, therapeutic works of art. Music’s healing capacity would be taken to a new level in society if it became commonplace for composers to make deliberate decisions regarding the health of their listeners and performers. I hope that this project will raise awareness about music’s psychophysical elements and encourage musicians to engage in their work as an embodied, therapeutic practice.

Western cultures tend to view music performance and perception as an art of the intellect. Listening environments for music of considered sophistication and creative value, such as European classical music, expect physical passivity from the audience while folk musics of lesser respectability in musical elitism are more likely to accept body movement. Discussions in the field of musicology on music’s bodily effects are scarce, despite neurological evidence that the mind and the body are connected. If music is intellectual, then it must also stimulate the physical aspects of our being. The following section elucidates the philosophies behind how Western cultures and West African cultures view the mind and the body in musical practices.

Before jumping into this historical review, I will touch upon the neurological explanations of the mind-body connection in pertinence to music perception.

*The Embodied Perception of Music*

The connection between the mind and the body is most drastically pushed by embodied cognition, an ideology that cognition is situated in the sensory-motor system and the environment. The theory of embodied cognition entered the field of cognitive science during the late twentieth century and was paralleled by a shift in the humanities towards studies of embodied experience rather than textual analysis. Thus, embodied cognition has received praise in many contemporary anthropological works, which use the theory to explain the cultural relevance of their described practices. Embodied cognition has also, however, been criticized by some neuroscientists for its oversimplified treatment of cognition. Goldinger et al. (2016) cite
examples of cognitive processes such as the word frequency effect, short-term memory scanning, and face perception that are inexplicable using embodied cognition theory. The authors conclude that cognition is embodied in some but not all perceptual situations. For the purposes of this current work, I argue that embodied cognition is relevant to ethnomusicology because musical experience is a situation in which human cognition is mediated by bodily and environmental factors.

The mechanisms of embodied cognition in ascertaining objects can be explained by Barsalou’s (1999) theory of perceptual symbol systems. Barsalou’s claim is that cognitive processes and the sensory-motor system inform one another in creating a symbolic perception of the environment. All perceptive experiences of a new object begin with bottom-up processing, meaning that the perceiver first senses details of the object to then cognitively create a symbolic conception of what the object is. For instance, if one sees two houses for the first time, they will take details applicable to each house to create a general symbol of what they then categorize as a house. When perceiving a house again, they will use top-down processing to identify the object as a house by first recognizing that the object aligns with a stored cognitive symbol. This realization made in an associative cognitive area is communicated with the sensory-motor system, which then perceives more detailed information about the object. The theory of perceptual symbol systems is a classical example of how the sensory-motor system, commonly considered to be the body, and cognition, conceptualized as the mind, are connected in shaping our experience of the physical environment.

The perceptual symbol systems theory can be applied to music processing when taking the object of perception as sound. Todd (2015) has developed a sensory-motor theory pertaining to rhythm, stating that rhythm perception is constructed by both a sensory representation of the
auditory input and a motor representation of the musculoskeletal system.³ The term “sensory representation” is much like Barsalou’s use of the word “symbol” and “motor representation” refers to the workings of the central nervous system that control body movement. Motor representations of rhythm has been examined by Schubotz et al. (2000), who found that cerebral structures involved in planning body movement are always activated when listening to music, even when the listener is not moving.⁴ This specific finding does contradict embodied cognition theory as the cognitive representation precedes the bodily execution. Yet, it demonstrates the mind-body connection by illuminating that body movement always plays a role in musical perception regardless of the parameters of the musical practice.

The perception of objects further initiates communication between the mind and the body when the object arouses an emotion. Emotions are a linear process beginning with the sensation of a stimulus and ending with the conscious recognition of a feeling. The question psychologists have faced is the order of perceptual events in between that create an emotional experience. While there are disagreements between somatic and cognitive approaches, a widely accepted model of emotional processing is Arnold’s appraisal theory, stating that right after a person senses an object, the brain appraises the object’s implication.⁵ If the object is significant, the central nervous system then produces physiological responses that the brain interprets as a feeling. The experience of emotion is a constant back and forth along opposite ends of the central nervous system that many consider separate workings of the mind and the body. Integrative approaches like the appraisal theory show that emotion is neither solely somatic nor cognitive.

The field of music psychology has a similar debate over whether listening to music only produces perceptions of emotion or whether music induces emotion as a bodily response. The most widely accepted view is a unified theory by Justin (2013), who claims that people process
music with both a contagion mechanism, which allows the listener to experience emotional arousal, and an aesthetic judgment mechanism, which allows a listener to perceive the emotion as an artificial production. Studies researching the contagion mechanism have found that one of the most common bodily responses to music are chills, which can include shivers, goosebumps, and tingling along the spine. In determining which aspects of music can cause chills, Sloboda (1991) found that shivers are usually induced by harmonic modulation and, in a later study, observed that unexpected changes in harmony caused electrodermal activity (Sloboda, 2006).

Hearing harmony can activate physiological responses involving both the bodily and mental sides of the central nervous system.

Applications of sensory-motor theories of music have been exhibited in music education techniques. Based on my experience with American music education, whether or not music teachers are aware of the science behind embodiment, much of their advice is derived from the concept that the mind has power over the body. For instance, band directors typically instruct wind instrument players on proper articulation by telling them to imagine the sound of a phoneme. Imagining a “do” sound helps to play legato articulation and imagining a “to” sound helps to play an articulation. Similarly, auralizing a pitch can help wind instrument players to hit that note on their instrument. Both of these techniques exemplify that creating a sensory representation in the mind can have an effect on how the body executes an action.

Despite overwhelming evidence that musical experience is embodied, Western thought is pervaded by the philosophy of mind-body dualism that categorizes Western classical music as exclusively an art of the intellect. Understanding this philosophical background is necessary in evaluating the Western perception of music on a broad scale for, as the theory of embodied cognition states, our sensorimotor perceptions are situated in our cultural environment. In the
following section, I analyze the ways in which mind-body dualism shaped the development of Western classical music during Ancient Greece and the Middle Ages.

*Soul-Harmony Theories of Ancient Greece and the Middle Ages*

One of the first appearances of mind-body dualism is in Plato’s dialogue *Phaedo* (c. 360 BC). The dialogue primarily addresses the nature of the soul, for which Plato proposes his Theory of Ideas. Plato’s theory uses the concept of the soul interchangeably with that of the mind, stating that physical objects originate from cognition. On his view of the soul in relation to mental ideas, Plato writes, “Our souls…existed earlier on, before inhabiting human form; they existed apart from bodies, and they had intelligence.” While souls can exist within a body, it is clear that Plato believes the soul and the body are essentially separate. Plato’s use of a possessive pronoun before ‘souls’ but not before ‘bodies’ also suggests that our true nature is of the soul. There are many examples throughout *Phaedo* in which Plato speaks of bodily tendencies as something to escape from as the soul, “it [the soul] is dragged by the body towards objects that are never constant, and itself wanders in a sort of dizzy drunken confusion.” The soul is seen as being afflicted by the body and bodily objects that bring temporary satisfaction. As such, the wellbeing of the soul is valued over the desires of the body.

Classical Greek philosophers often theorized about the nature of music as well as the soul and, at times, their conclusions on the two topics contradict one another. In *Phaedo*, Simmias creates a musical metaphor in an attempt to explain the relationship between the soul and the body. The metaphor is referred to as the soul-harmony theory, stating that the soul is to the body what harmony is to the lyre. Socrates objects to Simmias’s theory, for, according to the Theory of Ideas, the soul is not dependent on the body as harmony proceeds from the plucking of a
lyre. The fact that the soul-harmony theory does not correspond with the Theory of Forms creates a dilemma for those valuing the soul over the body. In order to create harmonic music, a person must physically interact with an object to produce waveforms that are cognitively interpreted as harmony. Music is an example in which bodily objects and the cognitive soul are interdependent.

Regardless of psychophysical interdependence in music production, the study of music as an intellectual discipline became an exciting new field in ancient Greece. Intellectual interest in music can be attributed to explorations in the physics of music. Prior to Plato’s *Phaedo*, Pythagorus (c. 580 – c. 500 BC) had studied the mathematics of sonic waveforms as related to pitch. The ability to quantify pitch in mathematical terms allowed musicians to think about melody more analytically. Thus, the field of music theory was created. Music theory earned an established position in the academic world during the Middle Ages. The structure of medieval education can be attributed to Martianus Capella (c. 365 – c. 440 AD), who, in his treatise *The Marriage of Mercury and Philology*, categorized music harmonics as one of the seven liberal arts. Interestingly enough, Pythagorus’s discoveries did not pertain to rhythm and, consequently, musical rhythm was not highlighted in European medieval curriculum. Instead, specifically harmonic aspects of music were considered subject of intellectual discourse.

Ancient Greek philosophies on mind-body dualism and musical harmony continued to have influence on European thought through the scholasticism of the Middle Ages. Scholasticism was a movement aimed to combine Greek philosophy and Christian doctrine into one tradition. The most prominent scholastic work is *Summa Theologiae*, written by catholic philosopher Saint Thomas Aquinas (c. 1225 – 1274). In *Summa Theologiae*, Aquinas elaborates on the mind-body problem posed in *Phaedo* by questioning whether the wellbeing of the body is
necessary for the happiness of the soul. His concluding argument is that, “the perfect condition of the body is required for happiness that is in every way perfect, and this is the case both as a condition for and as a result of happiness…because there will be an overflow from the happiness of the soul into the body.” Aquinas’s argument could be considered radical for the time in comparison to groups such as the Catholic Platonists, who believed it was unnatural for the soul to be held in bodily form. Aquinas’s acknowledgment that the body can have a positive effect on the soul is hopeful for proving the importance of bodily action in creative practice. However, though Aquinas’s question addresses the condition of the body, the body is still considered a mere factor in the ultimate objective of cultivating happiness for the soul.

Monastic communities worked towards cultivating the happiness of the soul with communal chanting. It is out of this monastic practice that polyphony was invented. Polyphony is a musical style in which two or more voices sing contrapuntal melodies at the same time. The early usages of polyphony in the medieval church are highly significant because they shaped two distinguishing features of Western music, harmony and notation. Firstly, monastic polyphony strengthened the view of harmony as a matter of the intellectual soul. As monks gathered to chant verses of the Bible, their polyphonic vocals were thought to improve contemplation of God. Due to the contemplative effects of the style, polyphony began to be employed in liturgical performances, particularly during important church seasons such as Easter. The Church’s continued usage of polyphony in special devotion services confirms the perceived value of harmony for, as Aquinas writes, “The direct and principle effect of devotion is the spiritual joy of the mind.” Harmony was believed to facilitate the effects of devotion and this association with spirituality endured, even as it was employed in secular music.
The second reason that monastic polyphony was significant is that it led to the common usage of music notation in European tradition. European music was solely transmitted orally until the Middle Ages, when the complexity of adding multiple melodic lines to one chant posed a challenge to the oral tradition. During the ninth century, monks decided to notate the melodic lines of their chants in order to memorize and document their experiments with harmony. A framework to notate exact pitch was then developed during the eleventh century, when an Italian monk named Guido of Arezzo (c. 991 – c. 1050) invented the staff. Arezzo’s intention behind making the staff was to eliminate the need for oral transmission and give musicians the ability to learn pieces directly from notation.

After the transition into notational transmission occurred, Ars Nova musicians at the cathedral of Notre Dame saw a need to notate rhythm. Ars Nova was a regional style that used isorhythmic motifs for structural organization, distinct from other medieval classical styles that used pitch-based motifs. The musical structure of Ars Nova is likely why a demand for rhythmic notation occurred in this particular region. The earliest system of rhythmic notation was described in Parisian music theorist Johannes de Garlandia’s (c. 1190 – c. 1270) treatise *De mensurabili musica*.\(^{14}\) The approximate four-century gap between the work of ninth century monks and Garlandia shows that rhythmic notation was an afterthought to harmonic notation in a larger shift towards written transmission. Furthermore, given that music notation was initially established for the purpose of preservation, medieval Europeans may not have thought that their developments in rhythm were worth documenting.

Due to the confluence of mind-body dualism and music theory, European classical music evolved into an intellectual art form with a foundation in harmony. Aside from the somewhat obscure style of Ars Nova, attention to rhythm in European classical culture faded. The
connection between harmony and the mind left rhythm to be associated with the body. The influence of the Church on Western society has been extremely widespread to the extent that early Christian philosophy still pervades modern cultural views. The mind-body standpoint is evident in Western reactions to foreign musics that have not been influenced by similar philosophies, particularly musics of Africa and the African diaspora. The next section will explore the reasons why past Western ethnography has typically characterized African music as being simultaneously “rhythmically complex” and “primitive.”

*West African Dance-Drumming*

Mind-body dualism was reinforced in global labor structures of colonial America when Europeans attempted to justify the African slave trade. A widespread belief among early Euro-Americans was that Africans were physically superior and intellectually inferior in comparison to other races. Europeans were thought to be of the opposite disposition, which conveniently made them suitable to supervise the physical labor of enslaved Africans. This falsified belief was reinforced by the Christian theory of polygenism that emerged to replace monogenism during the eighteenth century. Monogenism is a theory of human origin stating that all humans are descendants of God’s creation. In order to account for human variation, monogenists claimed that racial differences were a result of environmental factors. Polygenism rejected the notion of a united humanity in claiming that each race descended from a different origin, essentially meaning that Europeans and Africans were of a different species. Furthermore, polygenists believed that characteristics of race were inherent and unchangeable by the environment. The racist theory that humans are predetermined to be either mentally skilled or physically skilled was clearly informed by the preexisting ideology that the mind and body are separate.
Polygenist ideology is apparent in early ethnographic accounts of African music, which tended to highlight the music’s rhythmic complexity and characterize a reliance on rhythm as primitive. In 1893, musicologist Richard Wallaschek published a book titled *Primitive Music: An Inquiry into the Origin and Development of Music, Songs, Instruments, Dances, and Pantomimes of Savage Races.* One of Wallaschek’s central claims in *Primitive Music* is that, “We do not meet with a single instance among savages of melody,” and, thus, he concludes that, “the origin of music must be sought in a rhythmical impulse in man.”\(^{16}\) By using the word “primitive” as a title descriptor, Wallaschek immediately establishes the music he will be reviewing as underdeveloped. He then equates primitiveness with an inherent, bodily sense of rhythm. Many musicologists of the early twentieth century echoed Wallaschek’s claims including W. E. F Ward, who wrote, “Africans have not merely cultivated their sense of rhythm far beyond ours, but must have started with a superior sense of rhythm.”\(^ {17}\) Ward diminishes the musical achievements of Africans by declaring that their rhythmic skill is biologically predetermined. The body is viewed in these accounts to be a rudimentary element of musical skill.

Starting in the late twentieth century, some ethnomusicologists began to question polygenist accounts of African music and, specifically, the obsession with African rhythmic complexity. Ghanian ethnomusicologist Kofi Agawu has proposed that the notion of certain rhythms being “African” is an invention of white scholarship implying a fundamental difference between black people and white people.\(^ {18}\) Agawu supports his theory by pointing out that a direct translation of the word “rhythm” is actually not found in West African languages. Therefore, presumptuously using Western terminology to describe African traditions is a reflection of Euro-American influence on African representation in the West. Agawu explains that there are words in the Ewe language to reference qualities of rhythm such as stress, duration, and periodicity.
The multiplicity of Ewe translations for “rhythm” show that Europeans and the Ewe people of West Africa most likely have different conceptions of musical and bodily rhythm. Gaining a better understanding of these West African musical concepts could expand how one views the relationship between music and the body.

The most revealing fact in understanding West African conceptions of rhythm is that, according to Ghanian drummer C. K. Ladzekpo, the Ewe word for “music” is directly translated to mean “dance-drumming.”¹⁹ West African instrumentations are mostly comprised of percussion and it is likely that this guided the European invention of African rhythm. In Western culture, drums are sectioned off as instruments that exclusively contribute to the rhythmic structure of a piece. However, the drum plays a multifaceted role in West African music practices as both a rhythmic and a tonal instrument. The concept of the tonal drum is validated by physical principles of sound production. In comparison to other types of instruments, the vibration of percussive instruments contains a higher number of frequencies, yet, these frequencies do combine to produce a discernible pitch.

It is possible that West Africans are especially attentive to percussive pitch because they speak tonal languages, meaning that they are already more aware of vocal pitch than non-tonal language speakers. West African musicians symbolize the percussive tonality of each drum type with syllables. For instance, the sogo drum makes the low sounds “de” or “ge” and the higher sounds “ku” or “tu” while the idi drum makes the sounds “ki,” “di,” “ku,” and “tu.” To those familiar with the Ewe language, the combination of syllables in an Ewe drum ensemble can be heard as verbal phrases. Thus, in West African culture, rhythm is viewed as being intertwined with tonality and linguistic meaning.
Dance is explicitly tied with drumming in West African conceptions of music because the primary purpose of West African drumming is to accompany the movement of dancers. In response, the bodily rhythm of dancers impacts the musical rhythm of the drums. West African drum patterns typically contain syncopated rhythms that are visible in natural movements of the human body. Walking is an example of a simple, universal action that creates syncopation with contralateral movement of the limbs. When walking naturally, one’s ipsilateral limbs pass by each other in the air and the raised foot touches the ground during the stance phase. If one were to take the stance phase as a downbeat, the interaction of the ipsilateral limbs would occur on the off-beats. An unnatural way to walk would be to move one’s limbs ipsilaterally so that the cycle only contains downbeats. The tendency of the human walk suggests that one is most naturally able to embody rhythm while syncopating beats. In West African music education, observing one’s own walk is sometimes used as a method for feeling syncopation in the body. This method teaches that rhythm can always be traced back to bodily movement.

Another fundamental West African conception of music is that the musician’s body is fully integrated into the process of music production. The importance of body movement is apparent in Olly Wilson’s (1985) common approaches of West African and West African diaspora musics. According to Wilson, West African cultures believe that music can have an affective power on an audience and, in order to achieve musical affect, it is necessary for musicians themselves to perform expressive movement.\textsuperscript{20} Expressive movement is considered to be any movement of a musician that is not directly involved in the mechanical execution of an instrumental sound. Yet, expressive movements are not superfluous because performing them helps the audience to experience affective, bodily responses, whether they are emotional, physical, or contemplative. West African belief in musical affect is accepted by emotivist
positions and Juslin’s contagion mechanism in the field of music psychology as discussed above (see *The Embodied Perception of Music*).

The contribution of expressive movement in creating affective power is also substantiated by the work of music psychologist Jane W. Davidson. When asking musicians to perform the same piece of music with three different levels of intended expression, Davidson (1993) found that musicians displayed more expressive movement during levels of high affect than levels of low affect. These performances were shown to subjects with either visual information only, aural information only, or a mix of visuals or sound. The subjects who were non-musicians relied on visual information more so than aural information in ascertaining expressive intention.21 Aligning with West African belief, these results conclude that musicians unconsciously perform expressive movements in order to achieve expressive affect and these movements aid audiences in perceiving affective power. In further experiments, Davidson (1994, 2002) observed that musicians do display expressive movements during performances of low expressive intention but that the amplitudes of the movements are small. Davidson (2007) hypothesizes that the urge to move expressively is always present but can be controlled depending on intention.22 The ever-present urge for expressive movement shows that musical affect is embodied in a musician’s movement vocabulary.

Expressive movement is the basis for which one can perceive the pulse in West African music. Westerners have often categorized West African music as being rhythmically complex because the two cultures differ in their organization of musical beats. In Western music, beats are evenly grouped into meters that are delineated in the rhythmic parts. All sonic phrases fit into the meter so the listener can easily perceive the pulse. On the contrary, in West African music, there is no conception of meter and, instead, the beat is set by multiple, cyclical rhythmic patterns. The
beginning of each rhythmic pattern starts on a different beat, which, to the Western ear, implies there being more than one meter. Amongst these interlocking patterns, there is one rhythm, usually played by the bell, that functions as the main pattern. The goal of “dance-drumming” is to feel the pulse of the main pattern and balance oneself amidst the cross-rhythms. Since the pulse is somewhat hidden in the sound, listeners of West African music are expected to internalize the pulse themselves, drawing attention to their own body. When listening to any music that sonically reinforces a meter, one’s attention to rhythm is mainly directed externally.

The organization of rhythm influences how our perceptual systems are used to interpret sonic stimuli. The common musical structures of a culture, in combination with its predominant philosophical outlook, determine whether the culture will consider musical experience as embodied. While much is gained in delving into the intellectual properties of an art form, viewing music through mind-body dualism misses its fundamental property, that music is a highly stimulating object of the human nervous system in almost its entirety. The central nervous system includes the brain, expands down through the spine, and connects with the peripheral body. If the spine is a part of the central nervous system, then why is it considered to be of the body and not the mind? Why do we draw a line separating the mind and the body when the nerves perceiving our reality are integrated throughout our being? There is not truly a dividing line in our anatomy. In erasing the distorted perception of this line, it is clear that all musical experience is embodied, intellectual, psychologically stimulating, and physically impactful.


10 Ibid. 25.


14 Burkholder. 31-33.


In the previous section, it was established that music perception is a multifaceted experience engaging communication between the mind and the body. What now remains unanswered is, if the body plays such an important role in music perception, then how has it come to resonate with certain sonic structures and understand their organization as music? Finally, how does this embodiment facilitate the development of musical skill? One cannot develop skill in musical performance without innately understanding the laws of music. It is often heard that music is a “universal language” but, in actuality, each culture has a set of tonal and rhythmic rules that guide the structure of their particular styles. With or without formal music training, and whether or not everyone realizes it, most people who grow up listening and dancing to a certain cultural music style are accustomed to its rules and have embodied musical knowledge. This process of embodying music is more easily facilitated in musical environments that encourage participatory body movement.

The current section will discuss two case studies about musical environments that emphasize bodily participation: 1) Dalcroze Eurhythmics, a framework for musical motor development created by French professor Emile Jaques-Dalcroze, and 2) the trombone shout bands of The United House of Prayer, an example of how musicality can be developed without theoretical training. The seemingly effortless acquisition of skill among shout trombonists as described below may make one wonder, is musicality innate in the human body?

Section II
The Process of Embodying Musical Performance
The Innateness of Human Musicality

A study of the process of embodying music raises the question of whether musicality is innate in the human body or developed through bodily practice. Some music psychologists argue against a case for innate musicality, mostly in opposition to the implication that only select humans are born with musical talent (Howe et al. 1998). This perspective on innate musicality would possibly change under analysis of the ways in which musicality is judged. If one defines musicality as an instinctive understanding of musical structures, it is unquestionable that the majority of humanity possesses a musicality for the music of their own culture that developed with or without formal practice. I argue that musicality is innate insofar as all humans exhibit a natural sensitivity to music and unintentionally internalize musical structures through bodily engagement. Humans must have an innate capability to embody music because: 1) All human societies have had musical traditions since ancient civilization, 2) there exist universal biological processes that generate the musical structures of these traditions, and 3) children enculture the musical structures of their surrounding traditions without conscious effort.

Societal perceptions of musicality are formed by the ways in which a society structures their systems of music education. The education of Western classical music is devised so that learning is explicitly monitored by a teacher and sonic knowledge is transmitted through notation. The ability to read music notation is considered to be a marker of musicality that is necessary for one to be a professionally trained musician. By including sight reading in auditions, American music conservatories restrict those who qualify for higher music education. In his book *How Musical Is Man?* (1973), ethnomusicologist John Blacking questions the elitism of Western classical music transmission, writing, “if we consider social situations in musical traditions that have no notation, it is clear that the creation and performance of most music is
generated first and foremost by the human capacity to discover patterns of sound and to identify them on subsequent occasions.” A history on the invention of music notation (see Soul-Harmony Theories of Ancient Greece and the Middle Ages) has shown that notation was initially only used to document songs that were already being proficiently performed. Since humanity’s musical proficiency preceded the usage of music notation, judgements of musicality should not be limited to skills that are only acquired in formal educational settings.

Removing formalized skill as a determinant of musicality reveals that innate talent is not distributed selectively among humans. Musical proficiency does not arise from an extraordinary inclination towards musicality. In fact, a study by Henson and Wyke (1982) showed that non-musicians have a comparable level of musical intelligence to professional musicians. Henson and Wyke tested the musicality of professional orchestral musicians and the average Western population by asking the subjects to complete the Seashore Test of Musical Ability. The Seashore Test, created by American psychologist Carl Seashore, measures one’s sense of pitch, loudness, rhythm, time, timbre, and tonal memory. Seashore arranged the test into categories because he believed that musicality could manifest in multiple ways, but in order to succeed on a professional level, it was necessary to be exceptional in all areas. The latter part of Seashore’s belief was shown to be doubtable by Henson and Wyke’s study, in which the professional musicians only scored higher than the average on pitch, rhythm, and tonal memory. Additionally, the professional musicians even scored worse on identifying timbre. Given that the average population performed better than or equal to professional musicians on half of the Seashore Test, the average human who has not received extensive musical training must still have an adequate level of musicality.
A possible explanation for the mediocre scores of the professional musicians in Henson and Wyke’s (1982) study is that the talent of musicians is instrument specific. Certain instruments may pose challenges during the learning process that are only specific to select categories of musicality. If one redid Henson and Wyke’s study replacing the orchestral players with multi-instrumentalists, it is very likely that the study would produce different results for the timbre section. The impact of past learning experiences on timbral processing was proven by Pantev et al. (2001), who found that violin and trumpet players have stronger auditory cortical representations for timbres of their own instrument. Basically, learning to play an instrument fine-tunes the brain to recognize qualities of the instrument’s sonic world. Any exceptional demonstration of musical intelligence must therefore be cultivated from an attention towards those musical features. Attention to music in recreational listening environments should also be considered a factor in the development of musical intelligence since humans without formalized training can still display musicality. It is extremely common for people to be exposed to music in these unformalized settings as music is integral to the culture of all human societies.

The ubiquity of music across cultures is unsurprising when considering that musicality has ancient roots in humanity. The only concrete evidence of musical beginnings are archaeological instruments, the first of which trace back to Europe in 30,000 BC, when humans first migrated to the continent. These instruments were carefully designed with attention to scaled intervals of pitch, indicating that some form of tonal music had been practiced vocally before the instruments were built. Cross (2009) hypothesizes that musicality has its origins in ancient Africa and spread throughout the globe as humans migrated. Given that musicality was a part of primitive human behavior, it is probable that there is an innateness to the place of music in human evolution. A genetic basis of musicality has been explored concurrently to research on
rare cases of music deficits. Congenital amusia, the inability to discern musical pitch, is usually shared with other family members and, therefore, is likely to be heritable (Peretz, 2006). The mutation of the gene FOXP2 has also been linked to deficits in processing auditory rhythm (Alcock et al., 2000). Although research on genetic musicality is in its early stages, the findings thus far on congenital amusia and the FOXP2 gene provide a strong case that an inclination towards musical appreciation exists in the human genome.

In addition to a genetic basis, the universal inclination towards musicality exists in part because the majority of humans possess the same cognitive foundation for processing music. Although different cultures have divergent structures for organizing sound, these structures arise from general cognitive processes that are widespread. Stevens and Byron (2014) identify the universals in music perception as, “a) processes which group and segment music at the perceptual level, b) processes for perceiving and responding to temporal information such as beats, c) processes resulting in emotional responses to music, and d) processes involving the meditation of musical experience using long-term memory information.” While each processing system could be elaborated on in-depth, for now, the focus will be on the third process, emotional response. The processing of musical emotion takes place in the limbic system, a primordial neural network involved in emotion, behavior, and motivation. When a listener experiences an emotional response to music, there is increased blood flow to brain regions in the limbic system that react to rewarding stimuli such as food and sex. The brain’s identification of music as a stimulus fulfilling basic human instincts suggests that music is integral to the fabric of humanity. The limbic system of listeners from different cultural backgrounds may not be activated by the same music but all cultures consider emotion to be an important part of music.
The variation in music perception across cultures is due to the musical enculturation that occurs during childhood. Musical enculturation is the subconscious process of entraining the musical structures of a cultural normality. Learning music through enculturation is contrastive to training, which is an educational process involving intentional effort and instruction. In his book *The Musical Mind* (1985), Sloboda overviews the musical enculturation of Western children, most of whom are shown to progressively develop musical skills with or without training experience. The majority of children already begin to display musical skill within the first year of life in their ability to recognize changes in the sequential structure of songs (Chang and Trehub, 1977). Through the age of eleven, Western children develop their knowledge of Western musical structures to include the recognition of dissonance, which is any combination of pitches that conflict with cultural rules of tonality. Those who have not received Western musical training most likely do not know the definition of dissonance, yet everyone who has been sufficiently exposed to Western music perceive dissonant chords as unsettling sounds. Sloboda claims to have found that children who have not previously received musical training perform equally to children with a musical training background in recognizing dissonance. Since training is nonessential for developing musicality, a basic understanding of musical structures must largely be acquired through enculturation.

The most notable aspect of the enculturation process is that the acquisition of knowledge is done without conscious effort. The ability of humans to develop musical knowledge in informal settings that are indirectly aimed towards education suggests that humans have an innate inclination to embody music. Although training is not necessary for acquiring musicality, the amount of exposure that one has to informal music settings does determine their obtained level of musical skill. The following subsections will analyze two settings of informal music
education, Dalcroze Eurhythmics and trombone shout bands. The two case studies may come with imperfect explanations of musical development but their focus on bodily movement sheds light on the role of the body in music-making.

_Dalcroze Eurhythmics and Musical Motor Development_

Dalcroze Eurhythmics is an educational method conceptualized in the early twentieth century by French professor Emile Jaques-Dalcroze. Dalcroze’s method was a reaction to his own experience in European music conservatories, where he noticed that music was purely taught at an abstract level. Students in these conservatories could mechanically play music notation but Dalcroze observed that they lacked an intuitive sense of pitch and time. In other words, concepts of harmony and rhythm that European music students abstracted from their education were not embodied. Dalcroze Eurhythmics was created with the philosophy that a proprioceptive sense of musical movement is achieved through habituating body movement. Courses on Dalcroze Eurhythmics are currently taught as an alternative approach to music education in multiple Western countries and are encouraged to precede formal instrumental training.¹² A current shortcoming of Dalcroze Eurhythmics, most likely due to the recent beginnings of Eurhythmic courses, is the lack of published evidence on the effectiveness of these courses in later learning a musical instrument. Despite insufficient practical evidence, Dalcroze Eurhythmics is valuable to the study of embodied music in that it provides a theoretical framework for how one could implement physical movement as a way to internalize musical structures in the body.

Dalcroze Eurhythmics aims to teach people the practice of musical movement so that music concepts can become embodied as tacit knowledge - ability so natural to oneself that its
execution requires low cognitive effort and is felt as intrinsically part of the body’s knowledge. The process of embodying motor skills has three steps: 1) the cognitive stage, 2) the associative stage, and 3) the autonomous stage. In terms of learning how to play an instrument, a beginner in a cognitive stage knows the actions required in playing a certain note but cannot actually use their body to produce that note. The student moves into the associative stage when they are capable of producing the note, but the action takes concentration. The time that a student remains in the associative stage depends on the physical demands of the instrument and the number of motor tasks one must attend to in producing a single sonic outcome. Eventually, a student moves to the autonomous stage when they cognitively combine the multiple motor tasks into a single task. Motor actions that have developed to this final stage feel automatic because the brain’s control over the action has moved from the primary motor cortex, an area managing conscious movement, to the cerebellum, which manages subconscious movement. The ability to perform a movement subconsciously gives an actor the impression that their knowledge of the movement is intrinsic.¹³

Tacit knowledge of rhythm is acquired through repeated practice of body movement so that one can perform a fixed motor pattern. Entraining rhythm is a type of fixed motor pattern in that it requires the synchronization of repetitive body movement to a constant beat. Neurological theories of rhythm entrainment suggest that humans have an internal timekeeper to set the pace for rhythmic motor patterns. In a study conducted by Wing and Kristoffersen (1973), the subjects were told to tap along to an auditory pulse and continue tapping after the auditory pulse had stopped.¹⁴ Wing and Kristoffersen found that the subjects maintained a steady pulse when the external guiding source was taken away. Despite the capability of humans to self-regulate rhythmic movement, an initial reliance on external stimuli is useful when generating a fixed
motor pattern. The importance of practice when learning to internalize rhythm has been shown to be vital by Adams’ (1971) closed-loop theory of motor behavior. Adams’ theory states that, in the associative stage of motor learning, one relies on a combination of sensory feedback in order to correct motor action and, during moments of self-correction, the input of external sensory stimuli aids in automating the action. In a study supporting closed-loop theory, Adams et al. (1972) found that the time spent practicing an action with augmented sensory feedback increases the accuracy of later performing the same action without external feedback. Therefore, attending to auditory rhythm while practicing musical movement can engrain rhythmic motor patterns.

The fundamentals of embodying musical patterns in Dalcroze Eurhythmics are comparable to certain music psychology theories. The internal timekeeper model and the closed-loop theory are essentially what Dalcroze alludes to when writing about a sense of inner rhythm. In his essay titled “The Initiation into Rhythm” (1907), Dalcroze writes, “The muscular system perceives rhythms. By means of repeated daily exercises, muscular memory may be acquired, conducing to a clear and regular representation of rhythm.” Dalcroze’s thoughts on entrainment begin to misalign with modern knowledge of music psychology in that he treats rhythmic and melodic aspects of music separately. When outlining his preferred sequence of music education, Dalcroze writes, “Consciousness of sound can only be acquired by reiterated experiences of the ear and voice; consciousness of rhythm by reiterated experiences of movements of the whole body… the question arises as to which of them should be attended to first.” Dalcroze was mistaken in claiming that body movement does not cultivate consciousness of melodic sound. According to a study by Bangert et al. (2006) on the cognitive activity of melodic processing, musical practice creates neurological connections between
auditory and motor systems. Melodic sensitivity and rhythmic sensitivity are actually
developed simultaneously when practicing motor skills.

The goal of Dalcroze Eurhythmics is for the rhythmic sensitivity developed during
movement exercises to be informative in instrumental training. Dalcroze explains the necessity
of pre-developed rhythmic skill, writing, “No schoolmaster would set a child to draw something
with which he was not familiar, and before he knew how to handle a pencil… No one can
exercise several faculties at the same time before he has acquired, however crudely, at least one
faculty.” Rhythmic sensitivity is a basic faculty that one must acquire before playing rhythmic
passages on an instrument. The impact of movement on the formation of rhythmic preference
was investigated in a study by Phillips-Silver and Trainor (2005), in which a group of infants
were presented with a series of unaccented beats. Half of the infants were bounced every two
beats and the other half were bounced every three beats. When later listening to beats in 2/4 and
3/4, the infants exhibited preference for the accent type they were bounced to. Phillips-Silver and
Trainor concluded that moving to music creates connections between the vestibular system,
involved in the perception of movement, and the auditory cortex, involved in the perception of
sound. The vestibular-auditory connections that the infants established when bouncing to beats
proved to have long-term influence over their musical understanding.

Dalcroze Eurhythmics strengthens vestibular-auditory connection by utilizing habitual
movement of the whole body prior to training the particular bodily movements of instrument
performance. When developing motor skills as a child, one is first capable of perfecting gross
movements, which are broad movements that utilize muscles throughout the body. Children are
also capable of accomplishing some fine movements, which are precise movements that utilize
particular muscle groups. However, children have greater difficulty in perfecting complex fine
movements as compared to gross movement. Eurhythmics exercises purposefully call for gross movement of the muscles, especially in children’s courses. An example exercise would be to have children walk to a beat and accelerate/decelerate their pace in response to changes in tempo. Given the progression of motor ability, Dalcroze believed that students should master gross musical motor skills before cultivating precise motor skills necessary for playing an instrument. Traditional formats of Western music education that lead from theoretical lessons straight into instrumental lessons force the student to perform fine motor skills that they are not aptly prepared to develop.

The essential argument of Dalcroze philosophy is that practical participation is the most effective introduction to music education. A formal education on the subjects of music notation and music theory is only beneficial when a student has already embodied musical concepts from practical movement. Dalcroze’s claim could be substantiated by studies on the long-term effectiveness of Eurhythmics. Do people who have taken Eurhythmics classes have a better sense of rhythm than those who have not? Do Eurhythmics students learn musical instruments more effortlessly than non-Eurhythmics students?

Although these questions specific to Eurhythmics have not been answered, there are other musical traditions that use physical engagement to develop musicality. The trombone shout bands of the United House of Prayer are a tradition in which the audience, in this case a congregation, is encouraged to have physical responses to the music. Congregational movement helps worshipers to cultivate the musicality needed to eventually participate in the trombone performance. The ability for people in the United House of Prayer to learn the trombone without formal music education shows that the informal method of congregational participation is effective in developing motor musicality. The trombone is an interesting instrument to examine
self-taught motor skill because the mechanics of the instrument lend itself to visual
demonstration. Before exploring the case study of shout bands, the next section will cover the
mechanisms of the trombone in order to understand how one could embody the actions of
trombone performance.

**The Mechanics of the Trombone**

The most distinguishing feature of the trombone is that its pitch altering mechanism is a slide. Until the introduction of the trombone to Western instrumentation, the pitch altering mechanisms of all other brass instruments were valves, which impose limitations on the frequencies one can produce. During the fourteenth century, German brass makers began to build trumpets that had a slide so trumpeters could play with chromatic flexibility. The trombone emerged as an instrument distinct from the trumpet during the fifteenth century, when brass makers extended the proportions of the tube. Along with subsequently lowering the trombone’s frequency range, lengthening the tube increased the range of arm movement, made slide positions more spatially distinct, and enhanced visual presentation. The evolution of the trombone from the trumpet is reflected in the Hornbostel-Sachs classification system, the most widely cited classification system in Western organology. Hornbostel and Sachs refer to the trombone as a slide trumpet for which they write, “The tube can be lengthened by extending a telescopic section of the instrument, *European trombone.*” The description of the trombone as telescopic again emphasizes the slide as a defining feature of the instrument.

The Hornbostel-Sachs system is organized by the ways in which the human body is meant to interact with a given instrument in order to produce sound. These five areas of the Hornbostel-Sachs classification are: 1) Idiophone: an instrument resonated by the vibration of its
whole body 2) Membranophone: an instrument resonated by the vibration of a membrane, 3) Chordophone: an instrument resonated by the plucking of a string, 4) Aerophone: an instrument resonated by the exhalation of air through a tube, and 5) Electrophone: an instrument resonated by the use of electrical energy. The trombone is classified as an aerophone, or, what is colloquially referred to as a wind instrument. The amount of air that one needs to exhale in order to resound an aerophone is dependent on the size of its tubing. According to Poiseuille’s law of fluid dynamics, an increase in the radius and length of a tube creates greater resistance against air flow. Brass players must exhale with a greater amount of pressure than woodwind players because the tubing of brass instruments are generally much longer than woodwind instruments. In comparison to other brass instruments, the trombone is more strenuous to play than the trumpet but requires lower air pressure than the tuba. Thus, when examining the kinesthetics of aerophone performance, the trombone exerts a noticeable degree of resistance on air flow while also acting as a middle ground for the brass family.

One determining factor of trombone pitch is slide position. When altering the length of the slide, a trombonist moves their right arm to either one of seven different positions. The slide can be extended at any distance, but the seven positions produce pitches in the just intonation system. First position is played with the slide fully inward, second position is between the near end of the slide and the bell, third position is slightly inward from the bell, fourth position is slightly outward from the bell, fifth position is between the bell and the far end of the slide, sixth position is at arm's length, and seventh position is played with the slide fully outward. Most players prefer to avoid seventh position because it can only be reached by holding the slide with just one’s fingertips so that the fingers are extended outward. The dilemma of seventh position illustrates the extent to which the design of an instrument has an impact on the physical comfort
of an instrumentalist. The trombone slide does pose a physical challenge when playing fast passages with changes in pitch as compared to valve brass instruments, which only entail movement of the fingers. That being said, from the perspective of a bystander, the more that an instrumentalist is spatially mobile the more that their technique is interpretative. One observing a trumpeter would have a hard time perceiving their valve movements, whereas, the dramatic arm movements of trombonists clearly lay out their pitch alteration technique.

The second factor contributing to trombone pitch is the diameter of air flow. Trombonists can change pitch by adjusting the embouchure of their mouth to either narrow or widen the stream of air. Narrowing the opening of the mouth raises pitch and widening the opening lowers pitch. When a trombonist changes their embouchure to a certain degree, the result is a switch in partials. An aerophone partial corresponds to a set sized embouchure opening that combines with the fingering or slide position to determine pitch. For instance, in the second trombone partial, seventh position is a ‘b’ and first position is an ‘f.’ In order to play chromatically up from the ‘f,’ one must change to fifth position in the third partial. First position in the third partial is now ‘d.’ Trombonists can play multiple notes in one slide position and the same note in different slide positions all depending on the partial. These lip adjustments that are done to change partials are not especially obvious to an observer because a mouthpiece covers the player’s mouth. An attentive audience member would only be able to notice slight movements in the sides of the player’s lips. However, if a trombonist changes pitch without changing their slide, one learning the trombone from observation can hear that there are factors besides slide position involved in pitch production. A student would then most likely discover partials from their own experimentation on the instrument.
An aspect of trombone air flow that is much more easily discernible is the necessity of forced respiration. Forced respiration is a mode of breathing that either occurs during exercise or under voluntary control of the respiratory cycle as opposed to the mode of quiet respiration, which is breathing that involuntarily occurs at rest. Since the trombone is a fairly large brass instrument, one must use forced respiration to exhale at a high velocity in order for air to travel through the whole tube. The model breathing technique for aerophone players is to push out their diaphragm during inhalation so that their thoracic cavity is expanded. Since the lungs reside in the thoracic cavity, when aerophone players inhale from their diaphragm, they are increasing their maximum potential lung capacity. The inhalation process of forced respiration can be visually observed and easily replicated by those learning to play an aerophone instrument. When considering both breathing technique and slide techniques, it is clear that the trombone can be learned through the informal educational practice of observation and imitation.

_The Trombone Shout Bands of the United House of Prayer for All People_

The trombonists of the United House of Prayer are living proof of how the trombone can be learned without formal education. The United House of Prayer for All People is an African-American Christian community known for their performances of shout music in liturgical service. Shout bands are usually composed of black, male trombonists, who have learned to play their instrument from aural and visual observation of trombone performances rather than from technical direction. A belief in The United House of Prayer is that this seemingly innate skill is selectively given to shout trombonists as a gift from God. The concept of spiritual gifts has its root in the North American revivalist movements of the nineteenth century that have influenced contemporary evangelical traditions. Whether or not one is a believer in God given gifts, the
apparently natural acquisition of skill among shout trombonists makes the musical environment of The United House of Prayer an interesting case study of innate musicality. In respect to the religious beliefs of the community, I believe that the education of shout trombonists is at least partially facilitated by the services’ encouragement of participatory bodily movement among congregational members, for this movement allows the body to develop musical knowledge.

The United House of Prayer for All People was founded by a priest named Charles Manuel ‘Sweet Daddy’ Grace. In 1881, Grace was born in Cape Verde, where most inhabitants practiced a mix of African customs and American Protestantism. The element of Protestantism in Cape Verde’s religious culture appealed to Grace, who, upon arriving in America, began to preach along the east coast. Grace established his first successful church in Charlotte, North Carolina during 1926 and continued to grow his community of followers through the mid-twentieth century. The community of the United House of Prayer was able to attract many members because of Grace’s charisma and his shout band tradition. According to the Charlotte Observer, soon after arriving in North Carolina, Grace attracted a gathering of 5,000 people who reportedly reacted enthusiastically with behavior such as, “shout, screaming, shivering and jumping up and down.” Over the following decade, Grace would include the performance of shout bands in his services with the philosophy that the community would be more engaged in the word of God if church attendance was enjoyable. Shout music amplified the joy that Grace aimed to spread among his congregations. Since Grace’s death in 1960, the United House of Prayer has continued the shout band tradition with churches in the Carolinas, Virginia, Georgia, Washington DC, and New York.  

The theology of the United House of Prayer closely aligns with the Pentecostalist belief in the gifts of the Spirit. Pentecostalism can be traced back to the teachings of John Wesley, an
eighteenth century English theologian. Wesley was a controversial figure in Western Christianity for his stance on *charismata* in the doctrine of the second blessing. *Charismata* are gifts from the Holy Spirit that take the form of speaking in tongues, healing, prophesying, and ecstasy. Early instances of spontaneously acquired gifts are recounted in the Acts as a manifestation of the Holy Spirit in the bodies of the apostles. In an account of the apostles’ baptism, it is written that, “Divided tongues, as of fire, appeared among them, and a tongue rested on each of them. All of them were filled with the Holy Spirit and began to speak in other languages, as the Spirit gave them ability.” Being immersed in the Holy Spirit during baptism graced the apostles with the gift of speaking in tongues. Spiritual gifts such as those in the Acts were common among prophets of the biblical times but, as *charismata* diminished in the Middle Ages, Western Christianity started to view charismatic behavior as demonic possession. Wesley challenged the negative view of *charismata* in his doctrine of the second blessing, which drew on the Acts to teach that converts receive spiritual gifts upon baptism. This conversion experience was referred to as ‘perfect love,’ implying that *charismata* deepened one’s connection with the Spirit.26

The acceptance of spiritual gifts in Wesley’s doctrine of perfect love sparked the North American revivalist movements of the Second Great Awakening. During the nineteenth century, Christianity in the United States was flooded with a wave of evangelicalism, making way for a variety of revivalist movements including Pentecostalism. The birth of early Pentecostalism is considered to be a movement called the Azusa Street Revival led by African-American preacher William Seymour. In the early twentieth century, Seymour began preaching in Los Angeles, California but was kicked out of a Holiness church for proclaiming that speaking in tongues was a sign of Spirit baptism. Unable to find support in existing Christian spaces, Seymour created his own church on Azusa Street. According to Frank Bartleman, a witness of the Azusa Street
Revival, Seymour’s services were known for, “spontaneity and ecstasy in worship, lack of ecclesiastical or even pastoral oversight…features Bartleman saw as similarities between Azusa and the day of Pentecost in Acts 2.” 27 The account of charismata in the Acts was apparently a noticeable influence on Seymour’s approach to worship. Currently, many Pentecostal denominations trace their theology to the Azusa Street Revival as the emphasis on the display of spiritual gifts and the presence of the Spirit is still foundational to modern Pentecostal practice.

North American revivalist movements appealed to African-Americans possibly because the movements’ inclusion of spirit presence and encouragement of bodily participation were features comparably found in West African ritual practices. West African religious rituals often involve participation in music and dance performances that function to induce spirit possession or at least the sense of a spirit’s presence. Spirit possession is a type of trance experience occurring when a spirit transfuses the human body, taking over the person’s consciousness and acting through their material body. West African belief in spirit possession is strikingly similar to the description of spiritual gifts in the Acts as the potential of the human body to be acted upon through possession by a supernatural force. Along with spirit presence, African-American ethnomusicologist Olly Wilson (1985) regards bodily participation as a second West African retention in African-American spirituality. On the role of movement in West African music-making, Wilson cites Kwabena Nketia (1974), “Affective response to music may be shown outwardly in verbal or physical behavior… Moreover, motor response intensifies one’s enjoyment of music through the feelings of increased involvement and the propulsion that articulating the beat by physical movement generates.” Body movement is included in West African worship because it helps one to further embody the affective intention of the ritual.
Although he recognizes differences between the two traditions, Wilson proposes that West African and African-American spirituality share conceptual approaches to sacred music.\textsuperscript{28}

Despite the dispossession of African customs during the Early Republic period, enslaved Africans attempted to retain elements of spirit possession traditions in African-American spirituality. Since Christianity was the dominant religion in the United States, if African-Americans were to publicly participate in organized religion, an adoption of Christianity was likely the safest option. While there was definitely a forceful nature to the spread of Christianity, I would argue that religion is always adaptable to the culture of its practitioners. Likewise, in his book \textit{An Introduction to Pentecostalism} (2004), religious studies professor Allan Anderson identifies an immediate presence of a spirit and maximal communal participation as two features of African-American worship that are also central to evangelical traditions. Thus, it is unlikely to be a coincidence that a majority of African-Americans converted to Christianity during the Second Great Awakening. Anderson argues that African-Americans were as much of an influence on the evangelical awakening as white revivalists. As seen with the Azusa Street Revival, African-Americans reclaimed religious authority in the nineteenth century by integrating black spirituality into the new openness of Christianity towards ecstatic expression. While the philosophical background of Pentecostalism can partially be traced to Wesley’s movement in England, Anderson advocates for studying Pentecostal origin with a multi-cultural approach, viewing it as a movement equally based in nineteenth century African-American culture.\textsuperscript{29}

African-American Pentecostal spirituality has been influential on the function of shout bands in the United House of Prayer to prompt ecstatic responses from the congregation. Grace was reflective of his intended purpose of shout band performances when naming the musical
style. ‘Shout’ was taken from an Arabic term meaning dance movements that express religious emotion. In the context of the United House of Prayer, ‘shout’ is similarly used in reference to outward expressions of being moved by the Spirit, which can manifest in dancing, stomping, jumping, and clapping. The performance of shout movement creates an environment for which trance can occur. As believed by members of the United House of Prayer, trance is an ecstatic experience in which the body of a congregation member is possessed by the Holy Spirit. Trance almost always occurs while the band is playing and, if trance spontaneously occurs without music, the band will start playing to guide the trance experience. Shout music facilitates induction into trance because its performance allows for the congregation to participate in bodily movement. Ethnomusicologist John Blacking (1973) has theorized that one most closely feels a music’s expressive intention through physical emulation of its musical movement. Blacking addresses emotion in musical experience, writing, “Since this experience may often begin as a rhythmical stirring of the body, it may be possible for a performer to recapture the right feeling by finding the right movement.” The body is the base of trance experience and, in the United House of Prayer, members of a congregation condition their body towards trance by interacting with the movements of shout trombonists.

As generations of The United House of Prayer grow up, young men emerge on stage as virtuosic trombonists who have primarily only learned their instrument from participating in congregational worship and observing their elders. A glimpse into this learning environment can be seen in online videos of shout band performances. In most of these videos, there is a consistent setup of the shout band playing in front of the altar, the congregation listening in the aisles or surrounding the band against the church walls, and a few teenage boys sitting beside the band holding trombones. From what I have watched, these boys do not play their trombones, or
even move their slides, but are positioned to watch the shout bands up close. A clear view of these trombone proteges can be seen in a YouTube video titled “Sounds Of Zion #2 uhop,” which zooms in on the boys’ facial expressions. One boy is nodding his head to the music and observing the performers intently. The other boy looks possibly intimidated and overawed by the band’s talent. It appears that teenage trombonists are given a special place in the musical service to absorb aural and visual information about trombone performance so they can refine their skill during personal practice.

Ethnographic works on shout band education reaffirms the usage of an observational style of knowledge transmission. However, the details concerning this transmission are somewhat unclear in the articles currently available. Hafar (2003) claims that trombone proteges do directly imitate the arm movements of their elders writing that, “their [young players’] slide arms often cannot remain quiet.” The direct bodily imitation that Hafar describes is not an action I witnessed in quite a few videos. This is not to say that shout trombonists never learn from direct bodily imitation, for particular practices of observational transmission probably vary from factors such as church location and generation. Since shout music is self-taught, there may not be an all-inclusive claim for how each trombonist goes about learning from observation. More personalized information about shout band culture is provided by Jefferson (2015), who transcribes his interviews with a few shout trombonists. Everyone interviewed said that they started learning shout trombone as early as the age of three or five. Understandably, the interviewees did not respond with detailed descriptions of their own educational experience as these were memories from early childhood.

Based on the information that is shared, shout music is primarily learned aurally and becomes skillfully expressed through personal experimentation on the trombone. In his interview
with Jefferson, when asked if he received any formal training before playing in church, trombonist Jonathan Burrell replied, “No, no sir not at all… I was basically learning all the music by ear… What's funny is all of the modulations and scales and different things that are played in the shout band I didn't fully understand until I actually got to college and learned what exactly I was doing.” Burrell’s answer shows that it is possible to aurally understand musical structures without knowing their theoretical explanations. Trombonist Hank Bilal tells a similar educational experience, “Being around music so much I just happen to inherited learning how to play the trombone… Music is learned aurally by ear. Some of the members and the shout band could read but is only because they decided to take lessons when they were in school.” Bilal’s choice of the word “inherited” implies that he feels as though his musicality is innate or embodied. If I had the chance to interview Bilal, I would ask more about what he means by inheriting trombone performance and why this inheritance was gained through aural transmission rather than formal training. Avoiding over speculation on that particular sentence, considering the early age of musical development and the aural transmission process, the education of shout trombonists can be characterized as a case of musical enculturation.

Exposure to the sounds, movements, and culture of shout trombonists can eventually lead to the acquisition of musical skill. The question is whether this musicality is a spiritual gift, the result of embodied participation, a mix of the two, or even an unmentioned explanation. In focusing on the possibility of embodied participation, the findings on motor musical development discussed above (see Dalroze Eurhythmics and Musical Motor Development) suggest that bodily movement is a major route to how humans develop musicality. The participatory environment of The United House of Prayer does effectively train trombonists through informal, body-based methods that could be adopted in music education programs.
Though, a problem with completely adopting the Pentacostal belief of spiritual gifts into educational programs would be the promotion of selective talent, which music psychologists caution against being a flawed mentality. Hafar pushes the commentary of spiritual gifts in The United House of Prayer, while individual accounts from Burrell and Bilal, who speak of aural transmission, suggest that some shout trombonists also see their education as an enculturation process.

The natural embodiment of trombone performance among shout band members seems phenomenal, and it is so, but it is a phenomenon of humanity. Everyone has the capability of teaching themselves a musical instrument if given sufficient exposure to musical performance. Dalcroze Eurhythmics explicitly addressed this issue through a critical lens and the shout band tradition exemplified its reality when integrated into cultural practice. While this section preached the value of bodily participation, a combination of mind-body exposure allows one to mentally program cultural musical tendencies and physically imitate performative movement. The embodied knowledge gained through these experiences could be applied to all instruments, as trombonists are not alone in being visually demonstrative. The truth of embodied instrumental performance can be found in the least visual instrument, the human voice. Not everyone understands the mechanics of singing, but many can vocally estimate pitch because these mechanics are embodied knowledge. Playing an external instrument is similar to singing for there comes a time in musicality when the instrument becomes, like the player’s voice, an extension of the body.

17. Ibid. 80.
23. Ibid. 3-29.
29. Ibid. 39-63.
30. Blacking. 110.
32. Hafar, 170.
34 Ibid. 32.
35 Ibid. 28.
There are similarities between the breathing exercises of pulmonary rehabilitation, specifically ventilation-feedback breathing and diaphragmatic breathing, and the techniques of a wind instrumentalist. Both activities augment the control over respiratory flow and the usage of the diaphragm in breathing. Due to the attention that wind instrumentalists must give to their breathing patterns, I consider playing a wind instrument to be a type of breathing retraining exercise that can increase ventilatory capacity and strengthen the respiratory muscles. The effectiveness of wind playing on improving pulmonary health, however, is influenced by the habits that musicians implement in their instrument practice and maintenance. Variables such as an individual’s practice-time, posture, and instrument hygiene determine whether playing a wind instrument does function as a healthy breathing exercise for that individual.

Ventilation-Feedback Breathing and Respiratory Rate

The use of breathing exercises to cultivate wellbeing can be traced back to ancient Yogic practices in India. The Yoga Sutra (c. 500 - 100 BC) was the first Yogic text compiled by the sage Patanjali. The goal of Yoga, as explained by Patanjali, is to separate the purusa (self) from material form through the discipline of the citta (mind). Patanjali offers eight practical disciplines to train the citta, one of which being pranayama (breath-control). On the nature and effects of pranayama, Patanjali writes, “The Pranayama having the external, the internal and the confining operations and being regulated by space, time and number, becomes long and subtle… Thence, the covering of the Effulgence is destroyed. And the capability of the mind for
Concentration” (YS 50-53). By ‘external’ and ‘internal,’ Patanjali is referring to the process of exhalation and inhalation, which he believes should be lengthened in order to reveal spiritual truths and concentrate the mind. The basic theory of pranayama is that nirvana can be achieved by slowing one’s respiratory rate.

The control of respiratory rate in pranayama is also central to the Western technique of ventilation-feedback breathing or timed breathing. Ventilation-feedback breathing is used to prolong respiration in pulmonary retraining for patients with chronic obstructive pulmonary disease (COPD) as these individuals struggle with a limitation in expiratory flow. Short expirations lead to dynamic hyperinflation of the rib cage, a condition that reduces the strength of the diaphragm and increases the mechanical work of breathing. Prolonging expiration through ventilation-feedback breathing can prevent hyperinflation so that the respiratory muscles are consciously controlled. Monitoring respiratory rate improves respiratory efficiency as shown in a study by Collins et al. (2008), which tested the effects supplementing exercise with ventilation-feedback breathing among subjects with COPD. The subjects who combined exercise with ventilation feedback breathing, as compared to the subjects who performed exercise alone, experienced less hyperinflation and greater exercise endurance. Due to these effects, ventilation-feedback breathing is prescribed to treat hyperinflation and increase endurance time.

Some contemporary doctors have similarly begun to re-examine pranayama in terms of how the spiritual practice could be prescribed for physiological treatment. Cardiovascular health has been of particular interest given the dependency of the system on respiration. At rest, the normal respiratory rate for human adults is twelve to eighteen breaths per minute. This rate is two to three times that of Mayer waves, which oscillate six times per minute. Mayer waves are oscillations of arterial blood pressure that are indicative of vagal and sympathetic activity. In a
2001 study, Bernardi et al. tested the effect of *pranayama* breathing on the autonomic nervous system by synchronizing respiratory rate with Mayer waves. The subjects were asked to recite a Yogic mantra six times per minute after first demonstrating spontaneous breathing. The results showed that controlling breathing to synchronize with cardiovascular rhythm lead to an increase in heart rate variability and arterial baroreflex sensitivity. In conclusion, Bernardi et al. (2001) deduced that breathing six times per minute benefits cardiac health by lowering heart rate.\[^3\]

Wind instrument playing is an example of an activity that involves the retraining of respiratory rate. When playing a music composition, the melodic structure of the piece dictates the rate at which one can breath. It would be unmusical to inhale in the middle of a phrase, as doing so would insert an unwanted rest. Thus, wind instrumentalists learn how to control their respirations to execute the musical requirements of a composition. Developing this skill when practicing a wind instrument could help to reduce chronic respiratory symptoms, increase endurance, and increase arterial baroreflex sensitivity as seen in the previously described studies. In this way, wind instrument playing is similar to ventilation-feedback breathing and *pranayama*.

*Diaphragmatic Breathing and Respiratory Muscles*

Various muscles are involved in respiration and the degree to which each muscle group is utilized determines the type of breathing that occurs. The type of breathing that normally occurs at rest is called quiet breathing. During the inhalation phase of quiet breathing, one contracts the diaphragm, a muscle positioned between the chest and the stomach, and the intercostal muscles, located between the ribs. The diaphragm and the intercostal muscles both function to increase the volume of the thoracic cavity, in which the lungs are located. When one exhales, these muscles then relax to decrease the size of the thoracic cavity and passively push air out of the lungs. The
movement of the respiratory muscles during quiet breathing is subconsciously controlled by the respiratory center, located in the medulla. Since the purpose of respiration is to remove carbon dioxide from the body, chemoreceptors in the medulla and the arteries are sensitive to the blood’s carbon dioxide levels. When carbon dioxide levels are high, the respiratory center increases rate and depth of ventilation to support carbon dioxide removal from the blood. Full breaths also increase the transport of oxygen into the blood.\(^4\)

Shallow breaths activate the autonomic nervous system in such a way that one experiences anxiety. The depth of ventilation decreases when one only contracts the intercostal muscles. This switch away from using the diaphragm occurs when an individual senses a threat from the environment. The psychological effects of shallow breathing have been tested by Conrad et al. (2007), who instructed those with panic disorders, those regularly experiencing tension, and those without anxiety or tension on different methods of breathing. When instructed to breath shallowly, all of the groups experienced higher levels of anxiety.\(^5\) Thus, learning how to modify breathing patterns can be mentally and emotionally beneficial as one’s psychological state is directly affected by ventilation depth.

The health benefits of diaphragmatic breathing have become a subject of inquiry in the field of respiratory psychophysiology. Diaphragmatic breathing involves usage of the abdominal muscles during expiration to minimize use of the intercostal muscles. During inspiration, there is an increased usage of the diaphragm in order to further enlarge the thoracic cavity and maximize respiratory volume. The amount of air that one inhales during breathing at rest is referred to as their tidal volume, which is around 500 milliliters for the average-sized adult. During vigorous physical activity, since the exercised muscles require more oxygen and more carbon dioxide removal, the respiratory system forcefully contracts the diaphragm in order to take in more air.
The average adult human’s maximum respiratory volume in one respiratory cycle, referred to as vital capacity, is around 4000 milliliters. Increasing the amount of oxygen entering pulmonary circulation through diaphragmatic breathing alters autonomic nervous system output. Chen et al. (2016) found that practicing diaphragmatic breathing over an eight-week period reduced anxiety, peripheral temperature, heart rate, and breathing rate. These positive health benefits of diaphragmatic breathing are why attention to the diaphragm is the core component of breathing exercises prescribed for anxiety.

The abdominal muscles are also employed in many types of pranayamas, especially kapalbhati pranayama, which involves performing a series of forced expirations. In a video presentation on kapalbhati, Swami Ramdev says, “All known ailments may effectively subside by practicing pranayama and the most important of them is kapalbhati pranayama… While practicing this pranayama, take care that you do it correctly… Head will not move, waist will remain still, only stomach will move.” As Ramdev simultaneously demonstrates kapalbhati, it is visible that he keeps a straight posture and forces each exhalation by contracting his abdominal muscles. Forced expiration has been shown to affect metabolic fitness in a study by Bal (2015), in which the subjects practiced kapalbhati over a four-week period. Over the course of the training period, there was a significant increase in the subject’s maximal oxygen consumption. The results of Bal (2015) indicate that practicing forced expiration using the abdominal muscles could be a beneficial substitute for respiratory training among people whose physical condition may prevent them from performing other aerobic activities.

In addition to its importance in the Yogic tradition, Western doctors have acknowledged the physiological effects of diaphragmatic breathing for treating non-severe respiratory disorders. Diaphragmatic breathing exercises are particularly favorable for those with non-severe asthma as
strengthening the diaphragm and the abdominal muscles addresses asthma symptoms. When undergoing an asthma attack, there is a spasm of the smooth muscle in the bronchiole, which creates a barrier in the pulmonary alveoli and constrains exhalation. The lungs then swell throughout an attack so that the intercostal muscles around the thoracic cavity are less effective in performing respiratory movements. Breathing with the diaphragm and abdominal muscles instead can expand the bronchi during inhalation and adjust the thoracic cavity during exhalation. The purpose of breathing exercises for asthmatic patients is thus to increase vital capacity, reduce movement of the intercostal muscles, strengthen the diaphragm and the abdominal muscles, and increase the expiratory phase.9

Although breathing retraining is in its early stages in Western medicine, the studies that have been conducted on diaphragmatic breathing exercises so far show that the intervention is successful in alleviating asthma symptoms. Thomas et al. (2003) administered the Asthma Quality of Life questionnaire and the Nijmegen questionnaire to asthmatic patients who practiced diaphragmatic breathing for ten minutes a day over six months.10 Based on their responses to the questionnaires, the subjects began to see an increase in their quality of life after one month. A study by Girodo et al. (1992) produced similar results when comparing the effects of diaphragmatic breathing and general aerobic activity on asthma symptoms.11 The subjects who received training in diaphragmatic breathing gained better respiratory functioning than the subjects who performed aerobic exercise, which could be because breathing retraining specifically targets respiration. A possible downside to prescribing breathing exercises, as found by a follow-up questionnaire, is that most of the subjects did not continue diaphragmatic breathing after the study. Diaphragmatic breathing would be a more sustainable method of treatment if it were coupled with an enjoyable activity.
Playing a wind instrument could be prescribed as a more enjoyable diaphragmatic breathing exercise in respiratory rehabilitation practices since aerophone technique emphasizes the respiratory usage of the diaphragm. As briefly described in the subsection *The Mechanics of the Trombone* (Section 2.3), wind instrument educators encourage contraction of the diaphragm in order to reach vital capacity and to produce a full sound upon exhalation. Practicing diaphragmatic breathing while participating in a musical setting could bring patients to be more engaged in their breathing exercises rather than practicing the exercises alone. In the definition of pulmonary rehabilitation, the American Thoracic Society and the European Respiratory Society include that a goal of the practice is, “to promote the long-term adherence to health-enhancing behaviors.” If pulmonary rehabilitation therapists aim for their patients to continue breathing exercises after formal treatment, the field could consider integrating music therapy into their exercises to augment a patient’s personal motivation.

The Pulmonary Health of Wind Instrumentalists

Playing a wind instrument allows one to practice ventilation-feedback breathing and diaphragmatic breathing while simultaneously engaging in a musical activity that many would consider more enjoyable than breathing retraining alone. Given the positive impact of these breathing exercises, one would assume that playing a wind instrument would lead to better pulmonary functioning. However, studies on the pulmonary functioning of wind instrumentalists produce contradictory results in regards to respiratory muscle strength and upper respiratory symptoms. Since breathing retraining and wind instrument playing use similar body movements, I argue that playing a wind instrument has the potential to improve lung function if the musician
practices healthy playing habits. This subsection will identify specific variables that influence the results found in studies on the pulmonary health of wind instrumentalists.

Spirometry tests are a common method of evaluation in studies on the pulmonary health of wind instrumentalists. A spirometer is a device that measures aspects of breathing pattern such as vital capacity, forced expiratory volume (the amount of air one exhales), and peak expiratory flow rate (the speed at which one exhales). The values obtained by a spirometer are good indicators of respiratory muscle strength and endurance. Given the resonating mechanism of aerophones, it is predictable that wind instrumentalists would have greater respiratory muscular strength and endurance than the average population and, thus, have a higher vital capacity, forced expiratory volume, and peak expiratory flow rate. Many studies have found that wind instrumentalists do perform exceptionally well on spirometry tests (Sagdeo and Khuje, 2012; Dhule et al., 2013; Bouhuys, 1964). However, these particular studies are incongruent with the results from some other studies showing that wind instrumentalists perform equally to or worse than the average population (Fuhrmann et al., 2011; Deniz et al., 2006). Inconsistencies in the data mean that there must be variables influencing the effect of the activity.

One factor that could alter the results of an experiment is the control population that the wind instrumentalists are being compared to. In a 2006 study, Deniz et al. found that the wind instrumentalists they tested had reduced pulmonary functioning. These negative results are less surprising when taking into account that the experimental group was comprised of Turkish Naval Band musicians and the control subjects were Turkish Navy officers. Since navy officers are required to have extreme levels of physical fitness for their service, it is inevitable that musicians would not have greater respiratory muscular strength and endurance than naval peers. Deniz et
al. (2006) would have had an entirely different analysis of their results if the control subjects were not military officers or any group with superior physical fitness. In order to reach reliable conclusions, studies on the pulmonary health of wind instrumentalists should compose control groups with comparable subjects.

Another factor influencing experimental results is the amount of time that the subjects spend playing their instrument. In Fuhrmann et al. (2011), which found no significant difference in the pulmonary function of wind instrumentalists, the subjects were taken from universities, professional music ensembles, and community ensembles. Musicians were only allowed to participate in the study if they played at least 5 hours per week. Despite the attempt to consider practice time, this prerequisite still leaves a large gap in the subjects’ background. Professional musicians typically practice around 21 hours per week while recreational players in a community ensemble probably do not play much more than 5 hours per week. The mix of musical backgrounds in Fuhrmann’s experimental group may be why the group’s average had similar spirometry results to the controls. Sagdeo and Khuje (2012) is an example of an experiment that separated professionally employed wind instrumentalists, recreational wind instrumentalists, and non-wind instrumentalists into three groups. The professional musicians had a higher vital capacity and forced expiratory volume than both of the other groups. The data collected would have been different if Sagdeo and Khuje grouped the recreational musicians with the professionals.

The health outcomes of practicing a wind instrument are also influenced by a musician’s technique, including their posture. Band teachers often remind students to straighten their posture when playing a wind instrument so to optimize air-flow. In a study by Albarrati et al. (2018), the effect of posture on respiratory efficiency was evaluated by asking the subjects to perform a
pulmonary function test while either slouching or sitting upright. The subjects who sat in an upright position had a higher forced expiratory volume than the subjects who sat in a slouched position. Albarrati et al. (2018) hypothesized that the difference in forced expiratory volume is due to the connection of the diaphragm to the spine. When the spine is bent, the diaphragm is constricted, the muscle generates less force, and less air circulates during a respiratory cycle. The mediocre performance of some wind instrumentalists in studies on pulmonary function could be explained by posture as people with poor posture may have weaker respiratory muscles.

In addition to respiratory muscle strength, the second question asked in some studies on the pulmonary health of wind instrumentalists is whether playing a wind instrument causes upper respiratory symptoms. Zuskin et al. (2009) investigated both lung function and respiratory symptoms of wind instrumentalists and string instrumentalists from three Croatian orchestras. The wind instrumentalists were found to have a higher ventilatory capacity than the string instrumentalists, but this increased lung function was coupled with a greater susceptibility for chronic upper respiratory symptoms. Sinusitis, nasal catarrh, and hoarseness were developed by 19% to 23.8% of non-smoker, wind instrumentalists while none of the non-smoker, string instrumentalists developed any of these symptoms. Although these data points to a strong correlation between wind playing and upper respiratory symptoms, about three quarters of the wind instrumentalists surveyed did not report these respiratory issues. Zuskin et al. (2009) does not provide enough information about the subjects to identify what differentiating qualities could explain why only some of the wind instrumentalists developed upper respiratory symptoms. If these symptoms are not entirely pervasive, there are probably specific aspects of wind instrument playing that lead to their emergence.
It is highly probable that the upper respiratory symptoms of wind instrumentalists are caused by a negligence of instrument cleanliness. Every type of wind instrument has a cleaning procedure that should be done on a fairly regular basis. For instance, trombones are usually bought with a long rod and cloth that are used to wipe the inside of the instrument’s slide. On occasion, trombonists should also soak their slide and bell in soapy water to wash out any bacteria that may have built up inside. The steps of cleaning procedures are known among musicians but the recommended frequency and the health value of cleaning are unclear. Due to the uncertainty surrounding the subject, the conversation on instrument hygiene fades to the background in music education and most wind players do not make it a habit to clean their instrument. It is not common practice for studies assessing the pulmonary health of wind instruments to ask the subjects how often they clean their instrument. Though one can safely assume that poor instrument hygiene leads to upper respiratory symptoms from bacteria build-up in wind instruments.

A study by Marshall and Levy (2011) provided useful information on the subject of instrument hygiene by testing for the presence of microbial contamination in wind instruments. When identifying the microbes swabbed from the instruments, those that had been played within the last seventy-two hours contained alpha-hemolytic bacteria found in the human mouth. Sharing wind instruments can thus aid the spread of bacteria if the instruments are shared in short periods of time without being cleaned. All of the instruments, particularly those that had been stored for longer periods of time, were also inhabited with significant amounts of environmental bacteria from soil, air, and water. When the bacteria were observed in isolation, most strains lived from three to five days following retrieval and one strain lived thirteen days. Marshall and Levy hypothesized that environmental bacteria are able to rapidly grow and persist inside of
wind instruments because the tubing provides a moist home for the microbes. Given the amount of potentially harmful bacteria found in the instruments, Marshall and Levy recommend taking a cautionary approach to wind instrument hygiene by cleaning tubing and mouthpieces more often than expected.

The solution to healthy wind instrument practice lies in simple changes to hygiene maintenance and playing technique. Cleaning one’s instrument on a regular basis may lead to the resolution of upper respiratory symptoms. In a case by Metersky et al. (2010), the respiratory symptoms of a trombonist who suffered from a chronic cough disappeared after his instrument was soaked in 91% isopropyl alcohol.21 There would most likely be a decrease in the amount of wind instrumentalists with respiratory symptoms if it became normal practice for music educators to caution against bacteria growth. A wind instrumentalist could even experience health benefits related to their playing if they consciously employed forced breathing, practiced with proper posture, and increased their practice time. The potential for increased lung function in wind instrument playing would be more widely accepted if researchers recognized that there are variables in musicians’ mutable habits. In the future, music educators and pulmonary rehabilitation specialists alike should consider the effect of playing a wind instrument on lung function when working with their students and patients.


Section IV
Composing for the Health of the Performer

Each of the previous sections explicated that music performance is an embodied practice that has an effect on our physical health. If the physicality of music performance is so important, what can we do with this information in our day to day lives? I believe that musicians can become conscious of their sonic physicality by making deliberate decisions about how their compositions will arouse body movement among listeners and performers. This current section focuses on the physical health of the musician, experimenting with how intentional, therapeutic compositions can be produced. During my compositional process, I took a calculated approach to writing pieces that intended to improve cardiorespiratory health as informed by scientific literature. Sheet music is attached at the end of the section if the reader would like a notational reference.

(Opalite)

The foundational rhythm of “Opalite” is based on human cardiac-respiratory phase locking patterns. The idea to replicate the heartbeat in a musical composition was inspired by the findings of Bettermann et al. (1999), which analyzed human cardiac cycles in thought of how these patterns could translate into musical rhythm.¹ Bettermann et al. notated heart period tachograms of 96 healthy subjects by signifying each beat with the number ‘1’ and each rest with the number ‘0’. The recorded tachograms showed that each individual had a certain rhythm that regularly reoccurred during sleep. The most common heartbeat among the subjects was a 4:1 interlocking pattern, signified as [1001], representing autonomic regulation between the cardiac
and respiratory cycles. Essentially, on average, the subjects’ heart beat four times per respiratory cycle. Other ratios commonly found were those in close alignment to 4:1 such as 7:2 [1001101], 9:2 [110011001], 3:1 [101], and 5:1 [11001]. Bettermann et al. suggest that amplifying these physiological rhythms through musical reproduction could be beneficial in music therapy practices aiming to improve one’s psychophysical state.

Optimal autonomic regulation of the cardiorespiratory system results in respiratory sinus arrhythmia, the synchronization of heart rate and respiratory rate at rest. Coordination of the cardiovascular and respiratory systems is important as both work cohesively to oxygenate the body. Hayano et al. (1996) tested the effects of respiratory sinus arrhythmia on pulmonary ventilation by modulating the heartbeat of seven dogs. When artificially producing respiratory sinus arrhythmia in the dogs, they experienced an increased consumption of oxygen. Hayano et al. hypothesized that synchronizing one’s heart rate to their respiratory cycle improves the efficiency of pulmonary ventilation by eliminating unnecessary heartbeats. While Hayano et al.’s study modulated heart rate by stimulating nerves of the autonomic nervous system, it is possible that, due to the laws of entrainment, one’s heartbeat could be adjusted by synchronizing with an external beat. “Opalite” intends to evoke respiratory sinus arrhythmia with the rhythm section symbolizing the cardiovascular system and the horn section symbolizing the respiratory system.

The drums in “Opalite” replicate common interlocking cardiac-respiratory patterns in ¾ time. The bass drum and the symbol play a 4:1 [1001] pattern while the snare drum plays a 9:2 [110011001] pattern. When musically notated in ¾, every number in 4:1 equates to a quarter note or quarter rest and every number in 9:2 equates to an eighth note or eighth rest. The patterns are followed exactly with exception to 9:2 on the snare, of which the second ‘1’ is delayed an eighth rest every other cycle. This was done for groove purposes in fitting with the bass. Since
these patterns do not perfectly fit into one measure of ¾, different beats are emphasized each measure. The contrasting pulses of the time signature and the drum line may give the piece a “polyrhythmic” feel. In different sections, the piano is used to either enforce the 4:1 pattern or outline the time signature, switching between playing quarter notes and dotted half notes. The piece ends with the whole band playing the 4:1 pattern in unison as a way of centralizing this rhythmic theme.

The melodic phrases of the horns serve to regulate respiratory rate in consideration of cardiac-respiratory phase locking. It is normal for humans to have a resting heart rate of 60 to 85 bpm with the healthiest individuals being on the lower end. If the heart beats approximately four times every respiratory cycle, then, for the heart rate to settle at 60 bpm, one should breath fifteen times per minute. Heart rate can be quantitatively compared to musical tempo as both are measured in beats per minute (bpm). The tempo of “Opalite” is intended to be played at 135 bpm because, at this specific tempo, the melodic phrases time the respiratory rate of the horns to fifteen cycles per minute. Breathing fifteen times per minute means that each respiratory cycle is four seconds long. At 135 bpm, a four second respiratory cycle would occur over a nine beat period. In section A of “Opalite,” almost all of the horn lines are eight beats long, leaving one beat for the inspiratory phase of the cycle. This calculation in the melody is not guaranteed to modulate heart rate to 60 bpm for a few reasons including individual variability in respiratory sinus arrhythmia, difference in flow rate between normal breathing and wind playing, and the psychological effects of performance on heart rate. However, strategically timing the respiratory cycle of wind instrumentalists is a starting point in applying physiological rhythms to music composition.
“Vital” was composed with the intention of being used by the vocalist as a breathing exercise for alleviating asthma. As discussed in Section 3, breathing exercises have begun to be prescribed by pulmonary rehabilitation specialists as a treatment for non-severe respiratory disorders. Asthma patients can benefit from breathing exercises in relieving symptoms of an asthma attack such as constriction of the pulmonary alveoli, which inhibits expiration, and hyperinflation of the lungs, which strains the intercostal muscles. Breathing exercises prescribed for asthma patients target these symptoms by increasing vital capacity, strengthening the diaphragm, reducing movement of the intercostal muscles, and increasing the expiratory phase of respiration. These respiratory issues are similarly addressed in the breathing techniques of vocal pedagogy, making singing an effective prescription for non-severe asthma patients.

The nature of singing requires an increased expiratory duration to complete musical phrases and a change in respiratory muscle usage to support the vocal tone of these extended exhalations. When vocal teachers speak of “supporting” one’s singing voice, they are referring to a stronger contraction of the diaphragm, a respiratory muscle located around the stomach. Diaphragmatic support takes conscious effort because an equal inspiratory effort is usually provided by the intercostal muscles along the ribs. According to Bouhuys et al. (1966), many vocalists do make the effort to employ their diaphragm more than their intercostal muscles in order to control airflow at higher lung pressures. This breathing technique could be useful during an asthma attack when the intercostal muscles lose some functioning ability. Additionally, diaphragmatic support can improve expiratory functioning as needed to combat constriction of the pulmonary airways. In a study testing the effect of vocal training on asthma symptoms, Wade (2002) found that children with asthma had higher peak expiratory flow rates after completing
vocal exercises. An increase in flow rate indicates a greater utilization of vital capacity, the quantity of air that one is capable of exhaling after a single forced inhalation. Vocalists can expand their vital capacity, and thus improve lung functioning, by singing phrases requiring diaphragmatic support for prolonged expiration.

“Vital” aims to increase the vocalist’s vital capacity through calculated expiratory durations in the composed musical phrases. The piece was to be performed by a specific vocalist, whose vital capacity and functional residual capacity I was able to calculate using Baldwin et al.’s (1948) equation. Based on variables of sex, age, and body length, I estimated the vocalist’s vital capacity to be 3.36 liters. Functional residual capacity, the amount of air left in the lungs after a passive exhalation, is always about slightly less than half of vital capacity, in this case being 1.7 liters. Most of the phrases require the vocalist to expire more than her functional residual capacity but less than her full lung volume. This expiratory quantity thus pushes the bounds of the vocalist’s vital capacity while reserving enough air to support her vocal tone.

Variables such as dynamics, tempo, and vocal rhythm were set at specific values so that each phrase would expend the desired quantity of air. In order for the diaphragm to be contracted over a longer period of time, I chose to have the vocalist project at softer volumes requiring less expended air. According to Sundberg (1987), at a mezzo forte volume, vocalists exhale 0.2 liters of air per second. Singing mezzo forte for twelve seconds would thus expel 2.4 liters of air, which is about halfway between the vocalist’s vital capacity and functional residual capacity. The tempo was fixed at quarter note equals 50 bpm meaning that twelve seconds would pass by over ten quarter notes. Therefore, almost every vocal phrase is ten quarter notes in length so that each phrase, the vocalist is exhaling the ideal value of 2.4 liters to exceed the normal quantity of passive exhalation. Due to the very specific calculations behind this composition, the
performance of “Vital” would not necessarily have the same effect on those with different body types and respiratory conditions. Personal variables are always a factor in the effect of music performance on a given individual. The composition process of “Vital” can serve as an example for how music therapists can personalize their prescribed exercises.

Vital

Nina Hill
3/5/20

Voice

Tenor Trombone

Piano

Improvised piano intro
embellish chords, loose interpretation

AbΔ7
DbΔ7
AbΔ7
C7

DbΔ7
AbΔ7
DbΔ7
AbΔ7
Bb7
Eb7

AbΔ7
DbΔ7
AbΔ7
DbΔ7
Bb7
EbΔ7
AbΔ7
Conclusion

Musical experience is a psychophysical experience that deserves inquiry because our relationships with music impact our health and wellbeing. Our embodied perception of music holds a world of untapped knowledge. In writing this thesis, my hope was to learn about my own physical experience as a music performer as well as to spark a curiosity among readers in music’s psychophysical nature. Becoming conscious of our reactions to music beyond aesthetics, although this has its place in perception, can turn musical experiences into actively reflective practices that provide a therapeutic or medical function. This current work suggested a few methods for creating a health-oriented relationship with music, mainly geared toward the practices of wind instrumentalists and composers. Still, the embodiment of musical experience is an under-researched and incredibly broad topic that could be explored in a multitude of directions.

Further research could expand on the current discussion about aerophones by studying the morphology of a wider range of instruments. Every instrument has its own set of mechanics that exercise the body through a particular means of sound production. Additionally, the effects of playing an instrument varying depending on an individual’s physical condition. There is a definitive masculinity societally ascribed to brass playing that implies certain physical qualities and attitudes. As a small cisgender female trombonist, I know that it is possible for people of all genders and body types to excel at playing brass instruments. However, due to my naturally lower vital capacity, I surely have a different physical experience playing the trombone than my male peers. Almost no current studies on the pulmonary health of brass players account for

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1 See Baily (1977) for an analysis of the movement patterns of Herati dutar players in relation to the instrument’s morphology.
gender differences and, since most of the subjects are male, the results show a one-sided perspective. Studies on the kinesiology of music performance would be more informative if body type variables were factored in. These assessments can help composers to accommodate physical health by clarifying what their music will require of the human motor system.

It should be noted that, while attempting to broaden the definition of musicality, certain aspects of music perception were absent in this paper. Musicality was framed in terms of a developed sense of rhythm and tonality. My choice to limit the discussion to these two aspects was probably influenced by my own Western background, viewing rhythm and tonality as the primary components of music. This perceptual hierarchy is not unanimously held among all cultures though. In many Asian cultures, the forefront of musical aesthetics is timbre. Due to the time constrictions of this project, timbre was not included in the conversations on Western and African musical conceptions, although it is accounted for in these cultural approaches. Some African and African diasporic traditions will often change the original timbre of an instrument by adding interference to the sonic projection. The preference of Western classical musicians to leave tones pure and untampered is also, in its own way, a timbral choice. Timbre is just one example of a sonic quality that ethnomusicologists could explore in discussions about embodied musical aesthetics.

The list of possible directions in the study of musical embodiment could continue onward, which is exactly what makes it an exciting field of research. I was driven to spend a year researching rhythmic conceptions, motor musicality, aerophone respiration, and medical composing because the full reality of the topics is unknown. The present stage of music therapy is preliminary, with the potential to create innovative, holistic treatments in healthcare. The

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field’s advancement will be most productive if music therapy researchers draw from a wide source of information including ethnomusicology, psychology, and physiology. Music sparks the interconnectedness of our being and our research into its healing effects should inquire into every form of this embodiment.
Works Cited