Liberty University

School of Music

The Emotional, Physical, and Mental Effects of Physiological Entrainment and Heart Coherence in the Choral Ensemble

A Thesis Submitted to

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by

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Abstract

Despite endless studies on the benefits of music related to stress reduction and decreased anxiety, there is more in-depth research in the holistic health realm, which has yet to be applied, especially to music educators. Scientists have made groundbreaking discoveries in the last decade, proving that music can heal the nervous system; and guide one's body into a state of physical and emotional coherence. This study gathered existing research and applied it through the lens of the choral music educator. Guided by the founders of the HeartMath Institute and additional scientific pioneers, this mixed-method study identified methods of holistic health and therapeutic music that have not yet been explored and documented in the choral ensemble setting. This information was collected through scientific data and anonymous surveys. Investigations on heart coherence, sympathetic vibration, and physiological entrainment have emerged as themes in exploring existing literature and research. A short curriculum has been created with examples of incorporating these exercises or ideas in the choral ensemble setting. This work is essential due to the overwhelming amount of mental health distress, autoimmune disorders, and chronic health issues that plague the world today, especially in youth. If therapeutic music is viewed as a tool that alleviates stress and is an integral part of healing the mind and body, the possibilities are endless. If music can be a tool to treat and potentially cure these ailments, it will revolutionize the overall approach towards music education.

Keywords: human biofield, frequency, dissonance, resonance, entrainment, holistic, consciousness, coherence, sympathetic vibration, sound therapy

Dedication

Although my name is on this cover, many people in my life have helped contribute to its completion. This achievement is as much yours as it is mine.

To God for the gift of music and for Your unending grace and love.

To my family and close friends for your unwavering support in my pursuit of the arts and in my passion for music. To my cats Milton and Mabel for the extra snuggles.

To Kevin Kosiak, my high school choir teacher who inspired me to pursue music education, and to Dr. Valerie Errante, for transforming my idea of singing into what it is today.

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To the endless number of peers, colleagues, and fellow music educators whom I admire and take inspiration from daily. Your work does not go unnoticed and is so vital to humanity.

To the choir students at Alma College for taking part in the research and for so positively welcoming the concept of HeartMath into their daily rehearsals. Go Singing Scots!

To my past and present students and singers: You have made my life better every day because I have the honor to stand in front of you. You give me life and you are the true teachers. Thank you.

You always have something to sing about.

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Abbreviations

Heart-Focused (HF)

Socio-Emotional Learning (SEL)

Heart Rate Variability (HRV)

Institutional Review Board (IRB)

Chapter One: Introduction

Music has "an extraordinary ability to facilitate a relatively deep experience of attunement, an experience of profound connection with something outside or beyond oneself."[1] The relationship between music, emotions, and overall well-being has become a topic of great debate in recent decades. In a world filled with technology, overstimulation, and growing violence, students need to experience honest, positive, and fulfilling connections with others more than ever. The choral classroom is the perfect space to pursue these connections.

Background

Since the ancient time of Plato, musical practice was seen as a means "of mediating between a discordant everyday world and the harmonious order of the world of ideas and self-transcendence."[2] Today, as a society, we have lost much of this rationalization. If we shift our thinking to utilize all that music can offer beyond the notes on the page, we can continue to change students' lives, bringing more awareness to themselves and others through music.

Growing evidence suggests our consciousness goes far beyond the limitations of the brain and can affect the physical world surrounding us. This discovery was labeled in 1994 by the National Institute of Health as the "human biofield."[3] Consciousness is defined as "1) the state of

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[1] Wayne D. Bowman and Ana Lucia Frega ed., *The Oxford Handbook of Philosophy in Music Education* (New York: Oxford University Press, 2012), 139.

[2] Ibid.

[3] Eileen Day McKusick, *Tuning the Human Biofield: Healing with Vibrational Sound Therapy* (Vermont: Healing Arts Press, 2021), 108.

quality of awareness; 2) of being aware of an external object or something within oneself; 3) or having a sense of selfhood."[4]

For years, scientists viewed the body, brain, and heart as three separate entities that often worked together but were not considered connected.[5] Now, through recent research studies, scientists have discovered a significant connection, linking the mind and body in all parts of our lives. Consciousness emerges from the body and the brain acting together. Additionally, the heart is now recognized by scientists as "a highly complex system with its own functional 'brain'."[6]

In addition to the extensive neural communication network linking the heart with the brain and body, the heart communicates to the brain and throughout the entire body with its electromagnetic field. The heart is the most powerful source of electromagnetic energy in the human body, producing the largest rhythmic electromagnetic field of any of the body's organs.[7] This electromagnetic field produced by the heart is sixty times greater in amplitude than that of the brain and permeates every cell in the body.[8] Furthermore, the heart has a magnetic component around 5,000 times stronger than the brain's magnetic field and can be measured up to several feet away from the body.[9]

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[4] Helane Wahbeh, "Collective Consciousness and Our Sense of Interconnectedness," *Cardiology and Vascular Research* 5, no. 1 (2021): 1.

[5] Rollin McCraty, Raymond Trevor Bradley, and Dana Tomasino, "The Resonant Heart," *Shift: At the Frontiers of Consciousness* (February 2005): 15.

[6] Ibid.

[7] Rollin McCraty, *Science of the Heart: Exploring the Role of the Heart in Human Performance* (California: HeartMath Institute, 2015), 40.

[8] McCraty, Bradley, and Tomasino, "The Resonant Heart," 16.

[9] Ibid.

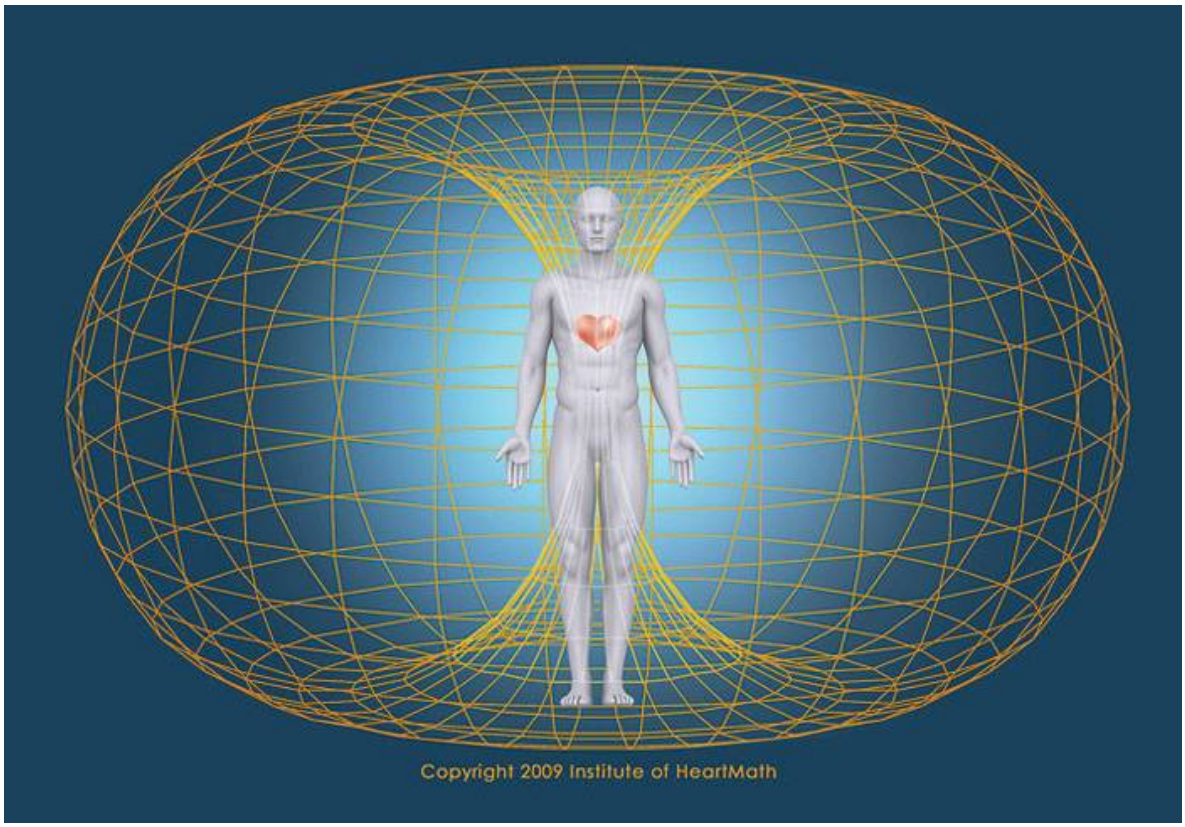

Figure 1.1 Visual Representation of the Heart's Electromagnetic Field[10]

The more humans are attuned to these subconscious energy fields, the more aware and interconnected they are which is noted to support positive psychological states, nurturing our relationships with ourselves and others. In a world filled with separation, divisiveness, prejudice and war, humanity would benefit from endorsing a worldview of interconnection. In the meantime, we can continue our scientific efforts to evaluate consciousness' role in the physical world."[11]

[10] McCraty, *Science of the Heart,* 50.

[11] Wahbeh, "Collective Consciousness and Our Sense of Interconnectedness," 1.

The HeartMath Institute is a non-profit institution founded by cardiologists, led by Doc Childre, in 1991. The scientists there are committed to researching the influence of the heart as its own entity, as well as investigating the heart's relationship to other body systems and the possibility of overall global heart coherence. The HeartMath Institute provides research and development of scientifically based tools that "bridge the connection between heart and mind and deepen people's connection with the hearts of others."[12]

Research at the HeartMath Institute shows that information pertaining to a person's emotional state is communicated through the body via the heart's electromagnetic field.[13] Negative emotions, such as frustration or anger, create an erratic, incoherent pattern in the heart rhythms or waves. These inconsistent patterns create desynchronization in the reciprocal action between the parasympathetic and sympathetic branches of the autonomic nervous system.[14] When the two branches of the autonomic nervous system are out of sync, it is like driving a car with one foot on the accelerator (the sympathetic nervous system) and the other on the brake (the parasympathetic nervous system) at the same time. The result can be emotional incoherence, increased energy drain, and added wear and tear on the body.[15]

In contrast, positive emotions, like love and gratitude, are associated with smoother, coherent patterns in the heart (see Figure 1.2).[16] When positive, calming emotions are sustained in someone, it allows them to enter a state of psychophysiological coherence. During this mode,

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[12] HeartMath Institute, Accessed February 12, 2024, https://www.heartmath.org.

[13] McCraty, Bradley, and Tomasino, "The Resonant Heart," 15.

[14] Lourdes Arguelles, Rollin McCraty, and Robert A. Rees, "The Heart in Holistic Education," *Encounter: Education for Meaning and Social Justice* 16, no. 3 (Autumn 2003): 15.

[15] Ibid.

[16] Ibid.

the body is in harmony with itself and the interactions of the surrounding bodily systems. Psychologically, this mode is "linked with a notable reduction in internal mental dialogue, reduced perceptions of stress, increased emotional balance, and enhanced mental clarity, intuitive discernment, and cognitive performance."[17]

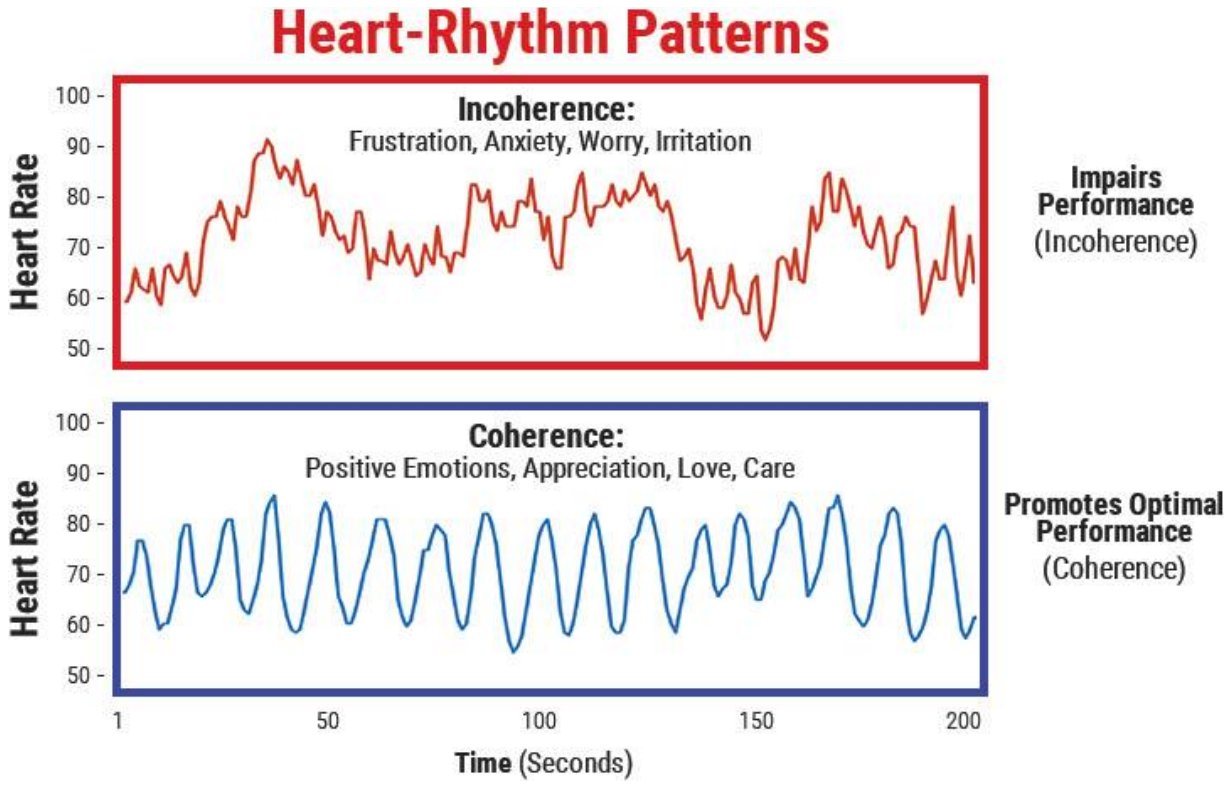

Figure 1.2 Incoherence and Coherence in Heart-Rhythm Patterns[18]

In a 2015 study, the renowned composer Eric Whitacre and his professional choir teamed up with the Centre for Performance Science (a partnership of the Royal College of Music and Imperial College London) prior to a public concert at Union Chapel concert venue in London.

[17] McCraty, Bradley, and Tomasino, "The Resonant Heart," 16.

[18] McCraty, *Science of the Heart,* 38.

The day before the concert, the singers took part in a low-stress rehearsal, before and after which they filled out anxiety rating surveys and provided a saliva sample. The following day, the singers sang the same music in a high-stress performance to 700 people at Union Chapel, completing the same data collection before and after the performance. The study found that during the low-stress rehearsal, there was a decrease in levels of stress hormones in saliva.[19] However, during the high-stress concert, there was a significant increase in both hormones. This finding that the same music is sung in two psychologically different contexts (high-stress and low-stress) and produces different biological responses, supports the importance of considering the mind in studies on music and biology in music education.[20]

The musical classroom is a unique space where students must feel safe enough to be vulnerable with their instrument and their music-making. Our consciousness "of place – of where (and when) we are – shapes both body and performance in various ways."[21] Educator David Gruenewald advocates that the music classroom should attempt to embrace the human experience in connection with others and with the word of nature.[22] If we could utilize these holistic exercises and entrainment to create a more well-connected, socio-musical space for our singers, what might that look like?

Because of the influence of the heart's electromagnetic field, there is now evidence that the heart's field can transmit energy and information between individuals up to five feet apart.[23]

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[19] Penelope Gouk, James Kennaway, Jacomien Prins, and Wiebke Thormahlen, eds., *The Routledge Companion to Music, Mind, and Well-Being* (New York: Taylor & Francis, 2019), 185.

[20] Ibid.

[21] Bowman and Frega ed., *The Oxford Handbook of Philosophy in Music Education,* 438.

[22] Ibid.

[23] McCraty, Bradley, and Tomasino, "The Resonant Heart," 16.

In a choral ensemble, students often stand within a foot of each other; imagine the amount of energy that is being transmitted without any words being spoken! The nervous system of each student acts as an "antenna," which is tuned to and responds to the electromagnetic field produced by the hearts of other surrounding people. HeartMath researchers have observed that this energetic communication between individuals can be intentionally enhanced, producing a much deeper level of nonverbal communication, understanding, and connection between people.[24]

The idea of social coherence and entrainment to others in the choral ensemble suggests harmonious relationships that facilitate efficient energy communication, cohesion, and synchronization.[25] Particularly in the early stages of psychological and emotional development, the influence of other people has been identified as a critical component in providing necessary extrinsic motivation for a child to continue with music.[26] It would be beneficial to understand, as a larger society as well as within one's own smaller circles, and more specifically within our musical ensembles, that we do have a significant effect on those around us, even with just our thoughts. It is essential to know that "the energetic interactions between people are likely to be influenced by the qualitative aspects of our thoughts and emotions."[27]

Through the formation of stronger emotional connections, teachers will be able to connect with students on a deeper level, resulting in an overall better classroom environment. A study conducted in the mid-1990's in the Chicago Public School system showed that schools

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[24] McCraty, Bradley, and Tomasino, "The Resonant Heart," 18.

[25] Steven M. Morris, "Achieving Collective Coherence: Group Effects on Heart Rate Variability Coherence and Heart Rate Synchronization," *Alternative Therapies* 16, no. 4 (July/Aug 2010): 72.

[26] Gouk, et. al., *The Routledge Companion to Music, Mind, and Well-Being*, 198.

[27] Morris, "Achieving Collective Coherence," 72.

with a high degree of relational trust saw improvements in classroom instruction, curriculum, teacher preparation, and professional development.[28]A 2001 study by Persson, a renowned scientist in music and emotions, found social motives and the importance of belonging to be the second most influential factor in motivating pianists to continue playing.[29]

These powerful social motives for musical engagement have been studied by Faulkner and Davidson in the choral ensemble as well, showing that members of a choir feel that singing plays an important role in connecting with other people (family, friends and wider social groups) as well as communicating to others.[30] Because of this interconnected consciousness and potential for coherence among ensemble members, these holistic-based ideas can be easily applied to the choral education classroom and beyond.

Although no studies have yet been directly applied to the choral education classroom, hospitals implementing HeartMath programs have seen "an increased personal, team, and organization functioning, as well as significant decreases in anxiety, depression, and anger."[31] This study investigates whether incorporating these simple HeartMath exercises and ideas into the choral classroom would have a similar effect. According to HeartMath specialists, the benefits of these activities are endless:

> From a psychophysiological perspective, coherence interconnects positive emotions with the cardiovascular, respiratory, immune, and nervous systems. From a human as well as a social perspective, coherence applies to couples, teams, groups, organizations, and communities. Coherent relationships promote

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[28] Parker J. Palmer, "Teaching with Heart and Soul: Reflections on Spirituality in Teacher Education," *Journal of Teacher Education* 54, no. 5 (November/December 2003): 384.

[29] Gouk, et. al., *The Routledge Companion to Music, Mind, and Well-Being*, 198.

[30] Ibid.

[31] Stephen D. Edwards, David J. Edwards, and Richard Honeycutt, "HeartMath as an Integrative, Personal, Social, and Global Healthcare System," *Healthcare* 10 (2022): 379.

> communication, synchronized behavior in rowing teams, and groups with similar goals. From a global perspective, communities and countries working cooperatively can cause ecological and planetary peace and harmony. Experientially, HeartMath praxis is accompanied by the sentient, increasing awareness of the synchronization of pulsation, respiration, and the renewing of positive feelings, whereby emotions such as peace and love are cumulatively experienced as radiating throughout the body, and among people and the wider world in harmonious interconnectedness.[32]

Because the heart is a primary generator of rhythmic patterns in the body,[33] it provides an access point from which emotional and physiological changes can be made system-wide in a simple, low-cost way.

In a study conducted by the HeartMath Institute, findings showed that with the implementation of HeartMath exercises geared towards students with test anxiety in several high schools, two things occurred: 1) significant reductions in test anxiety were shown, which, in turn, improved students' overall academic and test performance; 2) students developed their emotional self-regulation skills, which improved stress management, emotional stability, relationships, classroom climate, and overall classroom function and organization.[34] One of the main concepts used in this research study is Heart-Focused (HF) breathing. HF breathing is a type of mindfulness exercise involving a shift in attentional focus to the breath and heart with a self-induction of positive feelings and gratitude.[35]

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[32] Edwards, Edwards, Honeycutt, "HeartMath as an Integrative, Personal, Social, and Global Healthcare System," 381.

[33] Arguelles, McCraty, and Rees, "The Heart in Holistic Education," 16.

[34] McCraty, *Science of the Heart,* 67.

[35] Carolyn McLeod and Mike Boyes, "The Effectiveness of Socio-Emotional Learning Strategies and Mindful Breathing with Biofeedback on the Reduction of Adolescent Test Anxiety," *Canadian Journal of Education* 44, no. 3 (2021): 821.

There is also a potential for the use of "tuning" the energetic biofield surrounding our bodies by utilizing more holistic tone sound therapy tools such as singing bowls, tuning forks, gongs, and chanting.[36] Researchers have proven that the constant noise of our daily lives, often of which we do not even consciously notice, can have a level of stress on our bodies that create tension, imbalance, low energy, and eventually may lead to chronic illnesses.[37] In a 2015 study by Colombia University, primary cilium, the antenna-like structures on our cell membranes, were discovered; these receive and respond to vibrational energy fields, like sound.[38] These cilia "quiver like a tuning fork, and if a vibration in the environment resonates with the receptor's antennae, it alters the proteins' charges, causing the cell to change shape."[39]

Humans are "constantly beaten down by the chaos that surrounds us as our bodies struggle to retain the inner harmony dictated by our 'factory settings,' our prime frequencies."[40] A variety of sound therapies can use audible vibrations to bring the body back into harmony and achieve its 'prime resonance' to restore health.[41] Because music has no particular need for cognitive assistance to be efficacious, sound therapy is one of the most efficient, practical, non-invasive, non-chemical, non-pharmaceutical applications for addressing these issues.[42] By

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[36] McKusick, *Tuning the Human Biofield,* 76.

[37] Kulreet Chaudhary, *Sound Medicine: How to Use the Ancient Science of Sound to Heal the Body and Mind* (New York: Harper Collins, 2020), 33.

[38] Ibid.

[39] Ibid.

[40] McKusick, *Tuning the Human Biofield,* 39.

[41] Chaudhary, *Sound Medicine,* 36.

[42] Daniel J. Schneck and Dorita S. Berger, *The Music Effect: Music Physiology and Clinical Applications* (Philadelphia: Jessica Kinsley Publishers, 2005), 135.

incorporating the straightforward concepts of heart coherence activities, i.e., heart-focused breathing, into the daily choral rehearsal, our students' mental health and overall stress levels will be positively affected.

Statement of the Problem

Mental health issues are becoming overwhelming, especially in young adults today. In the past decade, there has been a significant rise in depression, anxiety, discipline issues, and the ability to regulate one's own emotions.[43] A study of first-year college students found that moderate-severe anxiety increased by 39.8 percent and moderate-severe depression increased by 47.9 percent since July 2020, near the start of the COVID-19 pandemic.[44] Additionally, students' inability to regulate their own emotions is affecting the connection, focus, and drive they have in the music education classroom. Students today often become overwhelmed or anxious. This can cause them to lash out or shut down emotionally.

Today, students are finding less comfort and security at school, where they often fear becoming victims of violence. These extreme episodes of violence in schools have recently raised public awareness of students' deteriorating emotional health and underscore the need for more effective solutions to help solve these issues.[45] Little emphasis has been placed on educating children to manage their own emotions. The ability to effectively communicate, resolve conflicts, and have good interpersonal skills is essential for children to develop a positive sense of self and to deal with the many stressors they face in life.

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[43] McCraty, *Science of the Heart,* 11.

[44] Janet N. Zadina, "The Synergy Zone: Connecting the Mind, Brain, and Heart for the Ideal Classroom Learning Environment," *Brain Sciences* 13 (2023): 2.

[45] McCraty, *Science of the Heart,* 66.

Significant, groundbreaking research has been discovered in the last decade which scientifically proves that music can heal the sympathetic and parasympathetic nervous system, as well as guide one's body into a state of physical and emotional coherence, utilizing tools that enhance heart coherence, sympathetic vibration, and physiological entrainment.[46] Multiple studies have proven that music exposure and experience improves emotional awareness and helps children more accurately identify and manage their emotional states.[47] Despite endless research on the benefits of music as it relates to overall stress reduction and decreased anxiety, there is much more in-depth research in the holistic health realm, which has yet to be applied to the field of music education. Existing literature only focuses on heart coherence in the general educational classroom environment. Much of the current literature focuses solely on the individual student instead of also incorporating the elements of group dynamics, shifting the perspective of viewing the students as a collective whole.

The researcher gathered this initial research and applied it through the lens of the choral music educator. Additionally, original data pertaining to this scientific focus was collected via Likert surveys, individual interviews, and in heart rate variability data utilizing the Inner Balance Coherence Sensor developed by the HeartMath Institute.[48] This sensor can track heart rate variability and heart coherence levels during live sessions of heart coherence and sound therapy activities. Using the student feedback and classroom data, the researcher found ways to impact the classroom culture, creating a deeper sense of community within the choral ensemble, as well as positively impacting the stress level of the students.

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[46] McCraty, Bradley, and Tomasino, "The Resonant Heart," 16.

[47] Eric Jensen, *Arts with the Brain in Mind* (Virginia: ASCD Publications, 2001), 31.

[48] "Inner Balance Coherence Sensor," HeartMath Institute, Accessed June 27, 2023, https://www.heartmath.org/store/products/inner-balance/.

Statement of the Purpose

The purpose of this convergent mixed methods, pragmatic, postpositivist study was to address the gap in the literature on incorporating HeartMath exercises into the choral ensemble. Programs implementing HeartMath tools have been introduced at the elementary, middle school, high school, college, and graduate levels across the United States and shown to improve emotional well-being, classroom behaviors, learning, and academic performance.[49]

This study aims to discover the ways these HeartMath exercises affect students' heart rate variability, physiological coherence, anxiety or stress levels, their focus, and their connection to others in the choral ensemble. According to researchers John and David Creswell, "collecting diverse types of data best provides a more complete understanding of a research problem than either quantitative or qualitative data alone."[50]

Although this study was conducted with a collegiate-level choral ensemble, findings from this study can be applied to all levels of choral ensembles, as well as instrumental ensembles who want to incorporate some vocal warmups that also enhance breathing techniques and elevate focus in the music classroom. Music educators and school administrators can apply information from this study to highlight the importance of music, advocating for the music programs in their school. This study could also lead to future research on the benefits of holistic health in the music education classroom setting.

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[49] Rollin McCraty, "Enhancing Emotional, Social, and Academic Learning with Heart Rhythm Coherence Feedback," *Biofeedback* (Winter 2005): 132.

[50] John W. Creswell and J. David Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (California: Sage Publications, 2018), 17.

Significance of the Study

Despite a vast amount of research conducted on the increased level of stress students encounter daily, little has been done to research holistically derived ways to improve this problem in the music education system today. Most research has viewed stress through the lens of the physiological responses of the body; however, hardly any attention has been paid to the role of the emotional system in the stress response.[51] There is recent significant research proving that the human heart is much more than a pump sustaining our life forces; it is proven that the heart affects mental clarity, creativity, emotional balance, intuition, and personal effectiveness.[52]

Historically, scientists have focused on the communication between the head and heart from a one-sided perspective; however, recent studies have discovered that the communication between the heart and brain actually is a dynamic, ongoing, two-way dialogue, with each organ continuously influencing the other's function.[53] The "heart-brain," as it is commonly called, is an "intricate network of complex ganglia, neurotransmitters, proteins and support cells, the same as those of the brain in the head."[54] This provides the ability for the heart to act independently of the cranial brain, giving it the potential to learn, remember, make decisions, and even feel or sense.[55]

Teachers have acknowledged in various interviews that their students came to school emotionally unprepared to learn, but the teachers felt their own educational training did not equip

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[51] Rollin McCraty and Dana Tomasino, "Emotional Stress, Positive Emotions, Psychophysiological Coherence" from *Stress in Health and Disease* (California: HeartMath Institute, 2006): 3.

[52] McCraty, *Science of the Heart,* 1.

[53] Ibid., 3.

[54] Ibid., 5.

[55] Ibid., 1.

them with the requisite skills to effectively manage their personal stress or to help their students manage their stress.[56] A 1993 study conducted by the HeartMath Institute showed that middle school students enrolled in a HeartMath self-management skills course "exhibited significant improvements in areas including stress and management, risky behavior, work management and focus, and relationships with teachers, family, and peers."[57] Being able to integrate easy methods for emotional management into the daily choral classroom with the HeartMath tools would not only benefit the teachers and their students, but the overall regulation and effectiveness of the performance ensemble.

When individuals are not emotionally self-regulated, it can cause social incoherence. The HeartMath coherence tools will not only improve the emotional regulation of individuals but will also help maintain a sense of social coherence within the group setting, which could be very beneficial in the music education classroom. Social and group coherence is "reflected as a stable, harmonious alignment of relationships that allows for the efficient flow and utilization of energy and communication required for optimal collective cohesion and action."[58] With these tools in place, there is freedom for individuals to thrive while maintaining cohesion and resonance within the larger ensemble's goals.

Research Question and Sub Questions

Western physicians are now beginning to accept and implement scientific developments regarding heart coherence, sympathetic vibration, and physiological entrainment as legitimate,

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[56] McCraty, *Science of the Heart,* 72.

[57] Rollin McCraty, Mike Atkinson, Dana Tomasino, Jeff Goelitz, and Harvey N. Mayrovitz, "The Impact of an Emotional Self-Management Skills Course on Psychosocial Functioning and Autonomic Recovery to Stress in Middle School Children," *Integrative Physiological and Behavioral Science* 34, no. 4: 246.

[58] McCraty, *Science of the Heart,* 81.

science-based evidence.[59] However, there is little research on how these concepts can be applied to the music classroom, specifically in the choral ensemble. To examine the effects of these ideas in the choral classroom, this study will seek to answer the following research questions:

Research Question One: What are the scientific indications, as monitored by heart rate variability biosensors, that physical, emotional, and mental health are affected through heart coherence and physiological entrainment when incorporating HeartMath exercises into the daily choral rehearsal?

Research Question Two: What are the benefits of shifting focus from a traditional mindset of the choral rehearsal toward one that embraces the possibility of sympathetic vibrations in a choral music education setting?

Research Question One could be addressed with the following hypothesis:

Hypothesis One: Scientific indications that physical, emotional, and mental health are affected through heart coherence and physiological entrainment include lowered stress, anxiety, and depression, enhanced mental clarity and cognition, increased emotional regulation, and a more well-balanced nervous system and bodily organ functioning.

Research Question Two could be addressed with the following hypothesis:

Hypothesis Two: Benefits of shifting focus from a traditional mindset of the choral rehearsal toward one that embraces the possibility of sympathetic vibrations in a choral music education setting include improved sense of community within the choral ensemble, acceptance and positivity towards oneself, and overall lowered stress level in the choral classroom.

[59] McCraty, *Science of the Heart,* 11.

Definition of Terms

Human Biofield- Initially defined in 1994 by the National Institute of Health as "the field of energy and information that surrounds the human body."[60] Often referred to now by biophysicists as "nature's original wireless communication system."[61]

Frequency- The number of vibrations within a particular amount of time. Each organ and system in our body resonates at a particular frequency. In this way, "the human body is like a symphony with many instruments; ideally, everything is in tune and in harmony, but stressors can cause different parts of our being to lose their coherent frequency."[62]

Dissonance- Tension or clashing of two disharmonious elements; lack of harmony.[63]

Resonance- Comes from the Latin word *resonantia,* meaning "echo."[64] Resonance occurs when one object vibrates at the same natural frequency as a second object.

Entrainment- A shared tendency between physical and biological systems to coordinate their rhythms.[65] Entrainment music therapy is "any stimuli that matches or models the current mood or state of the individual and then moves the person in the direction of a more positive or pleasant mood."[66]

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[60] McKusick, *Tuning the Human Biofield,* 108.

[61] Chaudhary, *Sound Medicine,* 69.

[62] McKusick, *Tuning the Human Biofield,* 30.

[63] John R. Pierce, *The Science of Musical Sound* (New York: W.H. Freeman and Company, 1992), 76.

[64] Chaudhary, *Sound Medicine,* 35.

[65] Ibid., 37.

[66] McKusick, *Tuning the Human Biofield,* 74.

Holistic- Treatment of the "whole" person, considering the body, mind and spiritual components of a person in addition to the physical elements.[67]

Consciousness- The state of being aware. The thoughts and feelings, collectively, of an individual or of a group of people.[68]

Coherence- Logically or aesthetically ordered or integrated; consistent. Having the quality of holding together and being cohesive.[69] A coherent frequency is "one that is ordered, consistent, clear, and in phase (meaning operating at the same frequency); an incoherent frequency is disordered, not clear, and out of phase.[70]

Sympathetic Vibration- The natural ability of a substance, such as living flesh and bone, to vibrate to a frequency imposed from another source. A harmonic phenomenon where a passive string or vibratory body responds to external vibrations to which it has a harmonic likeness.[71]

Sound Therapy- Using the principles of resonance, entrainment, and vibration to effect changes in tissues and organs, usually neurologically oriented.[72]

Summary

Communicating and recognizing emotions are key to social relationships and survival. Music is a means through which this skill can be honed; music transforms feelings into an

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[67] Larry Trivieri Jr., *Health on the Edge: Visionary Views of Healing in the New Millenium* (New York: Penguin, 2003), 6.

[68] Ibid., 20.

[69] McKusick, *Tuning the Human Biofield,* 37.

[70] Ibid.

[71] Joshua Leeds, *The Power of Sound: How to be Healthy and Productive Using Music and Sound* (Vermont: Healing Arts Press, 2010), 267.

[72] Ibid., 266.

"audible landscape."[73] The start of the twenty-first century marked a shift in studying music and emotions in the scientific community. The educational role of music has come into the spotlight, and in addition to the impact of music on the development of general skills, music's social, emotional, and physical effects on the body are also being researched.[74]

Due to this recent research, it is imperative that we delve into the importance of the heart as it relates to teaching and learning. By learning self-regulation tools provided by the HeartMath Research Institute and incorporating them into the school classroom, students can shift their physiology into a more coherent state, with "increased physiological efficiency and alignment of the mental and emotional systems…across all four energy states:" physical, emotional, mental, and spiritual.[75]

Because scientists have viewed this brain-heart connection as separate for many years, the field of education has also evolved to favor logic and intellect over emotions and the heart.[76] With a deeper understanding of how the heart relates to the entire bodily system, teachers and school staff can gain rich knowledge on how to be more effective in their implementation of this type of training. If schools can tap into the emotional and spiritual element of students' beings, as well as their intellectual side, then an understanding of those implications might prove useful to students, teachers, or administrators.

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[73] Judit Varadi, "A Review of the Literature on the Relationship of Music Education to the Development of Socio-Emotional Learning," *SAGE Open* (January-March 2022): 6.

[74] Ibid., 1.

[75] McCraty, *Science of the Heart,* 9.

[76] Parker J. Palmer, *The Courage to Teach: Exploring the Inner Landscape of a Teacher's Life* (California: Jossey-Bass, 1998), 22.

Despite the cultural bias that all power resides in the "outward, visible world, history offers ample evidence that the inward and invisible powers of the human spirit can have at least equal impact on our individual and collective lives."[77] We currently provide our educators with pedagogical tools and discipline-specific techniques; however, teachers lack the training to assist our students becoming well-rounded, emotionally-sound individuals.[78] Rather than solving these issues with more technology or high-stakes testing, we should be pursuing the power of the human heart and the whole self.

The purpose of this research was to shed further light on the positive effects that holistic, emotion-focused HeartMath coherence exercises can have in the choral classroom. Using convergent mixed methods analysis gathered through scientific data and reliable and valid surveys and interviews, a shift in the scope of education regarding the implementation of more holistic ideas was validated in the choral ensemble setting. Through the collected data and research, new perspectives on the ideas of heart coherence and physiological entrainment were gleaned; through this, a short curriculum was written by the researcher to support these ideas and help incorporate them into the choral classroom.

[77] Palmer, "Teaching with Heart and Soul," 377.

[78] Ibid.

Chapter Two: Literature Review

Introduction

Mental health issues are on the rise. Since 1978, assaults on teachers have increased by 700% and the rate at which teenagers commit suicide has tripled.[1] Additionally, students are unable to self-regulate their own emotions, resulting in increased anxiety, depression, hostility, burnout, or erratic behavior in the school system. These issues are part of a larger systemic deficiency facing many schools in the United States' educational system. Namely, the lack of a healthy social and emotional environment that optimizes the growth and performance of all individuals in the school system. How can we create an ideal atmosphere in which students are connected while also recognizing their individual roles as part of this greater whole? How can we continue to foster a compassionate, whole-person education lens while improving academic experiences?

This literature review will explore topics pertinent to the study, reviewing the studies already completed that correlate closely, as well as gaps in the scientific research. To better focus the research, the following topics will be discussed: sound medicine, physiological coherence, social coherence, heart coherence in the classroom, and emotional self-regulation.

Sound Medicine

The idea of using external frequencies to restore internal rhythms has been around for centuries. It has been passed on throughout many cultures, including ancient Egyptians, Tibetan monks, and Native American shamans.[2] These groups utilized songs, chants, and instruments to

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[1] McCraty, *Science of the Heart,* 67.

[2] Chaudhary, *Sound Medicine*, 34.

instinctively understand what scientists later proved: that there is a direct relationship between environmental sound and our physiological health. Many contemporary researchers, notably John Stuart Reid, have performed extensive research on the healing sound created within the King's Chamber in the Egyptian Great Pyramid at Giza. Reid discovered that specific vowel sounds, when sung, create cymatic images that match ancient Egyptian hieroglyphs.[3]

The emerging field of soundwork or sound therapy, which is different than music therapy, is based on the theory of vibration: how frequency resonates and affects our nervous system. Soundwork is neurological in nature, working with vibrations "to create a charge in the brain and nervous system."[4] Since sound waves vibrate our entire body, we essentially "hear" with our whole selves. The tenth cranial nerve, or vagus nerve, is often nicknamed the superhighway of the body. It attaches to both sides of the eardrum before traveling down the torso and attaching to every organ, except for the spleen. Every sound that we hear affects – to whatever degree – the organs of the body through this nerve.[5]

Many contemporary scientists and researchers believe the quality of feeling and emotion is rooted in physiological processes. Recent expression of this view is expounded by neuroscientist Antonio Damasio:

> The fact that we, sentient and sophisticated creatures, call certain feelings positive and other feelings negative is directly related to the fluidity or strain of the life process. The feelings we experience as 'negative' are indicative of body states in which life processes struggle for balance and can even be chaotically out of control. In contrast, the feelings we experience as 'positive' actually reflect body

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[3] Carol Flicka Rahn and Tammy McCrary, *The Transformational Power of Sound and Music: A Handbook for Sound Healers and Musicians* (United States: Life in 432 Publishing, 2018), 18.

[4] Leeds, *The Power of Sound,* 29.

[5] Ibid., 38.

> states in which the regulation of life processes becomes efficient or even optimal, free-flowing, and easy.[6]

It is predicted that "up to 60-80% of visits to the doctor are stress-related including physical health complaints such as high blood pressure, cardiovascular disease, back pain, digestive problems, poor sleep and metabolic syndrome."[7] One recent approach to stress management is positive psychology. A positive psychology approach underlies the HeartMath system of self-regulation techniques used in stress management.[8] After the implementation of HeartMath exercises, therapists, clinicians, and other health care practitioners report seeing improvement in perception, self-regulation, and behavior in clients with acute, chronic, and recurrent pain, psychophysiological problems, learning and performance issues, and chronic illness.[9]

In 2008, Dr. Ronny Enk at the Max Planck Institute led a study that had three hundred people listen to dance music for fifty minutes. During that time, their levels of the stress hormone cortisol decreased, and their levels of antibodies increased, strengthening their immune system.[10] A 2009 review of twenty-three music-based studies covering almost 1,500 patients found that listening to music reduced heart rate, blood pressure, and anxiety in heart disease patients.

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[6] Timothy Culbert, *HeartMath Clinical Certification for Stress, Anxiety, and Emotional Regulation* (California: HeartMath Institute, 2019), 3.

[7] Lucy H. Field, Stephen D. Edwards, David J. Edwards, and Sarah E. Dean, "Influence of HeartMath Training Programme on Physiological and Psychological Variables," *Global Journal of Health Science* 10, no. 2 (2018): 126.

[8] Ibid.

[9] Culbert, *HeartMath Clinical Certification for Stress, Anxiety, and Emotional Regulation*, 3.

[10] Chaudhary, *Sound Medicine,* 40.

Similarly, Chaudhary's 2015 research at Stanford showed that music engages areas of the brain involved with focus and updating events in our memory.[11]

Mark Rider, Ph.D., a research psychologist affiliated with Southern Methodist University, has conducted the largest series of studies to date on the powerful positive influence of music on the protective cells of the immune system, which fight invading pathogens and regenerate injured tissues.[12] A study by the HeartMath Institute called "Music Enhances the Effect of Positive Emotional States on Salivary IgA" showed that:

> Music can be designed to enhance the beneficial effects of positive emotional states on immunity, and that this effect may be mediated by the autonomic nervous system. This data raises the tantalizing possibility that music and emotional self-management may have significant health benefits in a variety of clinical situations in which there is immunosuppression and autonomic imbalance.[13]

The neural networks underlying emotion, motivation, and learning intertwine, which stems from evolution when threats to our well-being often mean life or death. A stressful situation can hinder learning, as emotions are heightened, and the fight-or-flight response is often triggered. Neurotransmitters in the brain block the uptake of new information and learning during negative stress.[14] In recent research from the Shamatha Project at the University of California, researchers found that focusing on the present through various forms of meditation, including heart-centered breathing, lowers the levels of the stress hormone, cortisol.[15] This is the

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[11] Chaudhary, *Sound Medicine,* 40.

[12] Mitchell L. Gaynor, *The Healing Power of Sound: Recovery from Life-Threatening Illness Using Sound, Voice, and Music* (Massachusetts: Shambhala Publications Inc., 1999), 18.

[13] Rahn and McCrary, *The Transformational Power of Sound and Music,* 83.

[14] Sharon J. Paul, *Art and Science in the Choral Rehearsal* (New York: Oxford University Press, 2020), 73.

[15] Rahn and McCrary, *The Transformational Power of Sound and Music*, 91.

first study to show a direct relation between resting cortisol and scores on any type of mindfulness scale.

Sound medicine is based primarily on the concept of vibrations and frequency. Since thoughts are also vibrations, there have been many recent studies on how thoughts – both positive and negative – can affect one's physical body, as well as those around them. In a 2003 study, "Modulation of DNA Conformation by Heart-Focused Intention," participants were asked to direct intentional, heart-centered, loving thoughts to samples of genetic material that they were holding in containers. The participants were able to unwind the DNA double-helix spiral, which is a necessary precursor to replication, thus altering the confirmation of the cell's DNA.[16] In many cases of this experiment, the DNA showed that the protein strands had healed completely; the bases had reconnected, and the double-helix form was present. Doc Childre, founder of HeartMath Institute, has postulated that "an energetic connection or coupling of information" took place between the participant and the DNA cells.[17] Therefore, it can be concluded that when an individual is in a state of loving compassion, there is a direct flow from that individual to another person, which can influence the systems, cellular structure, and health of the second person, proving physiological coherence is possible.

Physiological Coherence

Group dynamics are a critical element of a successful learning environment, especially in a music ensemble. The ability to sense what other people are feeling is an important factor in allowing effective connection and communication with others. Most research, however, has only

[16] Rollin McCraty, Mike Atkinson, and Dana Tomasino, "Modulation of DNA Conformation by Heart-Focused Intention" (California: HeartMath Institute, 2003): 3.

[17] Ibid.

studied learning at the individual level. Physiological coherence, or synchrony, occurs when the physiological measurements between groups are similar. This can also be known as sympathetic vibration or entrainment. The seventeenth-century Dutch scientist Christian Huygens noticed that the pendulums of two clocks, hung side by side, would begin of their own accord to swing to the same rhythm. We human beings also react in resonance with the vibrations and fluctuations in our surroundings, so it follows that the impact of sound waves may alter our physiological functioning.[18]

Synchrony enhances learning, as revealed in measurements of communication, comprehension, and memory formation and retention.[19] Students whose brains synchronized more closely to the brains of classmates and instructors learned better than those without the synchrony; this also improved the overall emotional climate of the classroom.[20]

A study led by F. Homes Atwater, a scientific investigator and behavioral engineer, poses three basic rules of the physics of entrainment:

1. *The resonance rule*: For one system to entrain another, the second system must be capable of achieving the same vibratory rate. In other words, a human being could not entrain with a rock, but he/she would entrain with another person.
2. *The power rule*: For one system to entrain with another, the first must have sufficient power to overcome the second. Therefore, proximity is an important consideration.
3. *The consistency rule*: For one system to be capable of entraining to another, the first must be at a constant frequency or amplitude. This is where periodicity comes into play: rhythms must be constant and regular.[21]

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[18] Gaynor, *The Healing Power of Sound*, 49.

[19] Zadina, "The Synergy Zone," 7.

[20] Ibid., 8.

[21] Leeds, *The Power of Sound*, 43.

Utilizing the physics of entrainment, a study conducted by Atkinson and Tomasino found that the electromagnetic waves generated by one person's heart synchronize with the brain of the other person using heart-brain magnetic fields.[22] Another study depicted in the movie *The Incredible Machine* as described by the scientist: "Two individual muscle cells from the heart are seen through a microscope. Each is pulsing with its own separate rhythm. Then they move closer together. Even before they touch, there is a sudden shift in the rhythm, and they are pulsing together, perfectly synchronized."[23]

Research conducted by Tsakiris, Schutz-Bosbach, and Gallagher in 2007 argues that both senses - owning a body and acting as a body - are pre-reflexive experiences emanating from sensory-motor processes. The experience of a coherent, unified body is created by the integration of multiple efferent and afferent signals during action.[24] Efferent signals, which contribute to self-agency, allow for the integration and coherence of the experience, whereas afferent signals generate the content of the body's experience. In a broad summary, the sense of self is built from multiple elements. The pre-reflexive state of body awareness carries both the recognition of self and the recognition of others, as well as the resemblance of the two, which correlates with coherence within one's own body and social coherence with others.[25]

A person in consistent physiological coherence has been proven to show increased efficiency in fluid exchange and filtration throughout the tissues, increased ability of the cardiovascular system to adapt to circulatory demands and increased temporal synchronization of

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[22] McCraty, et. al., "The Impact of an Emotional Self-Management Skills Course," 247.

[23] Gaynor, *The Healing Power of Sound*, 68.

[24] Manos Tsakiris, Simone Schutz-Bosbach, and Shaun Gallagher, "On agency and body-ownership: Phenomenological and neurocognitive reflections," *Consciousness and Cognition* 16, no. 3 (September 2007): 655.

[25] Ibid.

the cells in the body.[26] This results in increased system-wide energy efficiency and metabolic energy, improved immunity, and increased longevity. Several recent studies conducted in diverse populations have documented significant reductions in stress and increases in positive mood and attitude in people utilizing coherence techniques.[27] The following results have been found when utilizing coherence-building approaches in different studies: significant reductions in blood pressure in individuals with hypertension, improved functional capacity and reduced depression in congestive heart failure patients, improved psychological health and quality of life in patients with diabetes, and improvements in asthma.[28]

Carl Marci, a professor at Harvard University, conducted a study looking at the effect of physiological coherence between patients and their therapists using skin conductance measures. The preliminary results of his research study indicate that during periods of low physiological linkage, there are fewer empathetic comments, more incidents of incorrect interpretations, less shared affect, and fewer shared behavioral responses when compared to episodes of high physiological linkage.[29]

Much of this scientific research could not have occurred without the initial discovery of the mirror neuron system in the mid-1980s. This system has been "proposed as a mechanism allowing an individual to understand the *meaning and intention* of a communicative signal by evoking a representation of that signal in the perceiver's own brain."[30] This system is why a

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[26] Rollin McCraty, *The Energetic Heart: Bioelectromagnetic Interactions Within and Between People* (Institute of HeartMath, 2003), 5.

[27] Ibid.

[28] Ibid.

[29] Ibid., 8.

[30] Kay Norton, *Singing and Wellbeing: Ancient Wisdom, Modern Proof* (New York: Routledge, 2016), 27.

group can experience empathy and understanding towards one another. In other words, people automatically and unconsciously use the same neural resources to represent and understand the actions of others as when they perform their own actions.[31] Such a neural system suggests the possibility of experiencing the mind of another, essentially to "walk in another's shoes."

As illustrated in Figure 2.1, the music people hear activates brain cells dedicated to recognizing purposeful, intentional, and organized stimuli. The musical signal connects the various people involved because of a "shared and temporally synchronous recruitment of similar neural mechanisms in the sender and the perceiver of the musical message."[32] The perceiver's mirror neuron system resonates, or vibrates sympathetically, with the music, also known as entrainment.

[31] Norton, *Singing and Wellbeing,* 27.

[32] Ibid.

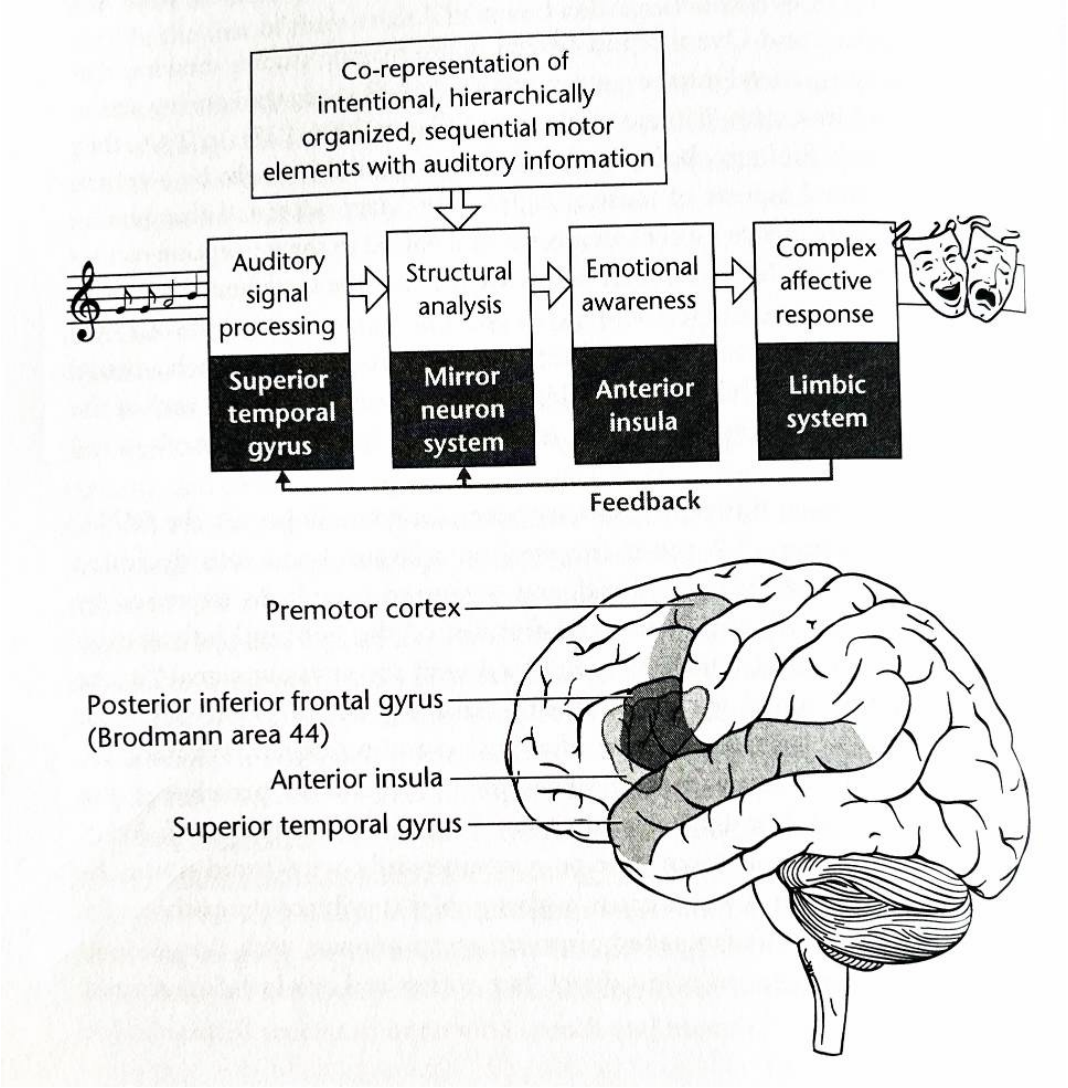

Figure 2.1 The Mirror Neuron System, as proposed by Molnar-Szakacs and Overy.[33]

Social Coherence

Research in evolutionary anthropology suggests that one of the primary drivers of evolution of the human species is our advanced capacities for social interaction and cooperation. This research also suggests that "humans are hard-wired to seek social connections and secure

[33] Norton, *Singing and Wellbeing*, 28.

attachments, independent of maturational stage, and culture."[34] The importance of social connections was highlighted by the groundbreaking work of James Lynch who found that "loneliness, itself, is a greater risk for heart disease than lack of exercise, smoking, excessive alcohol consumption, and obesity combined."[35]

Several studies are reviewed which have explored various types of synchronization in infants, pairs and groups, "indicating that feelings of cooperation, trust, compassion and increased prosocial behaviors depends largely on the establishment of a spontaneous synchronization of various physiological rhythms between individuals."[36] Artistic activities, such as singing in a choral ensemble, are rooted in social and emotional components.[37] A successful choral rehearsal or performance improves self-esteem, fosters a sense of community, and develops into a meaningful experience. It also helps establish social relationships and allows children to accept and build trust with others. Through practicing effective communication, collaboration, and problem solving, leadership competencies are developed.[38]

Figure 2.2 displays the results of an experiment of heart rhythm entrainment between two women who have a close working relationship, like in a choral ensemble. The two women were seated four feet apart with their backs to each other and their eyes closed. Then, they were asked to hold feelings of appreciation towards one another. The heart rates of both women began to

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[34] Rollin McCraty, "New Frontiers in Heart Rate Variability and Social Coherence Research: Techniques, Technologies, and Implications for Improving Group Dynamics and Outcomes," *Frontiers in Public Health* 5 (October 2017): 2.

[35] Ibid.

[36] Ibid., 1.

[37] Judit Varadi, "A Review of the Literature on the Relationship of Music Education to the Development of Socio-Emotional Learning," *SAGE Open* (January-March 2022): 3.

[38] Ibid.

show synchronization about thirty seconds after the women began thinking positive thoughts about one another.[39] This experiment highlights the power of thoughts, vibrations, entrainment, and the influence of the human biofield,

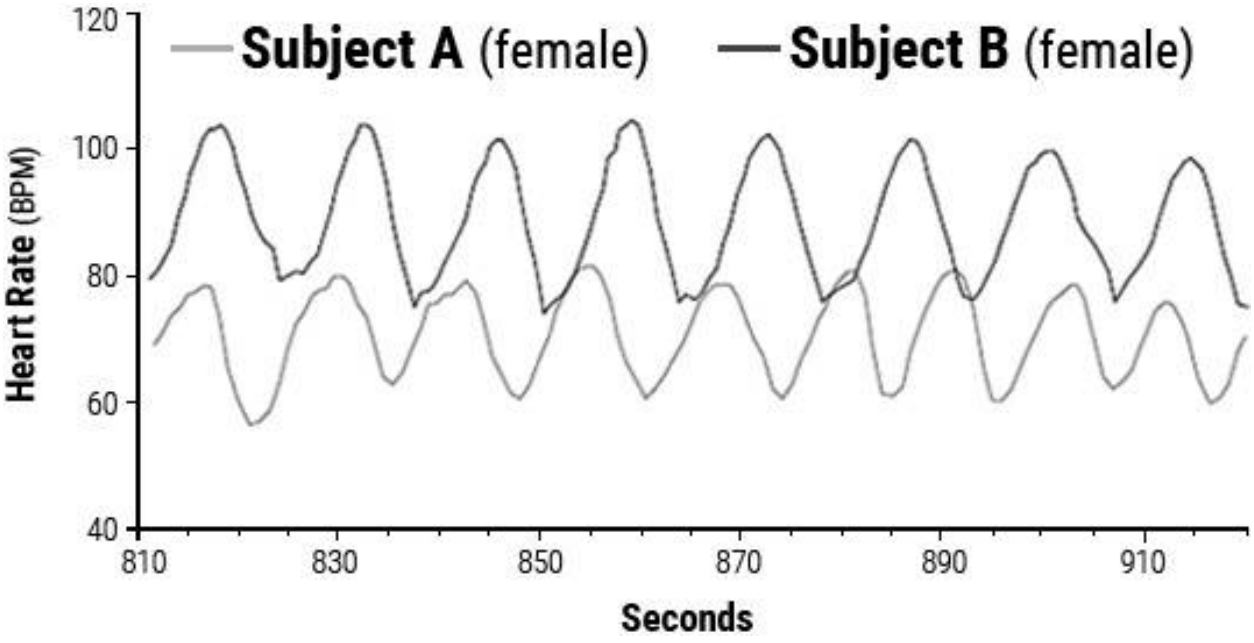

Figure 2.2 Heart Rhythm Entrainment[40]

Social-emotional learning (SEL) is the capacity to recognize and manage emotions, solve problems effectively, manage and control behavioral impulses, and establish positive relationships with others. The classroom is an ideal context for fostering healthy social and emotional development. Several seminal reviews were published from 1997 to 2007 reporting improvements in the following areas after SEL techniques, including HeartMath techniques, were applied: academic performance; aggressive and antisocial behavior; depression; substance

[39] McCraty, "New Frontiers in Heart Rate Variability and Social Coherence Research," 5.

[40] Ibid.

abuse; mental health; problem behaviors; and positive youth development.[41] Overall, programs that enhance SEL skills have resulted in significant improvements in students' social, emotional, and academic skills.[42]

Social-emotional learning involves developing skills in goal-setting, managing emotions, making responsible decisions, and forming and maintaining positive relationships.[43] The highly-valued SEL traits of successful humans "such as self-discipline, being able to work with others and in a team, problem-solving, and creative thinking are all effectively learned and enhanced through musical participation."[44] Although SEL programming is becoming increasingly popular, there is still a wide gap in the need for evidence-based practice and resulting implementation in school classrooms. The current school curriculum "does not adequately prepare children for the challenges and expectations of life, and mastering the curriculum is not enough to make students into successful adults with life skills."[45]

From a positive psychology and diversity perspective, "agency is the human capacity to affect other people positively or negatively through one's actions," much like coherence and physiological entrainment.[46] Agency is related to mediation, "a concept rooted in socio-cultural

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[41] Leslie C. Novosel, "Emotion Self-Regulation: A Mixed-Methods Intervention Study of Socioemotional and Reading Outcomes of High School Students with Reading Difficulties," (PhD diss., University of Kansas, 2012): 27.

[42] Ibid.

[43] McLeod and Boyes, "The Effectiveness of Socio-Emotional Learning Strategies," 820.

[44] Dawn Rose, Alice Jones Bartoli, and Pamela Heaton, "Measuring the impact of musical learning on cognitive, behavioral, and socio-emotional wellbeing development in children," *Psychology of Music* 47, no. 2 (2019): 298.

[45] Varadi, "A Review of the Literature on the Relationship of Music Education," 2.

[46] Esther Cores-Bilbao, Anali Fernández-Corbacho, Francisco H. Machancoses, and M.C. Fonseca-Mora, "A Music-Mediated Language Learning Experience: Students' Awareness of Their Socio-Emotional Skills" *Frontiers in Psychology* 10 (October 2019): 1.

learning theory, where social interaction is considered a fundamental cornerstone in the development of cognition."[47] Due to the social bonding effect that musical activities have, these social interactions in the language-learning setting may be facilitated through music. This is another example of how important music and connecting with one's emotions is to develop students' interpersonal and collaborative competencies to become active members of a more inclusive society.[48]

While there is adequate documentation of the importance of SEL strategies in many school districts, "more research is needed at the classroom level to determine how SEL skills are acquired, the appropriate dosage and developmental stage for use, and how they influence student emotional regulation, overall well-being, and social skills."[49] A 2020 study, which incorporated SEL strategies, study skills, and HeartMath Heart-Focused breathing techniques into the classroom discovered that these all help adolescents decrease worry and social stress, increase test preparedness self-efficacy, and improve academic performance due to lowered levels of test anxiety.[50]

Acquiring these critical SEL skills appears to have a "bidirectional effect, as lowering stress and worry reactions leads to increased self-efficacy, leading to further reduced stress and worry as the individual gains control and reassurance of having the capabilities required to handle the stressful situation."[51] Many participants from this study remarked on the ways in

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[47] Cores-Bilbao, et. al., "A Music-Mediated Language Learning Experience," 1.

[48] Ibid.

[49] McLeod and Boyes, "The Effectiveness of Socio-Emotional Learning Strategies," 821.

[50] Ibid., 815.

[51] Ibid., 838.

which the SEL tools they learned, especially the HF breathing, could be transferred and interwoven into other parts of their lives outside of the school classroom.[52] At present, there are few standardized assessment tools for SEL competencies, once called "soft skills," that might now be considered "essential skills" as they become increasingly necessary for effective social interaction and communication in the larger global community.

With the mental health crisis being so prevalent and rising daily, schools are searching for a solution to this issue. In April 2023, *The Washington Post* ran a story with the headline "One School's Solution to the Mental Health Crisis: Try Everything."[53] The article shared the story of a K-12 school in rural Ohio whose leaders had brought in more therapists and purchased a new social-emotional learning curriculum offering formal instruction in "qualities like empathy and trust, and skills like relationship-building and decision-making."[54] The school encouraged children as young as kindergarten to sing about their emotions in music class. The school's music teacher, who is trained in music therapy, said that not all students are ready or able to talk about their feelings, but music can often be a conduit for self-expression and emotional regulation. The staff and faculty there are witnessing incredible, positive changes in many students who have participated in this program.[55]

Social, or group, coherence occurs when there is freedom for the individuals to do their part and thrive while maintaining cohesion and resonance within the larger groups' intent or

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[52] McLeod and Boyes, "The Effectiveness of Socio-Emotional Learning Strategies," 839.

[53] Jonathan Haidt, *The Anxious Generation: How the Great Rewiring of Childhood Is Causing an Epidemic of Mental Illness* (New York: Penguin Press, 2024), 247.

[54] Ibid.

[55] Ibid.

goals.[56] Social coherence is seen as a "stable, harmonious alignment of relationships that allows for the efficient flow and utilization of energy and communication required for optimal collective cohesion and action."[57] A perfect space for social coherence to flourish is a music ensemble. Audiences entrain to performers, while choir members entrain to their fellow singers. It has been proven that individuals with a sense of meaning, purpose, and belonging often experience positive psychological states, which result from embracing a social environment comprised of others, such as larger communities.[58]

The benefits of social coherence and singing with others is not dependent on the quality of sound being made. According to a 2005 study titled, "Effects of Group Singing and Performance for Marginalized and Middle-Class Singers," researchers found that "the emotional effects of participation in group singing are similar regardless of training or socioeconomic status" and that "group singing and performance can produce satisfying and therapeutic sensations even when the sound produced by the vocal instrument is of mediocre quality."[59] This experiment validates that the connection of creating music in a group is beneficial, regardless of skill level, which allows for it to be applied to all ages of singers at all levels of musicianship.

In a similar discovery as the mirror neuron system, researchers have put for a hypothesis they call the "Shared Affective Motion Experience" model, or SAME. The SAME model proposes that "given the neural networks involved in the brains of both musicians and the audience, by synchronizing our experience (of sound, movement, and emotion), music conveys a

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[56] McCraty, *Science of the Heart,* 81.

[57] Ibid.

[58] Wahbeh, "Collective Consciousness," 5.

[59] Stacy Horn, *Imperfect Harmony: Finding Happiness Singing with Others* (North Carolina: Algonquin Books, 2013), 147.

sense of 'being together in time' with other people."[60] This perception is so powerful that it occurs even when someone is listening to music alone.

A 2023 study by Kathleen Riley and Rollin McCraty explored how a shared group intention by members of a string quartet would affect themselves and their interaction with other quartet members. This study looked at incorporating HeartMath's Quick Coherence and HeartMath Lock-In techniques. Quantitative results showed a significant change in heart-rate variability (HRV) among the musicians from baseline after the Heart Lock-In breathing technique was introduced. Qualitative results showed improved mental focus and feelings of connectivity among the musicians. After the final performance, qualitative comments focused on the performances being more engaging and the musicians feeling more connected.[61]

Several similar studies have proven that in ensembles, higher levels of physiological synchronization have been associated with increased conformity, stronger social connections, better cooperation and trust, and increased pro-social behavior.[62] In concert with an increased capacity for emotional self-regulation, a 2017 study led by McCraty linked vagally-mediated HRV with social functioning and feelings of connectedness.[63] A recent 2021 study of groups located in five countries found that being in a more coherent HRV rhythm for fifteen minutes increased synchronization, not only among group members, but also the HRV synchronization with the Earth's magnetic field.[64]

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[60] Horn, *Imperfect Harmony,* 169.

[61] Kathleen Riley and Rollin McCraty, "Exploring the Effects of Shared Heart-Focused Intention in Music Performance on Musicians and Audience Members," *Biofeedback* 51, no. 2 (2023): 36.

[62] McCraty, "Following the Rhythm of the Heart," 312.

[63] Elbers and McCraty, "HeartMath approach to self-regulation and psychosocial well-being," 74.

[64] McCraty, "Following the Rhythm of the Heart," 311.

Although HeartMath is not a religious practice, it is kindred to a state of meditation, which is often utilized for spiritual practices. In his book *How God Works: The Science Behind the Benefits of Religion,* social psychologist David DeSteno discussed the evidence that certain spiritual practices improve well-being. This often involves reducing self-focus and selfishness, which allows a person to be open beyond oneself. When communities engage in these practices together, and "especially when they move together in synchrony, they increase cohesion and trust, which means that they also reduce anomie and loneliness."[65]

Heart Coherence in the Classroom

Numerous years of research already mentioned, most conducted by the HeartMath Institute, have proven that there is a direct correlation between the physiological mode of cardiac coherence and emotional states of caring and bonding.[66] Through this research, the heart appears to be a central communication system, a generator of oscillatory patterns in continuous interaction with the brain and other parts of the body through various pathways, including "neurologically (through the transmission of neural impulses), biochemically (through hormones and neurotransmitters), biophysically (through pressure and sound waves), and energetically (through electromagnetic field interactions)."[67]

Heart rhythm coherence biofeedback is a new, exciting technology that can be applied in multiple facets in the educational classroom to help improve emotional, social, and academic issues. Utilizing this technology, students can enter a state of psychophysiological coherence

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[65] Haidt, *The Anxious Generation,* 202.

[66] Elbers and McCraty, "HeartMath approach to self-regulation and psychosocial well-being," 76.

[67] Ibid.

with themselves, which can improve emotional stability, cognitive function, and overall nervous system regulation.[68] In a study of high school seniors, who received three weeks of training in a heart coherence method had significant improvement in test scores; they also demonstrated reduced depression and hostility.[69]

Heart coherence leads to brain waves entraining with heart rhythm and activates the parasympathetic nervous system. This increases intuition and sidelines the analytical mind, indicating that heart coherence takes a person out of left-brain dominance.[70] Figure 2.3 shows the various ways the body can be influenced based on incoherence (left side) or a state of coherence (right side).

[68] McCraty, "Enhancing Emotional, Social, and Academic Learning," 130.

[69] Zadina, "The Synergy Zone," 11.

[70] Mira Cataya Rodriguez, "Opening the heart: exploring the interpersonal neurobiology of spiritual practices suitable for public education," *Journal for the Study of Spirituality* (2024): 8.

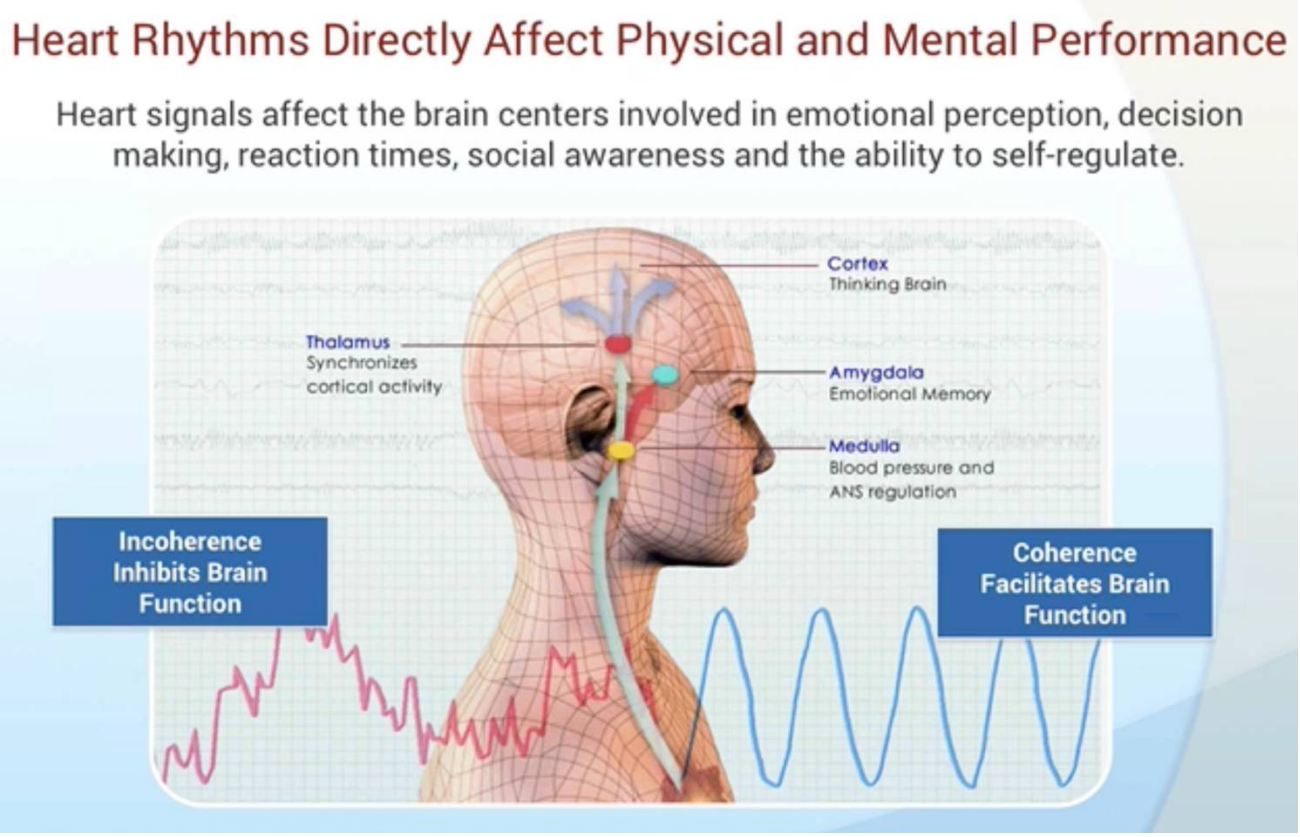

Figure 2.3 Heart Rhythms and Performance[71]

The HeartMath Heart-Focused breathing exercises are focused on breathing and cultivating positive emotions through the heart itself. Breathing is much more than a mechanical reflex for oxygen exchange; it is the "basis for all our cellular functions, our energetic well-being, and even our emotional health."[72] Yet most medical students, educators, or health practitioners learn little about the complexities and subtleties of breathing, rarely being taught to evaluate breathing as an index of health and healing. Deep breathing – such as those utilized in

[71] HeartMath Institute and Rollin McCraty, "Coherence: Increasing Self-Regulatory Capacity: The Scientific Basis of the Coherence Model," Accessed September 16, 2024, https://www.heartmath.org/resources/courses/coherence/.

[72] Gaynor, *The Healing Power of Sound*, 57.

HeartMath exercises – is key to breaking the vicious cycle of fight-or-flight in the nervous system. As soon as a person shifts to deeper abdominal breathing, the sympathetic nervous system, with its stress hormones, is quieted. All the physical manifestations of stress – cardiovascular, hormonal, immune, and muscular – begin to normalize.[73]

Figure 2.4 shows the connection between the heart-brain pathways and how they connect to the ganglia in the thoracic cavity, therefore influencing breathing.

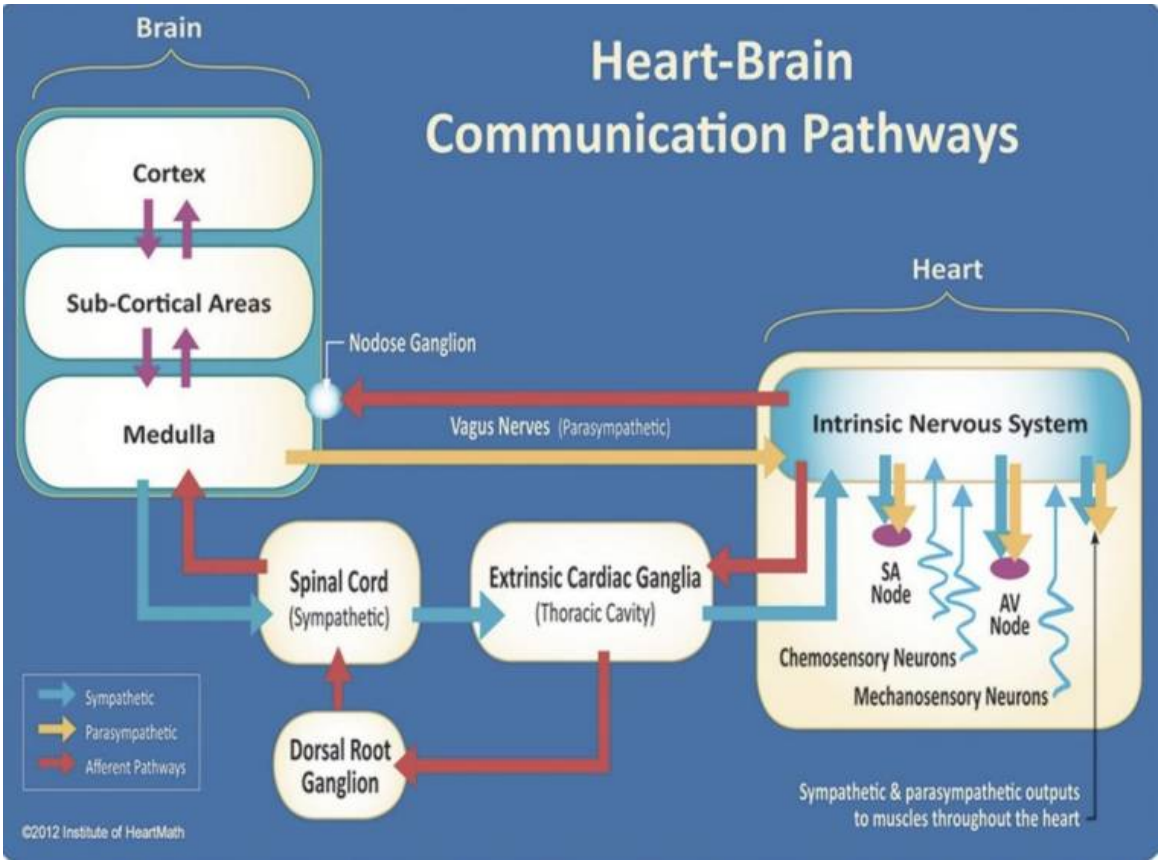

Figure 2.4 The Neural Communication Pathways Between Brain and Heart[74]

[73] Gaynor, *The Healing Power of Sound*, 61.

[74] Laura Hancock, "The Heart-Led Counselling Programme (HLC): Developing a Programme to reduce anxiety, using Heart-led interventions and Positive Psychology techniques in a counseling context," PhD diss., (2021): 18.

A study conducted in 2022 tested how breath-focused exercises would affect heart rate variability, anxiety, and stress in 585 elementary students aged 7-12. The results showed that after the breathing and biofeedback intervention, all students learned to breathe consciously and reduced their levels of both anxiety and stress.[75] Additionally, after the exercises were implemented, those students were also able to reduce their previous physiological stress, proven by a lowered HRV.[76]

The link between breathing and good health is more than just theoretical; studies have directly associated respiratory capacity with longevity. In Australia, a thirteen-year-long study demonstrated that respiratory capacity was a more significant factor than tobacco use, cholesterol levels, and insulin metabolism in determining people's longevity.[77] Additionally, in the 1960s, Nobel Prize winner Otto Warburg published landmark studies showing that cancer cells thrive in an environment starved of oxygen.[78]

The founders of the HeartMath Institute found through their earliest studies that participants' respiration rhythms were changing in response to the emotions they were experiencing rather than consciously altering their breathing. This suggests that "higher-level brain systems above the cardiorespiratory integration centers in the dorsal vagal complex

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[75] Ainara Aranberri-Ruiz, Aitor Aritzeta, Amaiur Olarza, Goretti Soroa, and Rosa Mindeguia, "Reducing Anxiety and Social Stress in Primary Education: A Breath-Focused Heart Rate Variability Biofeedback Intervention," *International Journal of Environmental Research and Public Health* 19 (2022): 1.

[76] Ibid.

[77] Gaynor, *The Healing Power of Sound*, 62.

[78] Ibid., 63.

involved in emotional processing and experience (amygdala, etc.) are unconsciously modifying the breathing rhythm."[79]

In Figure 2.5, the top graphs show an individual's HRV, pulse transit time, and respiration rhythms over a ten-minute period. At the 300-second mark, the individual used the Freeze Frame positive emotion refocusing technique, causing these three systems to come into entrainment (cross coherence). The bottom graphs show the frequency spectra of the same data on each side of the dotted line in the center of the top graph. Notice the graphs on the right show that all three systems have entrained to the same frequency.

[79] Rollin McCraty, "Following the Rhythm of the Heart: HeartMath Institute's Path to HRV Biofeedback," *Applied Psychophysiology and Biofeedback* 47 (2022): 306.

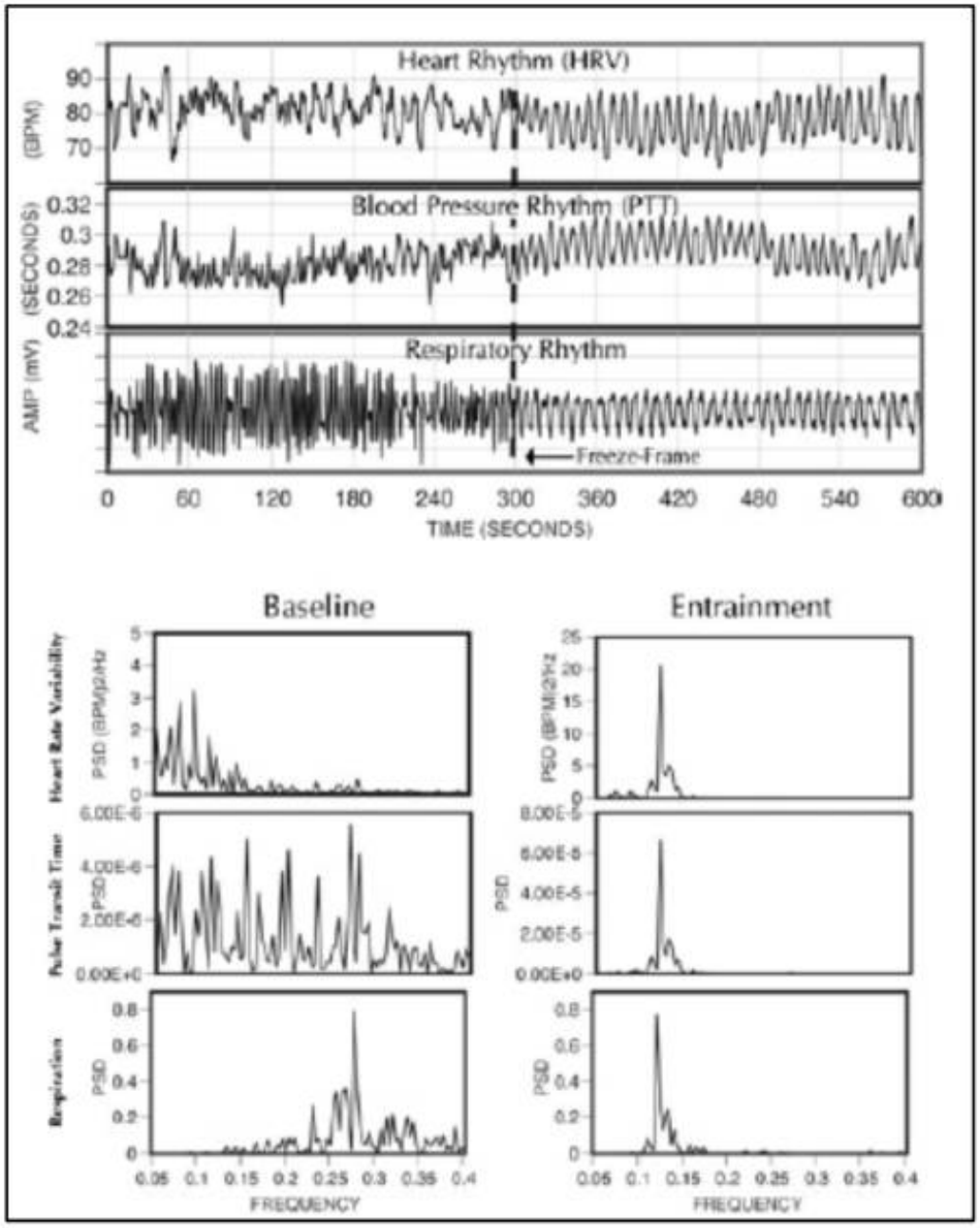

Figure 2.5 Full-System Coherence Using HeartMath Breathing Techniques[80]

The HRV and self-regulatory techniques of HeartMath exercises are effective in "improving human performance and decreasing anxiety among individuals, especially among

[80] Culbert, *HeartMath Clinical Certification for Stress, Anxiety, and Emotional Regulation*, 4.

university students in a multicultural university environment."[81] While these exercises benefit the students, they could also benefit the educators in the school system. Due to high pressures and expectations from the administration, as well as additional job requirements placed on teachers, many educators are experiencing increased stress, anxiety, and lower overall job satisfaction.[82]

A 2020 study conducted in Alberta, Canada assessed the effectiveness of a classroom-based HeartMath practice on resting HRV and self-reported emotional benefits in elementary students. Fifth-grade students participated daily in a five-minute, teacher-led Heart Lock-In exercise for four weeks. Univariate analysis of variance revealed that the HeartMath intervention significantly increased HRV compared to the relaxation control. Students reported enhanced emotional stability, more positive feelings about themselves, better focus, and improved interpersonal relationships. These findings provide evidence that a simple and short HeartMath breathing practice can be practical for school educators, administrators, and counselors to implement in the classroom.[83]

In Africa, a random controlled trial of thirty-eight middle school students diagnosed with attention deficit hyperactivity disorder, demonstrated that, after utilizing the HeartMath breathing techniques for four weeks, the students had a wide range of improvements in cognitive functions. These included short- and long-term memory, the ability to focus, and improved behaviors at

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[81] Abdul Qahar-Sarwari and Mohammad Nubli Wahab, "The Effectiveness of the Quick Coherence Technique using Heart Rate Variability-Biofeedback Technology on the Recovery of Heart Coherence among University Students," *Science and Technology* 26, no. 3 (2018): 1540.

[82] Candice Sue McCoy, "The Relationship Between a Self-Reflection Breathing Technique and Eleventh and Twelfth Grade Students' Academic Achievement," (PhD diss., Northcentral University, 2019): 28.

[83] Anomi G. Bearden, Sanne van Oostrom, and Stephen B.R.E. Brown, "The effects of HeartMath Heart Lock-In on elementary students' HRV and self-reported emotional regulation skills," *Psychology in the Schools* (2023): 1.

home and school.[84] A similar study from 2021 was conducted looking at the effect of HeartMath biofeedback and HRV techniques specifically relating to children and adolescents. Overall, eighteen studies were investigated, and all but one showed the positive contribution of HRV biofeedback sessions in children and adolescents.[85]

A more recent study completed in 2022 proved that HRV breath training utilizing the InnerBalance HeartMath biofeedback device before sleep increased the overall heart coherence levels in university students. In addition to their coherence levels improving, the students' overall happiness was rated higher. Essentially, with the improved coherence scores, the experimental group's autonomic nervous system works better after the eight weeks of HeartMath exercises, creating a higher state of physical and emotional health for the university students.[86]

Several studies have been conducted focusing on the effect of HeartMath biofeedback on the mental health of college students. In Texas, a 2010 study looked at the influence of HRV coherence biofeedback training and emotional self-regulation techniques on music performance anxiety and music performance among twenty university students. Results of this study revealed that the treatment group's average subjective decrease in music performance anxiety was 71% and the treatment group's average subjective improvement in performance was 62%.[87] Several years later, researchers at Florida State University found that students enrolled in a four-week

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[84] Jorina Elbers and Rollin McCraty, "HeartMath approach to self-regulation and psychosocial well-being," *Journal of Psychology in Africa* 30, no. 1 (2020): 75.

[85] Valerie Dormal, Nicolas Vermeulen, and Sandrine Mejias, "Is heart rate variability biofeedback useful in children and adolescents? A systematic review," *Journal of Child Psychology and Psychiatry* (2021): 9.

[86] Hamza Kaya Besler, "Can HRV Training Make Us Happy: An Experimental Study on University Students," *Journal of Educational Issues* 8, no. 3 (2022): 115.

[87] Lindsey Ryan Oakes, "The Potential Use of HeartMath's emWave Technology to Establish Evidence-Based Therapeutic Recreation Practice to Produce Physiological and Psychological Outcomes," *Therapeutic Recreation Journal* 56, no. 4 (2022): 480.

HRV biofeedback training program showed significant decreases in school burnout symptomology and brachial and aortic systolic blood pressure, as well as significant increases in cognitive performance from pre- to post-intervention assessments.[88]

Emotional Self-Regulation

Virtually no emphasis is placed on educating children to manage their emotions in the school classroom, yet society expects them to be able to function at an efficient cognitive level with appropriate focus and attention. Proficiency in emotional management, conflict resolution, communication, and interpersonal skills are essential for children to have confidence and the skills to handle the various stressors of life. Moreover, increasing evidence is highlighting the link between emotional balance and cognitive functions.[89]

Self-regulation is taking ownership or responsibility for one's emotions and thoughts; it can be thought of in three steps. The first step in emotional self-regulation is simply becoming aware of the emotion or thought itself. The next step is to determine if it is healthy or not. The final step of emotional self-regulation is self-correction and activating a new feeling.[90] HeartMath self-regulation techniques have been shown to be effective with young children, adolescents, young adults, and adults dealing with a variety of emotional, mental and medical challenges.[91]

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[88] Ross W. May, Gregory S. Seibert, Marcos A. Sanchez-Gonzalez, and Frank D. Fincham, "Self-Regulatory Biofeedback Training: an intervention to reduce school burnout and improve cardiac functioning in college students," *Stress* 22, no. 1 (2019): 1.

[89] McCraty, *Science of the Heart,* 66.

[90] McCoy, "The Relationship Between a Self-Reflection Breathing Technique," 13.

[91] Culbert, *HeartMath Clinical Certification for Stress, Anxiety, and Emotional Regulation,* 3.

Recent HeartMath research efforts have discovered that individuals can effectively initiate a repatterning process, whereby habitual emotional patterns underlying stress are replaced with new, healthier patterns that "establish increased emotional stability, mental acuity, and physiological efficiency as a new familiar baseline."[92] Most of the widely used stress management interventions do not directly focus on emotions when it is the emotions that activate the perceived stimulus as threatening – feelings of anxiety, irritation, frustration, etc. Emotions are what activate the autonomic nervous system and hypothalamic-pituitary-adrenal axis, leading to changes in the activity and function of the body's systems.[93]

Furthermore, in the last decade, research in neurosciences has made it quite clear that emotional processes operate at a much higher speed than thoughts, frequently bypassing the mind's linear reasoning process entirely.[94] This new research also indicates that within the brain, the neural connections from the emotional system to the cognitive system are much stronger and more numerous than those flowing from the cognitive to the emotional (see Figure 2.6).[95] This new discovery validates the importance of intervening at the level of the emotional system itself, creating a more direct and efficient path of change.

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[92] McCraty and Tomasino, "Emotional Stress, Positive Emotions, and Psychophysiological Coherence," 2.

[93] Ibid., 3.

[94] Joseph LeDoux, *The Emotional Brain: The Mysterious Underpinnings of Emotional Life* (New York: Simon and Schuster, 1998), 86.

[95] Ibid.

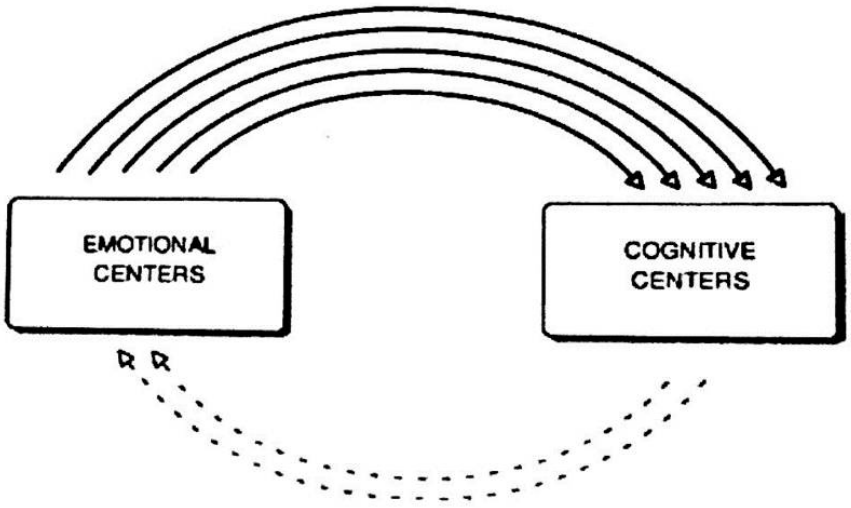

Figure 2.6 The Communication of Emotional Centers vs. Cognitive Centers of the Brain

A joint research study conducted by the Institute of HeartMath and the Miami Heart Research Institute in 1999 examined the impact of a HeartMath program on psychosocial functioning and physiological responses to stress in middle school students. Several of the students were at risk for anxiety, school dropouts, risky behavior problems, negative peer influences, and had difficult home lives. Results indicated significant improvements following the HeartMath implementation in 17 of the 19 areas of psychosocial functioning, including anger management, self-reliance, work management/focus, perceptions of family support/satisfaction, and decreases in risky behavior. Additionally, after the training, the students scored well above the average range on many of the scales on which they had previously scored below the norm.[96]

[96] Rollin McCraty, Mike Atkinson, Dana Tomasino, Jeff Goelitz, and Harvey N. Mayrovitz, "The Impact of an Emotional Self-Management Skills Course on Psychosocial Functioning and Autonomic Recovery to Stress in Middle School Children," *Integrative Physiological and Behavioral Science* 34, no. 4: 246.

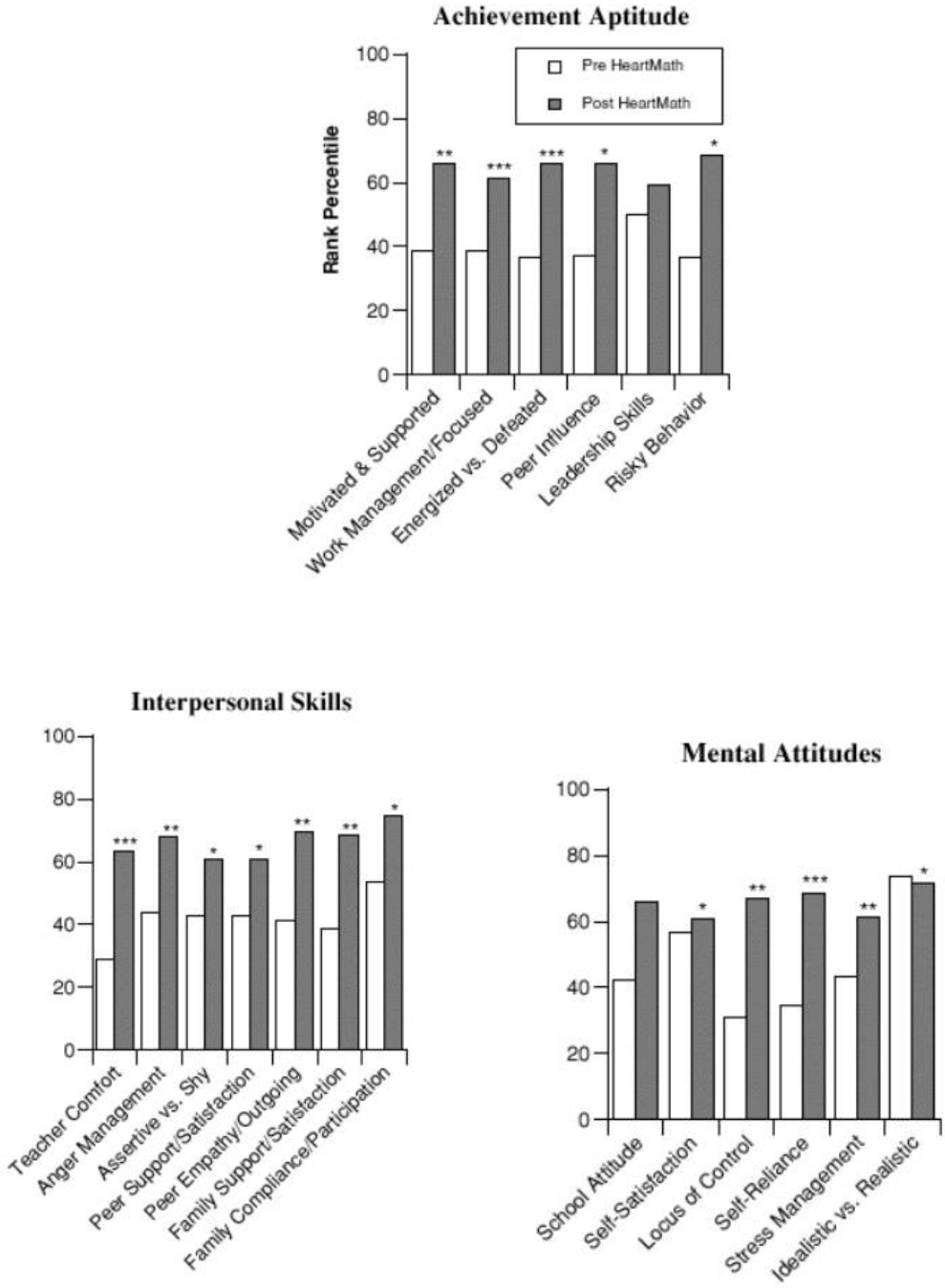

Figure 2.7 The Psychological and Behavioral Improvements Pre- and Post-HeartMath.[97]

[97] Rollin McCraty, et. al., "The Impact of an Emotional Self-Management Skills Course," 247-248.

Figure 2.7 shows the psychological and behavioral improvements for the at-risk seventh-grade students after learning the HeartMath tools and techniques. The measured criteria were divided into three general categories: Achievement Aptitude, Interpersonal Skills, and Mental Attitudes. Results are reported as percentile rankings based on norms established from analysis of an extensive age and gender-matched student population. With the implementation of this program, students demonstrated significant gains in nearly all measures.

Another HeartMath study focusing on implementing breathing techniques showed:

> the students in the experimental group also exhibited increased heart rate variability and heart-rhythm coherence during the resting baseline period in the post-intervention experiment – even without conscious use of the self-regulation techniques. This suggests that through consistent use of the coherence-building tools over the study period, these students had internalized their benefits, thus instantiating a healthier, more harmonious and more adaptive pattern of psychophysiological functioning as a new set-point or norm.[98]

Breathwork has been recently proven to help develop the ability to moderate one's emotions. Breath is a "direct pathway to the autonomic nervous system"[99] and can give students the tools to strengthen their sense of personal agency and control of their emotional state. Regulating one's breathing can also be helpful to increase one's energy if there is a need for focus. When we inhale, the heart speeds up and when we exhale, the heart slows down.[100] This is important knowledge as we learn to manage our energy in the rehearsal space, creating the desired environment for teaching and productivity.

Evidence-based mindfulness programs such as MindUp and the Mindfulness Education program integrated into regular classrooms have significantly improved student social-emotional

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[98] McCraty, *Science of the Heart,* 71.

[99] Ramona Wis, "Breath, Body, and Being: A Yoga-Inspired Choral 'Practice," *Choral Journal* 62, no. 3 (October 2021): 28.

[100] Ibid., 30.

awareness and text anxiety in the general education classroom.[101] A 2021 study by the University of Calgary revealed that a high school classroom-based intervention combining SEL and study skill strategies along with HeartMath HF breathing techniques using biofeedback helped "reduce feelings of test anxiety and worry, increased self-efficacy, and improved academic performance."[102] In this same study, students commented that learning about managing stress through HF breathing helped put things into perspective, enabling them to worry less about things beyond their control. Students' ability to use HF breathing to calm erratic and distracted thinking helped them focus and think clearly throughout the test being administered, improving their reading, analyzing, and problem-solving capabilities.[103]

Beyond just the need for self-regulation, there is a severe mental health crisis occurring specifically within our youth in the United States. Anxiety and its associated disorders seem to be defining the mental state of young people today. Based on a 2020 study, depression in U.S. teens (ages 12-17) became "roughly two and a half times more prevalent" and showed that "one out of every four American teen girls had experienced a major depressive episode in the past year."[104] Adolescent suicide (ages 10-14) in the U.S. shows a similar trend to depression, anxiety, and self-harm with a 91% increase in boys and a 167% increase in girls since 2010.[105] A 2022 study of more than 37,000 high school students in Wisconsin found an increase in the prevalence of anxiety from 24% in 2012 to 44% in 2018, with larger increases among girls and

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[101] McLeod and Boyes, "The Effectiveness of Socio-Emotional Learning Strategies," 821.

[102] Ibid., 837.

[103] Ibid., 839.

[104] Haidt, *The Anxious Generation*, 24.

[105] Ibid., 31.

LGBTQ+ teens.[106] Although all of these studies were conducted in the United States, the suffering is not limited by location. The same pattern is seen at roughly the same percentages among teens in the United Kingdom, Canada, and other major Anglosphere countries.[107]

Furthermore, the percentages of several mental illnesses in United States undergraduates increased by the following since 2010 (see Figure 2.8):

- 134% increase in Anxiety
- 105% increase in Depression
- 72% increase in Attention-Deficit Hyperactive Disorder (ADHD)
- 57% increase in Bipolar Disorder
- 100% increase in Anorexia
- 33% increase in Substance Abuse or Addiction
- 67% increase in Schizophrenia[108]

[106] Haidt, *The Anxious Generation*, 27.

[107] Ibid., 45.

[108] Ibid., 26.

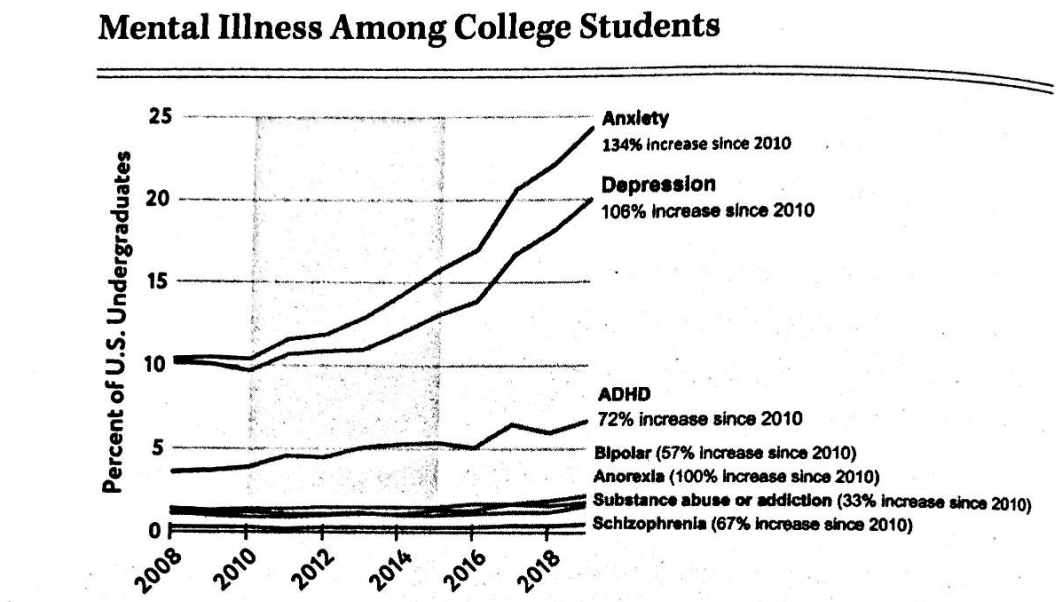

Figure 1.2. Percent of U.S. undergraduates with each of several mental illnesses. Rates of diagnosis of various mental illnesses increased in the 2010s among college students, especially for anxiety and depression. (Source: American College Health Association.)[9]

Figure 2.8 Mental Illness Among College Students[109]

Summary

This literature review examined key areas of interest and showed the many ways in which HeartMath Heart-Focused breathing can benefit human beings, both physically, mentally, and emotionally. A considerable volume of research shows a correlation between HF breathing techniques and an improved mental, physical, and emotional state of being. Despite the existing literature, more information is needed to determine the specific effects HF breathing will have on students in a music education ensemble rehearsal setting. The current study aims to address this

[109] Haidt, *The Anxious Generation*, 26.

gap in the literature by studying the HRV and coherence scores, as well as levels of mental health factors, in undergraduate choral singers at Alma College.

Chapter Three: Methods

Introduction

The purpose of this convergent mixed methods, pragmatic, postpositivist study was to address the gap in the literature on the effects of incorporating HeartMath Heart-Focused breathing exercises into the choral ensemble. According to researchers John and David Creswell, postpositivism recognizes that "we cannot be absolutely positive about our claims of knowledge when studying the behavior and actions of humans."[1]

Qualitative research is used for "exploring and understanding the meaning individuals or groups ascribe to a social or human problem."[2] The qualitative problem in this understanding is the lack of emotional regulation tools offered to students and their ability to connect deeply with others in the modern choral music classroom. This research method supports both qualitative and quantitative data to help understand what occurs properly. The quantitative data from the HeartMath sensors and qualitative data from the surveys and interviews were collected at the same time, analyzed separately, and then compared to one another.

An extensive examination of existing literature provided relevant research pertaining to scientific aspects of acoustics, consciousness, coherence, entrainment, and the physics of sound. These sources, as well as interviews, provided insight into the first research question. Music affects the body in two ways: "directly, as the effect of sound upon the cells and organs, and indirectly, by affecting the emotions, which then in turn influence numerous bodily processes."[3]

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[1] Creswell and Creswell, *Research Design, 6.*

[2] Ibid.*,* 250.

[3] David Tame, *The Secret Power of Music: The Transformation of Self and Society Through Musical Energy* (Vermont: Destiny Books, 1984), 137.

Literature pertaining to music education and the choral classroom informed the researcher of the interview questions that were asked to address the second research question. Based on these, a set of interview questions were created, and upon IRB approval, a sample of students were invited to participate in this study.

This chapter explains the study's methodology, including research design, participants, instruments used, procedures, and data analysis methods to provide relevant research to the subject.

Design

The study used a survey to further the phenomenological design. According to researchers John Creswell, William Hanson, Vicki Plano Clark, and Alejandro Morales, in a phenomenological method, "the inquirer collects data from persons who have experienced the phenomenon and develops a composite description of the essence of the experience for all the individuals—what they experienced and how they experienced it."[4]

HeartMath Inner Balance Coherence sensors were used to collect quantitative data from eleven college students in Alma Choir, a choral ensemble at Alma College. Likert-type scale motivation surveys were used to collect qualitative data after each rehearsal, as well as qualitative questioning and analysis regarding the impacts of incorporating the HeartMath exercises into their daily choral rehearsal routine before and after the research. Questions were compiled from existing surveys proving the instrument of the collection to be valid and reliable.[5] Permission was granted to the researcher from Alma College to conduct this study.

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[4] Creswell and Creswell, *Research Design,* 4.

[5] Carl Roberts and Laura Hyatt, *The Dissertation Journey: A Practical and Comprehensive Guide to Planning, Writing, and Defending Your Dissertation* (Thousand Oaks: SAGE Publications, 2019), 149.

The intent of this research was appropriate since it aims to "discover and illuminate the lived experience associated with this topic."[6] Despite the prevalence of the experimental and cognitive approach of research regarding emotions in music education, "self-reported feeling is still recognized as the most important form of evidence about musical emotions."[7] The identities of those who completed the survey were kept confidential.

Utilizing the convergent mixed method research approach, the collected data was able to be analyzed to identify the scientific data as well as the subjective experiences of the individuals involved in the study. After all the data was collected and analyzed, the researcher created a short curriculum with specific examples of how to incorporate these exercises or ideas into the choral ensemble setting.

Questions and Hypotheses

The questions and hypotheses used to guide this research study include the following:

Research Question One: What are the scientific indications, as monitored by heart rate variability biosensors, that physical, emotional, and mental health are affected through heart coherence and physiological entrainment when incorporating HeartMath exercises into the daily choral rehearsal?

Hypothesis One: Scientific indications that physical, emotional, and mental health are affected through heart coherence and physiological entrainment include lowered stress, anxiety, and depression, enhanced mental clarity and cognition, increased emotional regulation, and a more well-balanced nervous system and bodily organ functioning.

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[6] Roberts and Hyatt, *The Dissertation Journey*, 147.

[7] Gouk, et. al., *The Routledge Companion to Music, Mind, and Well-Being*, 200.

Research Question Two: What are the benefits of shifting focus from a traditional mindset of the choral rehearsal toward one that embraces the possibility of sympathetic vibrations in a choral music education setting?

Hypothesis Two: The benefits of shifting focus from a traditional mindset of the choral rehearsal toward one that embraces the possibility of sympathetic vibrations in a choral music education setting include an improved sense of community within the choral ensemble, acceptance and positivity towards oneself, and overall lowered stress level in the choral classroom.

Participants

Participants were recruited through an in-person setting. Participants for the study were eleven full-time college students at Alma College in Michigan, enrolled in the SATB choral ensemble, Alma Choir. All eleven participants were over the age of eighteen; five were male and six were female. All participating students signed an IRB-approved consent form before the research began. Students were not required to participate and were given the option to opt-out of the experiment.

Setting

The study took place in the fall of 2024. Once consent forms were received, the initial individual qualitative interview was conducted with each participating student by the researcher. The interviews were confidential and took place privately in the researcher's office on campus at Alma College, which was a familiar space to the choir students. They were audio-recorded on the researcher's phone, which is password-protected. The setting of the quantitative data collection was familiar to the students as they rehearsed in that location daily with the rest of the ensemble. After the quantitative data was collected, a post-research interview was conducted

with each participant in the same space by the researcher, concluding the research period for this experiment.

Instrumentation and Data Collection Method

Heart rate variability (HRV), or heart rhythm, is a measure of the naturally occurring beat-to-beat changes in heart rate that has proven to be invaluable in studying the physiology of emotions. HRV is a representation of the time between each heartbeat. The analysis of HRV provides a powerful, noninvasive measure of neurocardiac function that reflects heart-brain interactions and autonomic nervous system dynamics, which are particularly sensitive to changes in emotional states.[8]

The researcher used Inner Balance Coherence sensors, from the HeartMath Institute, to measure the HRV of each research participant. The Inner Balance Coherence sensor uses professional-grade photodetectors to measure a person's pulse wave 500 times per second.[9] The heart rate pattern and HRV data from each participant is then translated into a heart coherence score within ten seconds of the initial reading.

The researcher measured the HRV of each participant for one week prior to the HF breathing exercises to establish a baseline HRV and coherence score. Then, the researcher measured the HRV and coherence score of each participant at three points throughout each seventy-five-minute rehearsal for three weeks. These points were: at the beginning of class (before the HeartMath exercises), immediately following the implementation of the HeartMath exercises, and approximately fifteen minutes after the previous reading.

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[8] "Inner Balance Coherence Sensor," HeartMath Institute, Accessed February 2, 2024, https://www.heartmath.org/store/products/inner-balance/.

[9] Ibid.

In addition to the HRV and heart coherence score data, the researcher collected data from questions asked of the participants in a Likert-scale format after each rehearsal. Additional qualitative data was collected from a pre- and post-interview conducted by the researcher with each participant. The questions were the same for both interviews, with the option to provide additional comments about their experience with the HF breathing exercises at the end of the post-interview.

Procedures

Prior to the study, permission was secured to conduct the research. The Institution Review Board (IRB) approved the mixed method design and procedures of the study. This research study utilized a combination of open-ended questions, Likert-scale questions, and data collected from the HeartMath Inner Balance Coherence sensor, which measures heart-rate variability and coherence. Once IRB approval was granted, the students were recruited in-person by the researcher.

The HeartMath Heart-Focused breathing techniques (using the HeartMath Inner Balance Coherence sensor and accompanying app) were integrated into the regular choral warmup time for the Alma Choir during the fall 2024 semester. Students volunteered themselves to participate after a thorough introduction to the study in a verbal recruitment letter. Recruitment and data collection were handled by the researcher who was also the teacher/conductor of the ensemble.

Prior to the first rehearsal using the HF breathing techniques, a private interview was conducted. This interview provides a multi-faceted view of the participants' previous experience being part of a choral ensemble. Yes and no questions, with the ability to elaborate or explain, as well as open-ended questions about their individual experience in choir were asked of the participants and audio recorded before the research began and after it was completed.

The interview questions were:

1) Do you feel that music or choir rehearsal helps with your stress or anxiety levels?
2) Do you currently feel a high level of connection to the other singers in your ensemble?
3) Do you currently feel an increased sense of focus when you are in your ensemble rehearsal?
4) Do you feel that you can successfully regulate your own emotions daily?
5) What do you love most about being part of a choir or music ensemble?

Researchers Susan Weller and her colleagues explain that "open-ended questions are used alone or in combination with other interviewing techniques to explore topics in-depth, to understand processes, and to identify potential causes of observed correlations."[10] These open-ended questions allowed for the participants to freely share their personal experiences that they had before and after this study was conducted.

Once data collection began, the HeartMath Inner Balance Coherence sensor was connected to the student's ear, as well as via Bluetooth to a student device using the Inner Balance app, which provided biofeedback data from the sensor. The user was able to view their heart rate variability (HRV) and coherence score, enabling them to view the effects of HF breathing in real-time. Students recorded their average HRV and coherence score (after approximately one minute of readings) three times per rehearsal. The readings consisted of the following time frame:

1) At the beginning of rehearsal, prior to the HF breathing techniques

[10] Susan C. Weller, Ben Vickers, H. Russell Bernard, Alyssa M. Blackburn, Stephen Borgatti, Clarence C. Gravlee, and Jeffery C. Johnson, "Open-ended Interview Questions and Saturation," PLOS ONE 13, no. 6 (2018), 1, https://doi.org/10.1371/journal.pone.0198606.

2) Right after the HF breathing techniques were performed

3) Approximately fifteen minutes after the second reading

For the rehearsals during the research period, the researcher kept the order of the repertoire consistent, so that the data collected would not be altered due to musical elements, such as tempo, rhythm, musical selection style, etc.

After each rehearsal, the participants were asked to complete a short survey consisting of Likert scale questions. Researchers Tomoko Nemoto and David Beglar described the Likert scale as "a psychometric scale that has multiple categories from which respondents choose to indicate their opinions, attitudes, or feelings about a particular issue."[11] Participants were asked to rate the given statements using a five-point Likert scale in this research study. They could choose 1-strongly disagree, 2-disagree, 3-neutral, 4-agree, or 5-strongly agree. Nemoto and Beglar additionally explained four advantages of using Likert-scale questionnaires, saying:

> a) data can be gathered relatively quickly from large numbers of respondents, (b) they can provide highly reliable person ability estimates, (c) the validity of the interpretations made from the data they provide can be established through a variety of means, and (d) the data they provide can be profitably compared, contrasted, and combined with qualitative data-gathering techniques, such as open-ended questions, participant observation, and interviews.[12]

The questions asked of each participant on the short survey were:

1) I experienced less anxiety in/after rehearsal today.

2) I experienced more focus in/after rehearsal today.

3) I experienced a higher level of connection with my classmates in/after rehearsal today.

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[11] Tomoko Nemoto and David Beglar, "Developing Likert-Scale Questionnaires," JALT2013 Conference Proceedings (2014), 2, https://jalt-publications.org/sites/default/files/pdf-article/jalt2013_001.pdf.

[12] Ibid., 8.

4) I experienced a higher level of ability to regulate my own emotions in/after rehearsal today.

Likert-scale questions only provide part of the information needed in the study and should be paired with other approaches. Nemoto and Beglar explain that "by investigating a construct from multiple angles, there is a higher probability of accurately understanding that construct and arriving at more defensible interpretations and conclusions."[13]

Researcher Positionality

Before presenting the findings of this study, and in the spirit of self-reflection, the researcher acknowledges their standpoint as a Caucasian, educated, female United States citizen. No intentional bias or discrimination was purposefully applied by the researcher; however, the researcher does recognize that their current positionality and past experiences could have influenced this research to some extent.

Data Analysis

The researcher audio-recorded the initial and concluding interviews in this study, which took place privately; these recordings were kept on their personal, password-protected cell phone. The researcher hand-scribed data from each rehearsal – both the quantitative and qualitative feedback of each participant – and organized it in an Excel spreadsheet. Each participant's data was labeled with a letter of the alphabet to protect their privacy. All this data was kept on a laptop with a secure password and in a locked office, with the physical documents being shredded after transfer to the spreadsheet to ensure privacy. In this study, the quantitative data from the sensors was analyzed to reveal the effects of HeartMath HF breathing techniques

[13] Nemoto and Beglar, "Developing Likert-Scale Questionnaires," 8.

on the HRV and coherence score of participants in a choral ensemble. Thematic analysis was used for the qualitative portion of the study.

Each participant recorded their HRV average – or heartbeats per minute – as well as their average coherence score three times throughout the rehearsal. The coherence score is determined by a power-spectral analysis after the HRV wave form is obtained. This analysis is calculated into a moving average, which is updated every five seconds in real time in the InnerBalance App.

The "coherence range" is notated at the top of Figure 3.1; this range is between 0.04 and 0.24 Hz. The coherence score is determined by identifying the maximum peak within the coherence range of the power spectrum (the peak power), dividing that by the total power (area under the curve) subtracting that peak power number. An ideal coherence score is any number above 2.5; a higher coherence score indicates a greater amount of physiological coherence evident in the body.

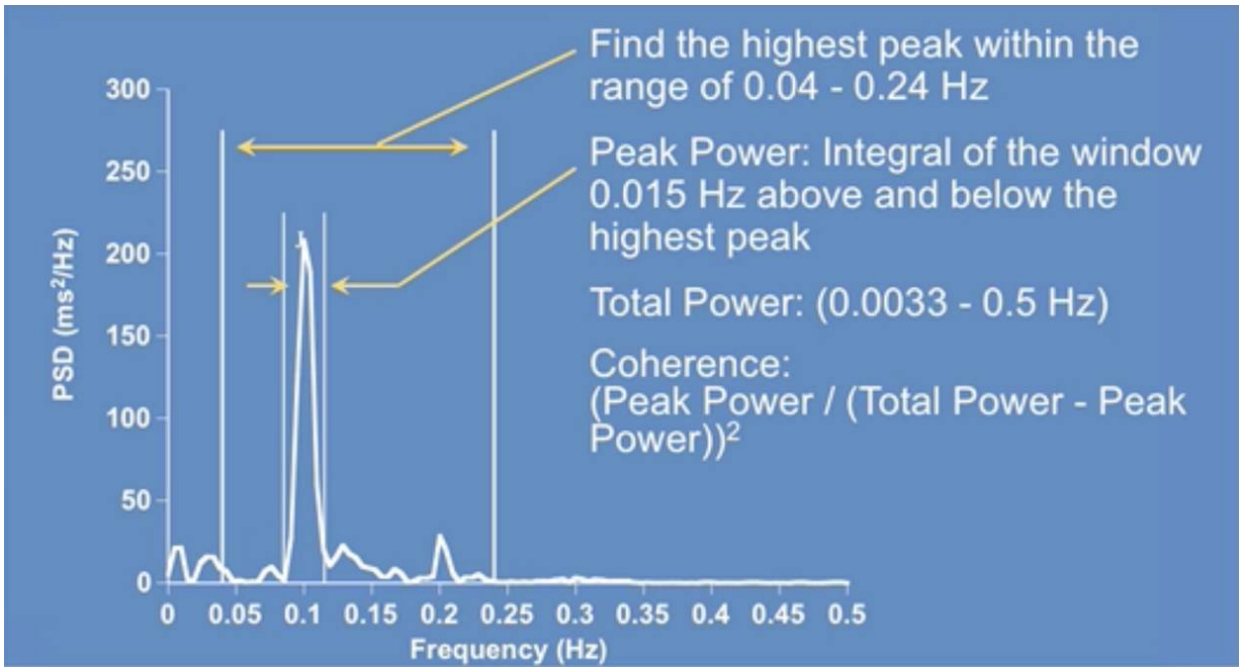

Figure 3.1 The Coherence Score Calculation[14]

Summary

The chapter outlined detailed research methodology in a mixed-methods design, providing critical information about incorporating HeartMath Heart-Focused breathing exercises into the choral rehearsal. A mixed-methods approach in research helps dissect quantitative and qualitative data. In this manner, quantitative methodologies via the InnerBalance sensor provided participant data and the participants' points of view from the Likert scale surveys and pre- and post-interviews uncovered the qualitative results.

[14] HeartMath Institute and Rollin McCraty, "Coherence: Increasing Self-Regulatory Capacity," https://www.heartmath.org/resources/courses/coherence/.

Chapter Four: Results

This chapter illustrates the various methodologies conducted for this mixed-methods research and to test the proposed hypotheses of the experiment. The research for this study involved the analysis of relevant literature and collection of both quantitative and qualitative data. The results revealed the effects HeartMath exercises can have on the physical, mental, and emotional aspects of an individual. This chapter shares the findings from this study and describes, analyzes, and explains the results. Additionally, it reports the themes uncovered from the qualitative data collected from the participants before, during, and after the research was conducted.

Quantitative Data Results

Four weeks of quantitative data from eleven college students in Alma Choir was collected via the HeartMath InnerBalance Coherence Sensor. This sensor measures heart rate variability (HRV) and provides a coherence score based on an equation established by HeartMath (see Figure 3.1). The first week of data was to establish a baseline for each student; this data was collected in the same increments, just without adding the HeartMath Heart-Focused (HF) breathing exercises. After this initial week of control data, the HF exercises were incorporated into the choral warmup, and the data collection continued. Each student tracked and recorded their data three times throughout the rehearsal: at the beginning of rehearsal before the HF breathing techniques, right after the HF breathing techniques were performed, and approximately fifteen minutes after the second reading.

Heart Rate Variability

Table 4.1 shows the average HRV reading for each participant over the four weeks. The first column – Baseline – provides the average for the first week without the HF breathing

exercises. The following three columns provide the total average HRV reading for the three consecutive weeks after the HF breathing exercises were added to the warmup portion of rehearsal. During the research phase of three weeks, ten of the eleven participants showed an increase in HRV for the second reading, which was taken directly after the HF breathing exercises. This second reading was also higher or equal to the baseline reading for all eleven participants. Additionally, nine of the eleven participants experienced a drop in HRV from the second to the third reading, which suggests that the HRV was positively affected by the HF breathing exercises.

Table 4.1 Average Participant HRV

Participant	Baseline (Week 1)	Reading #1	Reading #2	Reading #3
A	68	84	82	83
B	68	77	81	79
C	101	97	101	99
D	97	93	98	94
E	91	93	99	95
F	77	91	93	95
G	78	79	88	82
H	94	88	94	86
I	78	82	89	79
J	88	96	103	97
K	79	78	84	73

Heart rate variability is an important indicator of psychological resiliency and stress management. Higher levels of HRV are associated with superior mental performance on tasks requiring executive functions, such as critical thinking, sustained attention, and emotional control.[1] Higher levels of resting HRV are associated with better cognitive performance on tasks requiring executive functions.[2] Lower levels of HRV are associated with higher anxiety, depression, and emotional self-regulation issues.[3] This spike in HRV implies that the HF breathing exercises did have a positive effect on the research subjects, possibly improving focus and anxiety levels during the rehearsal.

Table 4.2 Average HRV – Weeks 1 & 3

Participant	**Week 1**	**Week 3**
A	68	82
B	68	81
C	101	101
D	97	98
E	91	99
F	77	93
G	78	88
H	94	94
I	78	89

[1] Rollin McCraty, *Heart Rate Variability Basics: Physiological Mechanisms and Assessments*, HeartMath Institute (2015), 8.

[2] McCraty, "New Frontiers in Heart Rate Variability and Social Coherence Research," 3.

[3] McCraty, *Heart Rate Variability Basics*, 9.

J	88	103
K	79	84

Table 4.2 shows the average HRV from Week 1, the baseline before the HF breathing exercises were introduced, and Week 3, the second week of the exercises being involved in rehearsal. This shows that nine of the eleven participant's HRV increased; only two participants had the same reading for both weeks. Figure 4.1 shows the same data in a graph form, with Week 1 readings in green and Week 3 readings in blue.

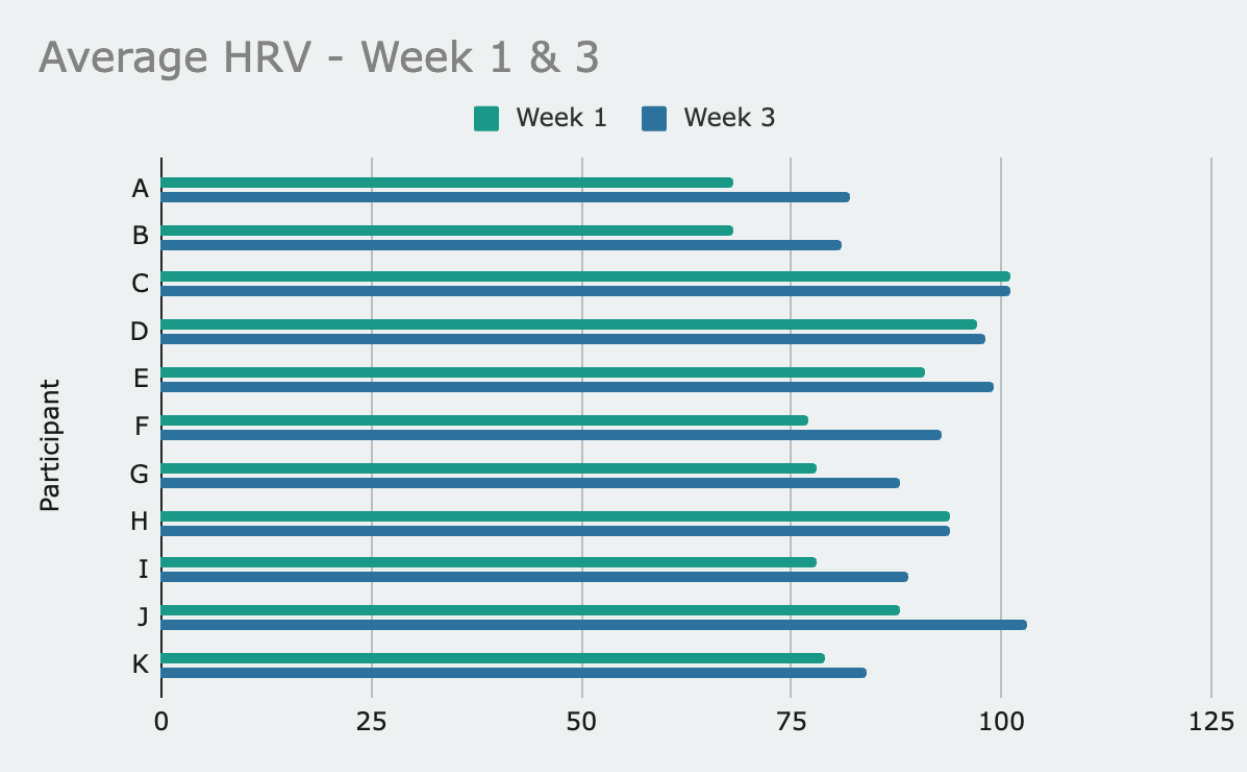

Figure 4.1 Average HRV – Weeks 1 & 3

One of the main skills that adolescents are expected to develop as they advance through middle and high school is "executive function," which refers to the child's growing ability to make plans and execute those plans, an example being time management.[4] Executive function skills are slow to develop because they are based mostly in the frontal cortex, which is the last part of the brain to rewire during puberty. Skills essential for executive function include self-control, focus, and the ability to ignore distractions. Because HeartMath exercises encourage psychophysiological coherence in the body and brain, they can assist in the development of executive functioning in young adults.

Heart Coherence

The average heart coherence score of each research participant is showcased in Table 4.3. The first column – Baseline – provides the average for the first week without the HF breathing exercises. The following three columns provide the total average heart coherence score for the three consecutive weeks after the HF breathing exercises were added to the warmup section of rehearsal.

Table 4.3 Average Participant Heart Coherence

Participant	Baseline (Week 1)	Reading #1	Reading #2	Reading #3
A	1.0	1.6	2.1	1.3
B	1.0	1.2	1.5	1.4
C	1.2	1.4	2.0	1.4
D	1.6	1.6	2.0	1.7
E	1.1	1.3	1.8	1.5

[4] Haidt, *The Anxious Generation,* 129.

F	1.4	1.3	1.7	1.4
G	2.3	2.0	2.9	2.2
H	1.6	1.6	1.9	1.2
I	1.3	1.4	1.6	1.5
J	1.7	1.4	2.0	1.6
K	1.6	1.7	1.8	2.0

All eleven participants showed an increase in average heart coherence between the first reading (collected at the beginning of rehearsal before the HF breathing exercises) and the second reading (collected immediately after the HF breathing exercises were performed). This second reading is also higher than the average baseline coherence score from Week 1's data for all the participants. Figure 4.2 displays the data of these two readings and the associated increase in heart coherence in a graph for all participants. Like the HRV data, ten of the eleven participants experienced a drop in their coherence score from the second to the third reading, which suggests that heart coherence was positively affected by the HF breathing exercises.

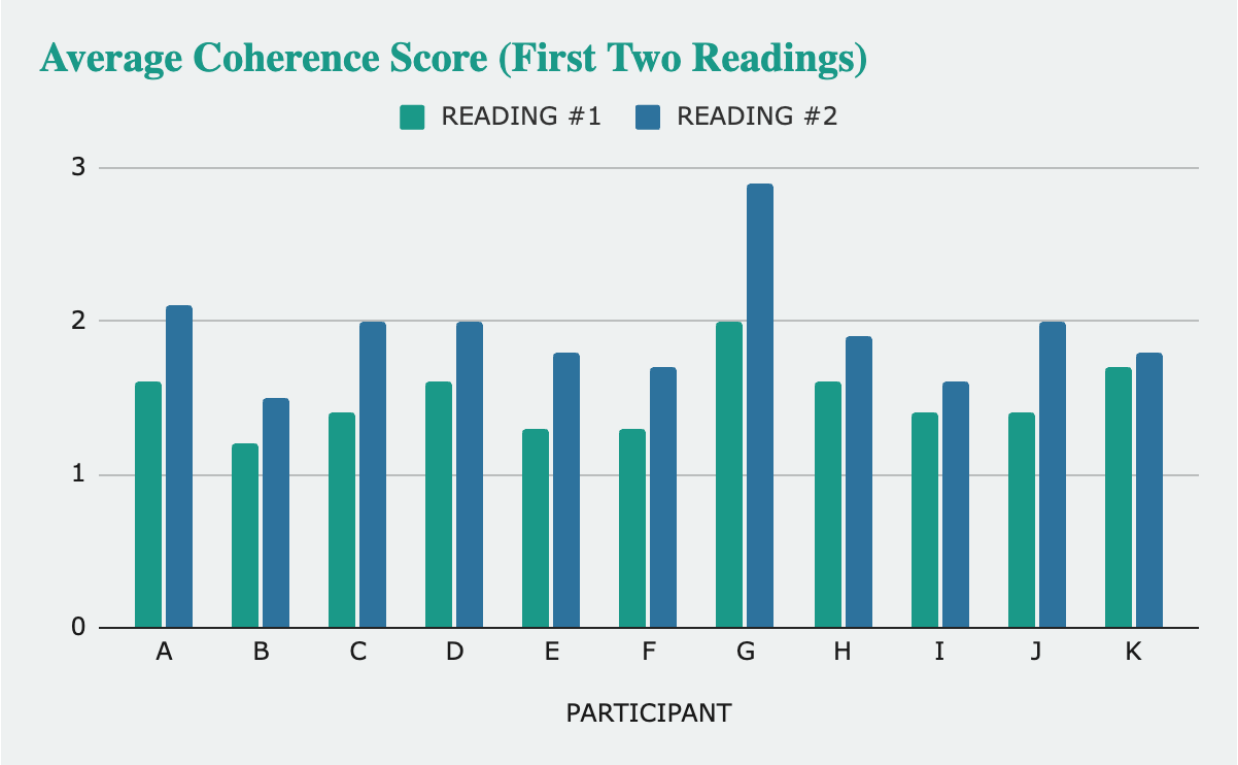

Figure 4.2 Average Coherence Score (First Two Readings)

Additionally, the average coherence score increased even higher for all eleven participants during the third week; this data is shown in Figure 4.3. These findings correlate to the idea that our bodies are like "antennas," where we pick up on the surrounding electromagnetic field produced by the hearts of others, often causing physiological entrainment, resulting in a deeper level of connection and understanding to the other group members.[5]

[5] McCraty, Bradley, and Tomasino, "The Resonant Heart," 18.

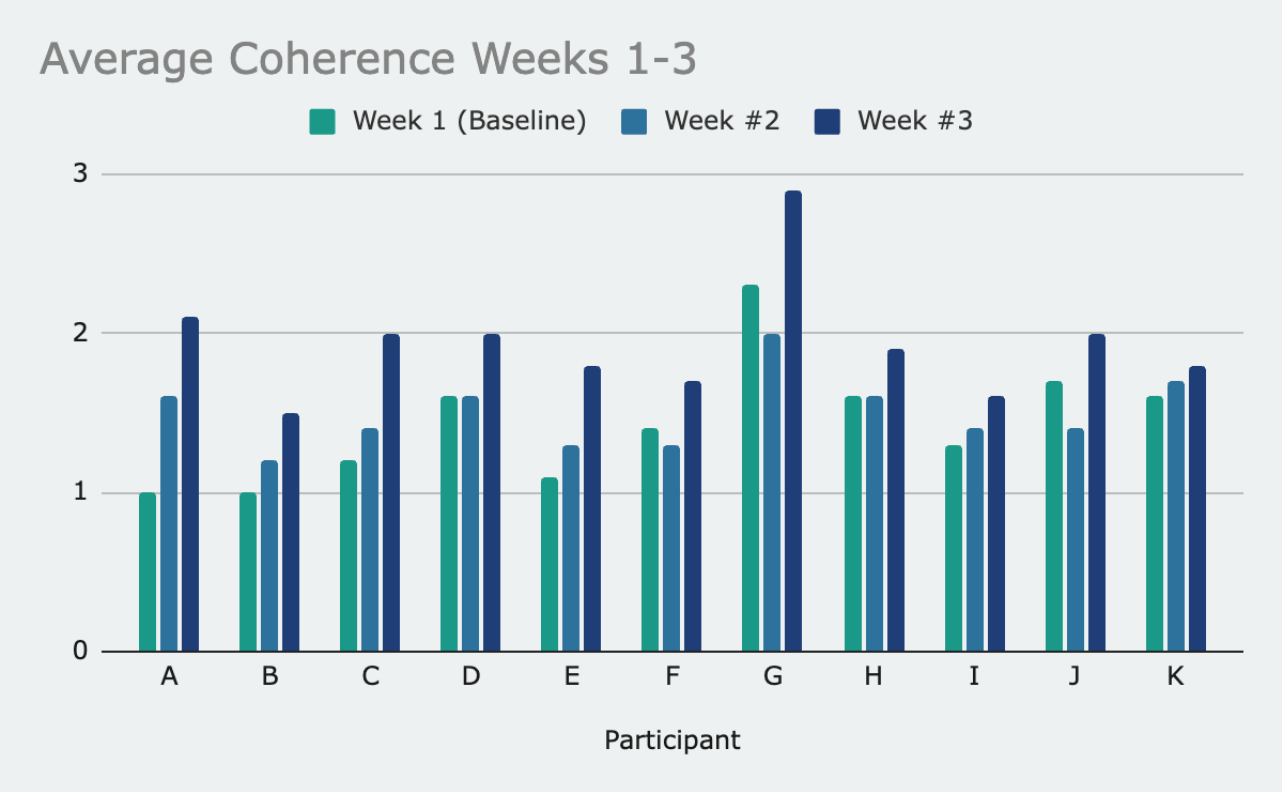

Figure 4.3 Average Coherence Weeks 1-3

Previous research has discovered that heart rate variability synchronization between participants was increased during periods of increased individual HRV coherence and was correlated with the degree of emotional bonding between participants.[6] Therefore, if the HRV coherence scores are improving for individuals, the overall social coherence will also be improving.

Qualitative Data Results

Thematic analysis is the process of identifying patterns or themes within qualitative data. Authors Maguire and Delahunt share that the "goal of a thematic analysis is to identify themes in

[6] McCraty, "New Frontiers in Heart Rate Variability and Social Coherence Research," 5.

a pattern, for example, patterns in the data that are important or interesting, and use these themes to address the research or say something about an issue."[7]

Themes from Daily Surveys

It has been proven that music plays a vital role in providing comfort, relaxation, and other beneficial responses to singers.[8] This study sought to gather a baseline of each participant to reflect on how music already emotionally affects them. The researcher distributed printed Likert-scale surveys to each research participant after each rehearsal. The first week of surveys served as a baseline for the participant; this was before the HF breathing exercises were introduced as part of the choral rehearsal. The three consecutive weeks provided the participants' answers after the HF breathing exercises became a part of the regular choral warmup.

The collected data is recorded in Tables 4.4-4.7. These tables provide an overview of all the responses made by the eleven participants for each question. Each column represents a different degree of response on the Likert scale. The rows separate the data by each week, with week one being the baseline. The numbers in each table represent how many respondents replied with a particular Likert-style response to each question; this number is the average of all responses for that entire week.

Anxiety

Question One of the Likert survey asked, "I experienced less anxiety in/after rehearsal today." Table 4.4 shows the total data collected from all the answers for the four weeks of research.

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[7] Moira Maguire and Brid Delahunt, "Doing a Thematic Analysis: A Step-by-Step Guide for Learning and Teaching Scholars," *AISHE-J* no. 3 (Autumn 2017): 3353.

[8] McCraty, *Science of the Heart,* 82.

Table 4.4 Participant Survey Results – Question 1

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Week 1	8	6	3	3	1
Week 2	14	11	6	1	0
Week 3	24	24	4	1	0
Week 4	12	14	5	1	0

Analysis of the completed responses revealed that before the HF breathing exercises, 67% of the participants strongly agreed or agreed that they experienced less anxiety during/after choir rehearsal, with 14% being neutral, 14% disagreed, and 5% of participants strongly disagreed. After just one week of HF breathing exercises (Week 2 results), those responses improved to 78% of the participants strongly agreed or agreed that they had less anxiety during/after choir rehearsal, with 19% neutral and only 3% disagreed. None strongly disagreed. After the second week of HF breathing (Week 3 results), the improvements in feelings of anxiety continued with a rise to an incredible 90% of participants who strongly agreed or agreed that they experienced less anxiety during or after choir rehearsal. These results are depicted in Figure 4.4.

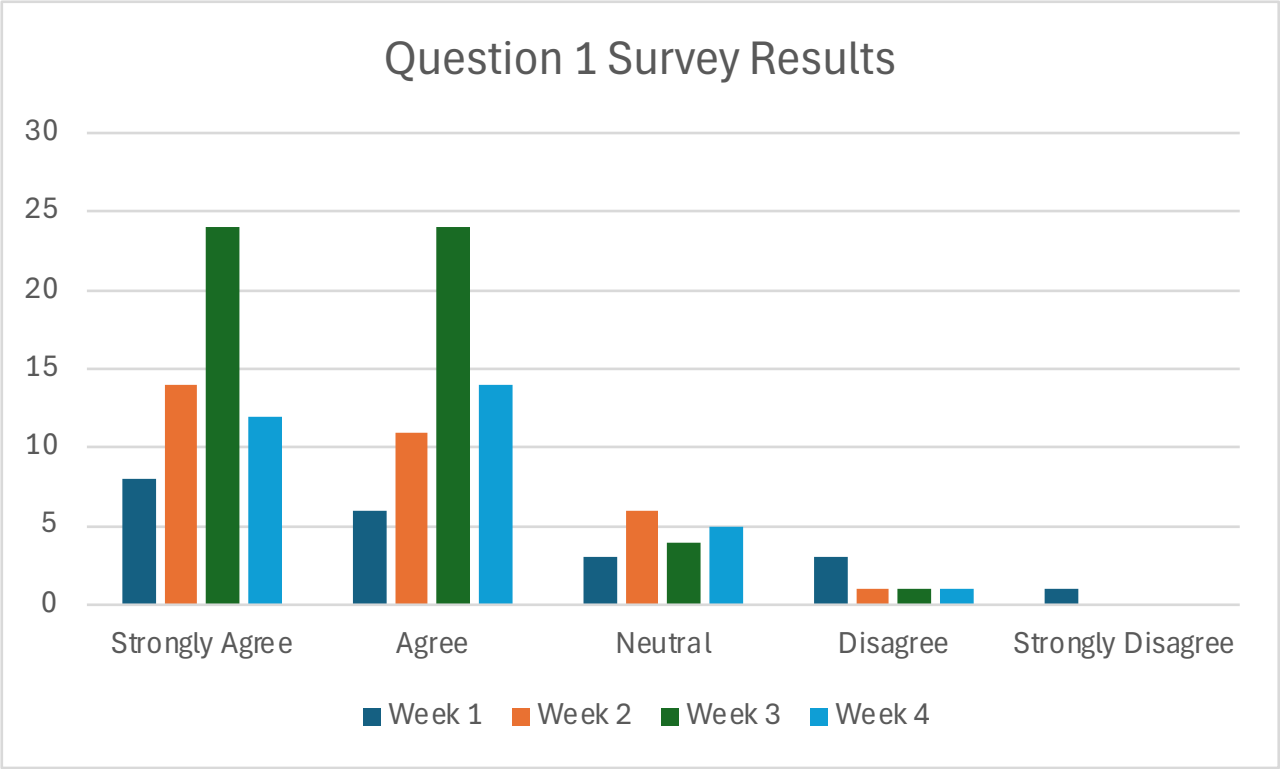

Figure 4.4 Question 1 Survey Results (Average)

A study of American college students from 2023 found that 37% reported feeling anxious "always" or "most of the time," while an additional 31% felt this way "about half of the time."[9] That means that only one-third of college students said they feel anxiety less than half the time or never. The qualitative data from Question One of the surveys provides evidence that the HeartMath Heart-Focused breathing exercises help to reduce anxiety for undergraduate college students. This provides a low-cost, easy way to assist students in reducing anxiety and stress, which they can utilize on their own, as well as in a group.

[9] Haidt, *The Anxious Generation,* 27.

Focus

The second question of the Likert survey asked, "I experienced more focus in/after rehearsal today." Table 4.5 provides the total data collected from all the answers for the four weeks.

Table 4.5 Participant Survey Results – Question 2

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Week 1	3	13	4	1	0
Week 2	11	15	5	1	0
Week 3	28	20	5	0	0
Week 4	13	14	4	1	0

Analysis of the completed responses revealed that before the HF breathing exercises, 14% of the participants strongly agreeing that they experienced more focus during/after choir rehearsal, 62% agreed, 19% chose neutral, and 5% disagreed. No participants strongly disagreed. After just one week of HF breathing exercises (Week 2 results), those responses improved to 34% of the participants strongly agreeing that they had more focus during/after choir rehearsal, with 47% agreed, 16% neutral and only 3% disagreed. None of the participants strongly disagreed. After the second week of HF breathing (Week 3 results), the improvements in feelings of focus continued with a rise to 53% of participants who strongly agreed to an increase in focus while 38% agreed and 9% were neutral. No participants disagreed or strongly disagreed for Week 3. Figure 4.5 displays this data in a graph.

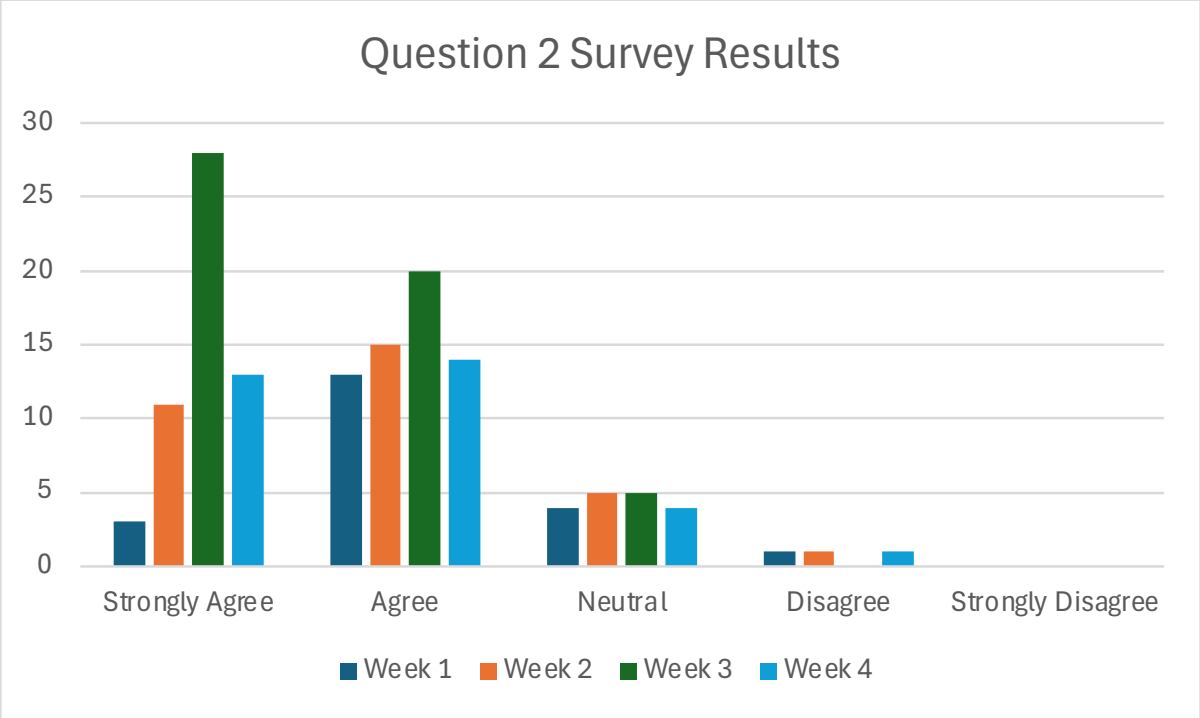

Figure 4.5 Question 2 Survey Results (Average)

Connection

Question Three of the Likert survey asked, "I experienced a higher level of connection with my classmates in/after rehearsal today." Table 4.6 provides the total data collected from all the answers for the four weeks.

Table 4.6 Participant Survey Results – Question 3

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Week 1	4	11	6	0	0
Week 2	11	10	9	2	0
Week 3	26	18	8	0	0
Week 4	13	11	7	1	0

Analysis of the completed responses revealed that before the HF breathing exercises, 19% of the participants strongly agreed that they experienced more connection to their classmates during/after choir rehearsal, 52% agreed, and 29% were neutral. No participants disagreed or strongly disagreed. After one week of HF breathing exercises (Week 2 results), those responses improved to 35% of the participants who strongly agreed they had more connection to others during/after choir rehearsal. However, there was a decrease in connection with the remaining participants 31% agreed, 28% were neutral, and 6% disagreed. None answered strongly disagree. After the second week of HF breathing (Week 3 results), the improvements in feelings of connection increased again rising to 51% of participants who strongly agreed to an increase in connection while 34% agreed and only 15% were neutral. No responses of disagreed or strongly disagreed were collected for Week 3. Figure 4.6 displays this data in a graph.

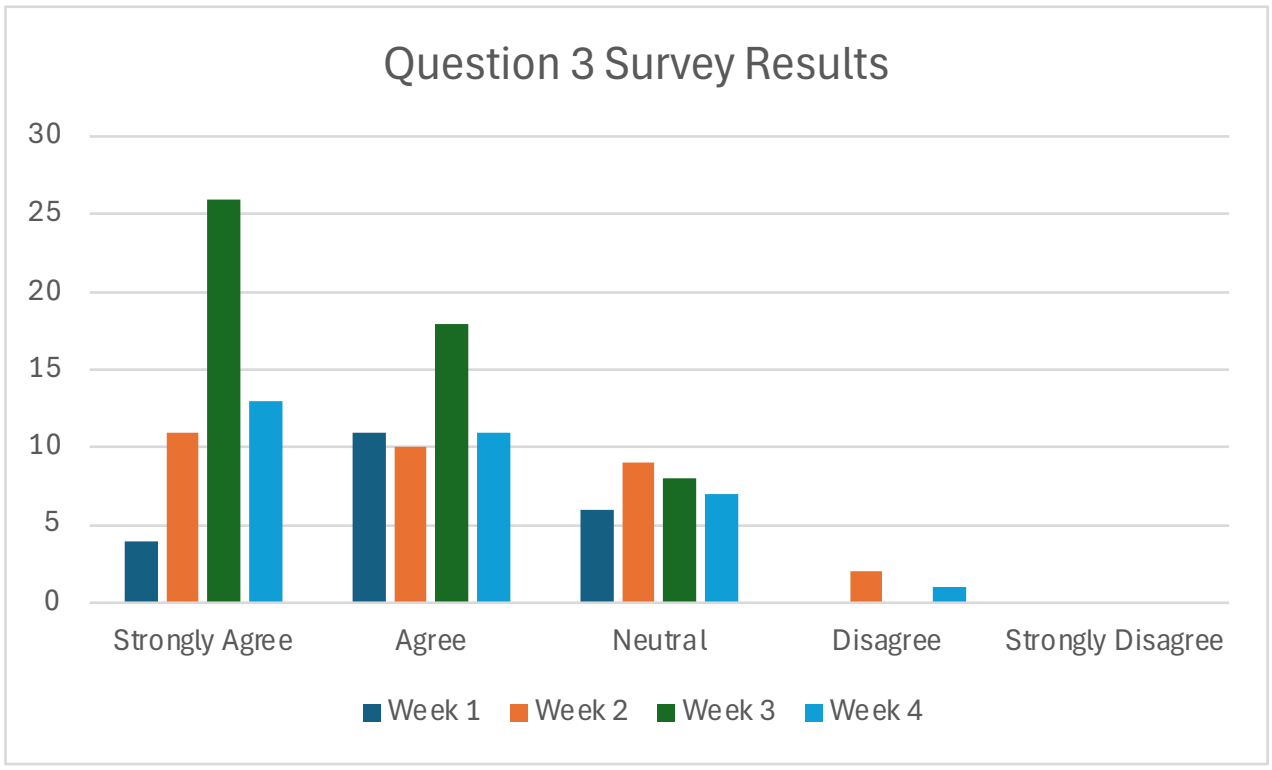

Figure 4.6 Question 3 Survey Results (Average)

An increase in coherence – connection with others – promotes communication and synchronized behavior in groups with similar goals, such as a choral ensemble.[10] The Centers for Disease Control and Prevention (CDC) says that the nation's schools are key to addressing the mental health epidemic, which was officially declared in 2021 and that "connectedness" to school is linked to better mental health.[11] Additionally, numerous studies of various populations, regardless of geography or culture, have found that when "individuals have close and meaningful relationships, they have reduced risk of mortality and susceptibility to chronic and infectious

[10] S. Edwards, D. Edwards, and Honeycutt, "HeartMath as an Integrative, Personal, Social, and Global Healthcare System," 381.

[11] Donna St. George, "One school's solution to the mental health crisis: Try everything," *Washington Post*, www.washingtonpost.com/education/2023/04/28/school-mental-health-crisis-ohio.

disease, have improved outcomes in pregnancy and childbirth and overall live happier and healthier lives."[12]

A study conducted in 2017 obtained electroencephalography (EEG) readings from student musicians playing instruments together during regular classroom rehearsals. This study simultaneously recorded EEG activity from twelve students as they engaged in rehearsal, as well as social interactions over eleven days. They found that brain-to-brain synchrony between the students was consistently associated with increased class engagement and improved social dynamics.[13]

In groups, synchronization and coherence has been shown "to increase conformity, cooperation and trust, and the strengthening of social attachment between group members."[14] The importance of social coherence for people's health, as well as for team and organizational performance and societal harmony highlights the need for programs that strengthen people's capacity for emotional self-management and focus on increasing social coherence. HeartMath HF breathing exercises could address social incoherence in a practical, low-cost manner to help increase and stabilize group coherence and resilience in organizations, teams, schools, and communities.

Emotional Regulation

The final question of the Likert survey asked, "I experienced a higher level of ability to regulate my own emotions in/after rehearsal today." Table 4.7 provides the total data collected from all the answers for the four weeks.

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[12] McCraty, "New Frontiers in Heart Rate Variability and Social Coherence Research," 2.

[13] Ibid., 4.

[14] Ibid., 3.

Table 4.7 Participant Survey Results – Question 4

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Week 1	4	7	9	1	0
Week 2	10	14	7	2	0
Week 3	22	20	10	1	0
Week 4	15	12	4	1	0

Analysis of the completed responses revealed that before the HF breathing exercises, 52% of the participants strongly agreed or agreed that they experienced a higher level of emotional regulation during/after choir rehearsal, with 43% choosing neutral, and 5% disagreeing. After just one week of HF breathing exercises (Week 2 results), those responses improved to 75% of the participants strongly agreed or agreed that they had an improvement in emotional regulation during/after choir rehearsal, with 29% choosing neutral, and 6% disagreeing. After the second week of HF breathing (Week 3 results), the improvements continued with a rise to 90% of participants strongly agreed or agreed that they experienced a higher level of emotional regulation either during or after choir rehearsal. For Week 3, 19% answered neutral, while only 2% disagreed. No participants strongly disagreed for any of the four weeks for Question Four. The data for Question Four is recorded in Figure 4.7.

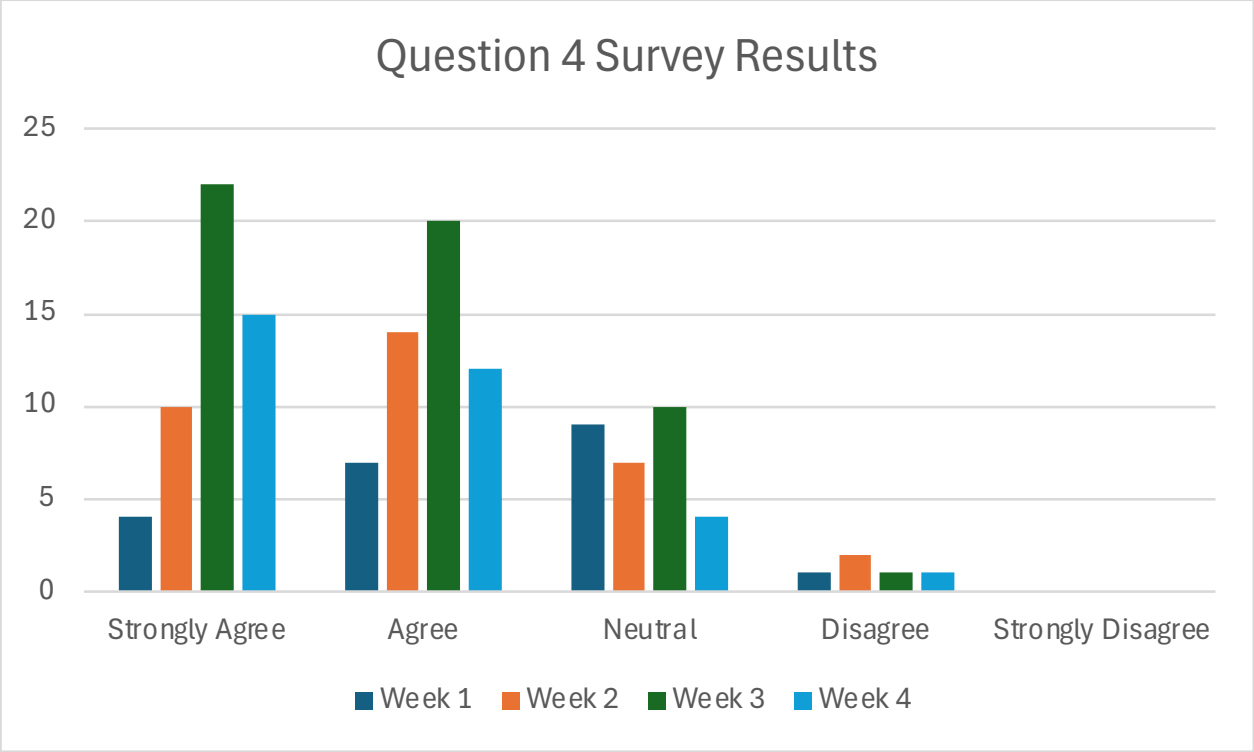

Figure 4.7 Question 4 Survey Results (Average)

Themes from Pre- and Post-Research Interview Questions

The researcher conducted a pre- and post-research short in-person interview with each research participant. In-person interviews provide a rich exchange of information, including the ability to observe non-verbal cues, enhancing the researcher's understanding of the participants' experiences. While identifying themes in qualitative research, authors Braun and Clark distinguish between two levels of analysis: semantic and latent.[15] Semantic themes are formed "…within the explicit or surface meanings of the data and the analyst is not looking for anything beyond what a participant has said or what has been written."[16] Latent themes start to identify or

[15] Maguire and Delahunt, "Doing a Thematic Analysis," 3353.

[16] Ibid.

examine the underlying ideas, conceptualizations, or ideologies as shaping or informing the sematic content of the data.[17] This study will focus on identifying semantic themes.

The participants were asked the same five questions before the research phase and after the research was completed. The first four questions were "Yes" or "No" questions, with the last question being open-ended. The first four questions correlated directly to the daily Likert-scale surveys that the students were also completing throughout the research process. The data and overarching themes are explained below.

Themes from Question One

The first question of the interview was "Do you feel that music or choir rehearsal helps with your stress or anxiety levels?" Ten of the eleven participants answered "Yes" to Question One in the pre-research portion of questioning. Several elaborated that choir is "my favorite part of the day."

In the post-interview, all eleven participants answered "Yes" to Question One, which shows an improvement in overall anxiety or stress. Several went on to comment that choir is a "reprieve from the rest of the day," "a place I can fully breathe and decompress," and that "I always feel better after choir."

Themes from Question Two

The second question of the interview was "Do you currently feel a high level of connection to the other singers in your ensemble?" Eight of the eleven participants responded with "Yes" in the pre-research interview. Those who responded with "No" were all new to this

[17] Maguire and Delahunt, "Doing a Thematic Analysis," 3353.

ensemble; they went on to explain that they did not yet feel connected because they were still getting to know the members of the choir.

In the post-interview, ten of the eleven participants answered "Yes" to Question Two, which shows an improvement in overall connection in the ensemble. Participant D commented "with doing the breathing, I felt there was a different level of connection, we would all breathe at the same time and share that silence together. It made us more whole in a way and more connected."

Amid the mental health crisis, feelings of isolation and disconnection are running high, much because of the rise of social media. One Canadian college student wrote the following to the author of *The Anxious Generation: How the Great Rewiring of Childhood Is Causing an Epidemic in Mental Illness*:

> Gen Z are an incredibly isolated group of people. We have shallow friendships, superfluous romantic relationships that are mediated and governed to a large degree by social media…There is hardly a sense of community on campus and it's not hard to see. Oftentimes I'll arrive early to a lecture to find a room of 30+ students sitting together in complete silence, absorbed in their smartphones, afraid to speak and be heard by their peers. This leads to further isolation and a weakening of self-identity and confidence, something I know because I've experienced it firsthand.[18]

American psychologist Jean Twenge has shown through several studies that teens who spend more time using social media are more likely to suffer from depression, anxiety, and other disorders, while teens who spend more time with groups of young people (such as singing in a choir or playing team sports) have better mental health.[19]

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[18] Haidt, *The Anxious Generation*, 123.

[19] Ibid., 121.

This study's research shows that HeartMath Heart-Focused breathing exercises increase feelings of connectedness among students. If these exercises can be utilized in all types of classrooms, not just music ensembles, to assist educators in connecting students more to one another, instead of their technological devices, the benefits to students' overall mental and emotional health are very high.

Themes from Question Three

The current use of technological devices, specifically cell phones, does not just affect the connection of students to one another but also decreases their focus and attention. In 1890, American psychologist William James described attention as "the taking possession by the mind, in clear and vivid form, of one out of what seems several simultaneously possible objects or trains of thought…It implied withdrawal from some things to deal effectively with others."[20] Attention or focus is something many students struggle with, especially with the rise of Attention-deficit/Hyperactivity Disorder (ADHD) among youths, and it is a choice we make every moment to stay on one task or one "mental roadway." When we allow ourselves to be frequently sidetracked, we end up in "the confused, dazed, scatterbrained state" that James says is the opposite of attention.[21]

The third question from the Interview was "Do you currently feel an increased sense of focus when you are in your ensemble rehearsal?" In the pre-research interview, eight of the eleven participants answered "Yes," two answered "No," and one answered "Sometimes – depends on what we are working on."

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[20] Haidt, *The Anxious Generation*, 127.

[21] Ibid.

In the post-interview, all eleven participants answered “Yes” to Question Three, which shows an improvement in overall focus during the choral rehearsal. Participant H mentioned, “It was cool to see after I did the breathing, I would have more focus in rehearsal, my heart rate would be lower – it was neat to see that and feel that in my body.” Participant C also commented that “it really helped me focus more. I get really distracted easily; [the HF breathing] helped me focus more on the music. Even when you were working with another section, I was looking at my music or thinking about my part.”

The HeartMath HF breathing exercises seem to increase focus and attention; they assist the student in focusing on the task at hand while encouraging them to let go or withdraw from other events, stress, or ideas that may be on their mind. With the endless array of notifications and a constant stream of interruptions that bombard our current students, perhaps HF breathing exercises could be a way to improve focus in a classroom and assist the students in their ability to fight attention fragmentation.

Themes from Question Four

Question Four from the interview the researcher conducted was “Do you feel that you can successfully regulate your own emotions daily?” All eleven students answered “Yes” in the pre-research portion. Two of the students went on to elaborate that it “varies a bit depending on what occurs in the day.”

In the post-interview, all eleven participants answered “Yes” to Question Four, which indicates neither an increase nor decrease in emotional regulation. Several participants did elaborate that they have utilized these exercises during times of stress in other parts of their lives, specifically relating to school or social situations, which has helped them calm down and shift their emotional state during these stressful moments.

A person's ability to regulate their own emotions is a necessity to progress through daily life. With the rise of social media and less communication and interaction with others in our youth, their ability to regulate their own emotions has diminished significantly. Emotional intelligence involves managing one's own emotions, especially in stressful situations, forming empathy, having good social skills, and inhibiting resilience. Deliberate practices, such as meditation or the Heart-Focused breathing techniques from this study, can strengthen the cognitive capacity to recognize, manage, and regulate feelings more efficiently.[22]

Themes from Question Five

The fifth and final question of the interview was the only open-ended question in the interview process. It asked, "What do you love most about being part of a choir or music ensemble?"

The largest theme from both the pre-and post-research portion was the sense of community. All eleven participants mentioned in some capacity that creating music with other people and feeling connected with others was the element they loved most about being in a choir. Participant E went on to explain "in a wordless way we all connect to each other, we all know each other very well in a way that words cannot communicate, only through music." Participant H discussed the "community built within the choir and the family that is created in choir" as being their favorite element of a music ensemble. This was further described by Participant J when they said "being able to be part of a team and work with others to have a unified goal" was their favorite part of choir.

This theme of community and the enjoyment of making music with others ties into the physiological coherence between musicians that occurs when singing. The unity that choir

[22] Haidt, *The Anxious Generation,* 291.

seemed to bring to the participants remained a common thread throughout all the answers during both the pre-and post-interview questioning.

Additional Comments About Heart-Focused Breathing Exercises

Participant H said the exercises were "super helpful in rehearsal if I was having a tough day, it would calm me right down and would let me focus." They went on to say:

> It was before a speech I had to do for my communications class – I used the breathing and was like Okay, I need to relax because I was freaking out and that brought me right down and let me give the speech in a better state of mind. And I've used them two other times when I've been freaking out. It helps to get something positive in your mind when everything else sucks, it helps.

This participant's comment directly correlates to the study conducted by McLeod and Boyes, which found that the HF breathing and other SEL skills learned through HeartMath could easily be transferred to other areas of study.[23]

Participant D echoed this feeling by stating "I enjoyed the intention and thinking about something you could put the breathing towards instead of just 'oh I need to calm down and need to breathe and I'm just going to slow down.' After we did our breathing with the intention, it's something I could carry with me through the rest of the day."

Both participant reflections showcase the versatility that HeartMath exercises can bring into a person's life. It can be utilized far beyond just the music classroom and the skills can be transferred throughout a student's life to assist in emotional regulation, stress management, connection, and focus.

[23] McLeod and Boyes, "The Effectiveness of Socio-Emotional Learning Strategies," 838.

Summary

This research study examines the effects of HeartMath Heart-Focused breathing exercises on the physical, emotional, and mental health of undergraduate college students enrolled in a choral ensemble. The study involves eleven college students, five male and six female, from Alma College who volunteered as research participants. The study utilizes two different forms of data collection: quantitative data from the InnerBalance Coherence Sensor, which gathered the heart rate variability and heart coherence score of each participant, and qualitative data, collected via five-point Likert-scale surveys and pre- and post-interviews with the participants. The researcher gathered both the quantitative and qualitative data into an Excel spreadsheet for analysis. The researcher then used the data to create several graphs and tables representing the findings and trends of the data. Additionally, the researcher analyzed the pre-and post-interview questions to find reoccurring themes. The researcher supported each theme with quotes from the interviews.

Chapter Five: Conclusion/Discussion

This chapter summarizes the current study and presents conclusions based on the mixed-methods research findings. Chapter five begins with a summary of the study, followed by an outline of the findings and prior research, and limitations of the study. Next, recommendations for future study are highlighted to build upon and strengthen these results. Finally, this chapter concludes with the potential implications for music educators, researchers, curriculum directors, and school administrators, which includes a short curriculum to assist those in introducing HeartMath Heart-Focused breathing exercises into a classroom.

Summary of Study

The purpose of this study was to examine the benefits that HeartMath Heart-Focused breathing exercises could have on the physical, emotional, and mental well-being of students in a collegiate-level choral ensemble. This study aimed to discover the ways HeartMath Heart-Focused breathing exercises affect students' heart rate variability, physiological coherence, anxiety or stress levels, their focus, and their connection to others in the choral ensemble.

The researcher used a mixed methods approach, collecting both quantitative and qualitative data from eleven volunteer research participants from the SATB ensemble, Alma Choir, at Alma College in Michigan. The significance of this research extends beyond academic contributions, offering practical implications for students looking to improve their physical, mental, and emotional well-being.

The research questions presented for study by the researcher are:

RQ1: What are the scientific indications, as monitored by heart rate variability biosensors, that physical, emotional, and mental health are affected through heart coherence and

physiological entrainment when incorporating HeartMath exercises into the daily choral rehearsal?

RQ2: What are the benefits of shifting focus from a traditional mindset of the choral rehearsal toward one that embraces the possibility of sympathetic vibrations in a choral music education setting?

While closely examining the issues that current music students face, it becomes evident that there is a need for a more holistic, low-cost way in which students' overall well-being is enhanced. Anxiety levels are at an all-time high and the effects of more social media usage is taking a toll on students' mental health. This study aimed to discover if HeartMath Heart-Focused breathing exercises could become a potential tool to improve students' mental and emotional wellbeing, as well as benefiting their physical bodies.

Summary of Findings and Prior Research

The findings of this study provide evidence that the HeartMath Heart-Focused breathing exercises are a tool from which system-wide emotional and physiological changes can be made for students in a simple, low-cost way. The researcher collected biofeedback quantitative data via the InnerBalance Coherence Sensor and qualitative data via pre- and post-interviews along with Likert-scale surveys. The researcher organized the quantitative data into tables and charts for analysis and the qualitative findings into four themes: Anxiety, Focus, Connection, and Emotional Regulation.

The quantitative results from this study provide a physiological reading of how the HeartMath HF breathing exercises affect the body. The quantitative results show an improvement in both heart-rate variability (HRV) and heart coherence scores. During the research phase of three weeks, ten of the eleven participants showed an increase in HRV for the

second reading, which was taken directly after the HF breathing exercises. This second reading was also higher or equal to the baseline reading for all eleven participants. Higher levels of HRV are associated with superior mental performance on tasks requiring executive functions, such as critical thinking, focus, and emotional regulation. The heart coherence data shows similar results. All eleven participants showed an increase in average heart coherence between the first reading (collected at the beginning of rehearsal before the HF breathing exercises) and the second reading (collected immediately after the HF breathing exercises were performed). This second reading is also higher than the average baseline coherence score for all the participants. Additionally, the average coherence score increased even higher for all eleven participants during the third week of data collection.

The qualitative Likert-scale survey results of this study provide a well-rounded scope of how HeartMath Heart-Focused breathing exercises affect the participants on a mental and emotional level. The qualitative results show an overall improvement in anxiety, focus, connection, and emotional regulation amongst participants. After two weeks of the HeartMath Heart-Focused breathing exercises, the number of participants who strongly agree/agree that they experience less anxiety during or after choir increased from 67% to 90%. Similarly, the percentage of participants who strongly agree they had more focus in or after choir increased to 53% from a starting point of just 14%. Similar trends were found in the feelings of connection amongst the participants with an increase from 19% to 51% of participants who strongly agreed that they feel connected to the other members of the ensemble. Finally, emotional regulation improved for the participants as well; these numbers increased from 52% who strongly agree they can regulate their own emotions to 90%.

Similar improvements were reflected in all four themes of the pre- and post-interview questions. Additionally, an overarching theme of community was discovered as a common thread throughout all the participants' open-ended answer in the interview. All eleven participants mentioned in some capacity that feeling connected with others and making music together was the element they loved most about being in a choir.

Although this study was conducted with a collegiate-level choral ensemble, findings from this study can be applied to all levels of choral ensembles, as well as instrumental ensembles who want to incorporate warmups that also enhance breathing techniques and elevate focus in the music classroom. Music educators and school administrators can apply information from this study to highlight the importance of music, advocating for the music programs in their school. HeartMath breathing exercises could also be utilized in other types of classrooms at all grade levels, especially prior to assessments or tests, where stress is often high. These exercises could also be used to assist a group of students to work together, focus on a specific task, or build community.

Limitations

This study used a mixed methods research method, including both quantitative and qualitative data. While the qualitative techniques used did offer depth and insight into the personal experiences and emotions of the participants, they carry several limitations. First, the study is limited to eleven students from Alma College in mid-Michigan, with only one being a person of color. While all the participants provide rich, varied perspectives on their experiences with HeartMath and the choral ensemble, the limited sample size and the low number of minority participants restrict the breadth of experiences represented in the study. This limitation may prevent the findings from fully encapsulating the range of views and experiences of music

students from a broader context. To lessen the impact of this issue, the researcher designed the study with interview questions to further explore the topics found in existing research and to close as many literary gaps as possible.

The shared usage of three HeartMath Inner Balance sensors may have affected the collection of the quantitative biofeedback data. If each of the eleven participants had their own monitor, the readings of the HRV and coherence score may have been more accurate to what was occurring with their bodies in real-time. These sensors could remain on the research participant the entire duration of the rehearsal, providing a more detailed and specific volume of data for each person involved.

Additionally, the timing of the research may have influenced the depth and quality of the data collected. The research was conducted when the researcher was stepping into a new role as Director of Choral Activities, while also preparing the choir for their first performance of the school year. The added stress of the first performance, as well as other life stressors outside of the choral rehearsal, may have influenced both sets of data collected throughout the research.

Future studies should aim for a larger, more diverse group of participants – perhaps from several locations across the United States – and should consider the impacts of the surrounding departmental and/or institutional events on the HeartMath data and research. Additionally, future studies could extend the research phase to collect data over a longer period. This may reveal the lasting effects of HeartMath implementation.

Recommendations for Future Study

A suggestion for future study would be for the study to be extended for a longer research period, as well as providing individual sensors for each participant. Thus, the synchronization of heart rhythms could be tracked for everyone in real-time, which would be an ideal approach for

studying real-time dynamics for the classroom, as well as physiological synchronization among the individual students. Additionally, given the data readings and the drop in quantitative data for most participants by the time the third reading was collected, it would be a suggestion to reimplement a short HF breathing session of one-minute or less later in the rehearsal, to see if the data was improved in any way with this small alteration to the overall process.

In addition to the length of the overall research period, another suggestion would be to elongate the time of the actual breathing exercises. In the post-interview, Participant A mentioned "I think it would work a bit better if we did the breathing for longer." The current study conducted the breathing exercises for approximately four to five minutes, but future studies should aim to extend this period by one to three minutes to see if the positive physiological effects are extended after a longer breathing time.

The HeartMath Institute has some exciting new technologies that could assist in future, larger-scale studies. They have created a new experimental control software, which provides real-time feedback of a group's collective coherence level. Each participant is provided with feedback of their own HRV coherence level while simultaneously being presented with the group's overall coherence score.[1] Essentially, there is both the individual's coherence and the group's social coherence scores being displayed. Utilizing this technology in a future study of a music ensemble would be fascinating. Additionally, it would be intriguing to study how the music being performed would affect the overall group coherence score.

[1] McCraty, "New Frontiers in Heart Rate Variability and Social Coherence Research," 7.

Implications for Practice

This study on the HeartMath HF breathing exercises in the choral ensemble offers valuable insights that can significantly benefit music education teachers, professors, and administrators. By shedding light on the incredibly positive effects that HeartMath can have on the choral ensemble, the findings provide a foundation for developing practices that can enhance the student experience, performance, connection, and overall physical and emotional well-being. The research underscores the importance of educators being well-versed in how to adopt teaching methods and create a classroom that fosters a safe, empathetic, and supportive environment in which to begin these exercises. The ability of an educator to implement these exercises into their rehearsals should improve students' focus and connection with others, as well as provide them with tools to manage their emotions and anxiety, creating a more holistic music education experience.

The researcher has created a short curriculum to provide a starting point for educators to begin studying HeartMath and begin to introduce the concepts of HeartMath into their music classroom or ensemble rehearsals.

Curriculum

HeartMath exercises should not begin until the teacher has established a positive, welcoming, and safe educational environment. Although the researcher implemented these exercises into the warmup portion of the choral ensemble rehearsal, the exercises can be performed at any time during the rehearsal process. In addition to a nice way to warm-up, these exercises may be a good way to refocus the ensemble if they have become off-task during a rehearsal or to provide an intention towards a specific piece of music, regarding mood, poetry, etc. which may benefit the overall music performance.

Heart-focused breathing is about directing one's attention to the area of the heart and breathing slower and more deeply than normal. It is a type of mindfulness exercise involving a shift in attentional focus to the breath and heart with a self-induction of positive feelings and gratitude. As the person breathes in and out, they should imagine they are doing so through their heart. In the beginning, placing their hand over their heart as they breathe can help direct the attention to this heart focus. The recommendation is to breathe in for five to six seconds and breathe out for five to six seconds in smooth, unforced breaths. There is also an option to hold the breath for two to three seconds before releasing it in an exhalation. Suggested full expansion of the diaphragm is especially beneficial for implementation into the choral ensemble. The total time of the breathing exercises should aim to be at least five minutes total for the full benefits to occur. The teacher should explain the methods of Heart-Focused breathing prior to placing an intention with the breathing exercise, so the students understand how to properly produce the exercises.

As the teacher has the students place their hands over their hearts to begin the breathing, declare an intention or feeling for the singers to hold in their mind and direct towards their heart in their breath; this seems to elevate the overall experience. The goal is for students to be able to activate and sustain the regenerative feeling, which could be love, appreciation, compassion, or gratitude. If an specific intention is desired, that should be repeated in a calm voice throughout the breathing exercises. The possibilities for intentions are endless and can be crafted to be an integral part of a teacher's warmup process or rehearsal plan. Allow the intention to be informed by the creative process; examples could be the choral repertoire, poetry, or a concert theme. Some suggestions for intentions could be:

- Think of something that fills you with gratitude, something that brings you joy and brings you feelings of love. Place this image in your mind as you breathe through your heart.
- The text of this piece of music revolves around the idea of friendship. Hold some space in your heart for a person who you consider a close friend and think of the things you appreciate about them or your friendship the most.
- Imagine a warm light emanating from the middle of your chest, right around your heart. Feel that warmth and comfort as you breathe in and out.

By incorporating the straightforward concepts of heart coherence activities, i.e., heart-focused breathing, into the daily choral rehearsal, our students' mental health, overall stress levels, and physiological well-being will be positively affected.

Summary

This study provides a detailed account of how HeartMath breathing exercises affect the physical, mental, and emotional states of college students in a choral ensemble. The study focused specifically on heart rate variability, physiological coherence, anxiety levels, focus, and students' personal connection to others. The convergent mixed methods analysis gathered through scientific data and reliable participant surveys and interviews, a shift in the scope of education regarding the implementation of more holistic ideas was validated in the choral ensemble setting.

In Chapter One, the researcher explains the topic, scope, and research questions of the study, thereby establishing the foundational context for the entire thesis. Chapter Two begins with a comprehensive summary and critical evaluation of relevant literature and completed research studies from various entities including the HeartMath Institute, positioning these within

the broader scholarly landscape. In Chapter Three, the researcher articulates the methodological approach employed to investigate the research questions, detailing the processes and strategies used to derive meaningful insights about using HeartMath exercises in the music rehearsal.

Chapter Four summarizes the research, outlining the study's objectives, methods, and approaches to the research questions. It integrates the findings with existing literature on HeartMath and overall student well-being, noting where they align or differ. The researcher collected both quantitative and qualitative data for the study through the HeartMath Inner Balance Sensor, Likert surveys, and individual participant interviews.

Chapter Five suggests further research needs, as well as provides a short curriculum suggestion that may help teachers begin to implement these exercises into their own ensemble rehearsals. This chapter aims to turn research insights into actionable strategies that improve the education and overall well-being of music students. Recommendations for future research include focusing on a more diverse participant pool, being aware of extraneous events that may affect the research and extending the research phase of the study.

By focusing on practical outcomes, the study aims to support the success of music students at all levels of education, emphasizing the importance of continuing research and action in studying the benefits of incorporating HeartMath exercises into the music classroom.

Appendices

Appendix A: IRB Approval (Part 1)

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

June 18, 2024

Nicole Mattfeld
Rebecka Rose

Re: IRB Approval - IRB-FY23-24-1591 The Emotional, Physical, and Mental Effects of Physiological Entrainment and Heart Coherence in the Choral Ensemble

Dear Nicole Mattfeld, Rebecka Rose,

We are pleased to inform you that your study has been approved by the Liberty University Institutional Review Board (IRB). This approval is extended to you for one year from the following date: June 18, 2024. If you need to make changes to the methodology as it pertains to human subjects, you must submit a modification to the IRB. Modifications can be completed through your Cayuse IRB account.

Your study falls under the expedited review category (45 CFR 46.110), which is applicable to specific, minimal risk studies and minor changes to approved studies for the following reason(s):

4. Collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving x-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications.)

For a PDF of your approval letter, click on your study number in the My Studies card on your Cayuse dashboard. Next, click the Submissions bar beside the Study Details bar on the Study Details page. Finally, click Initial under Submission Type and choose the Letters tab toward the bottom of the Submission Details page. Your stamped consent form(s) and final versions of your study documents can be found on the same page under the Attachments tab. Your stamped consent form(s) should be copied and used to gain the consent of your research participants. If you plan to provide your consent information electronically, the contents of the attached consent document(s) should be made available without alteration.

Thank you for your cooperation with the IRB, and we wish you well with your research project.

Sincerely,

G. Michele Baker, PhD, CIP
Administrative Chair
Research Ethics Office

Appendix B: IRB Approval (Part 2)

Date: 11-2-2024

IRB #: IRB-FY23-24-1591
Title: The Emotional, Physical, and Mental Effects of Physiological Entrainment and Heart Coherence in the Choral Ensemble
Creation Date: 3-22-2024
End Date:
Status: Approved
Principal Investigator: Nicole Mattfeld
Review Board: Research Ethics Office
Sponsor:

Study History

Submission Type	Review Type	Decision
Initial	Expedited	Approved

Key Study Contacts

Member Nicole Mattfeld	Role Principal Investigator	Contact [redacted]
Member Nicole Mattfeld	Role Primary Contact	Contact [redacted]
Member Rebecka Rose	Role Co-Principal Investigator	Contact [redacted]

Appendix C: Recruitment – Verbal Script (In Person)

Hello students,

As a doctoral student in the School of Music at Liberty University, I am conducting research as part of the requirements for a Doctorate of Music Education degree. The purpose of my research is to understand the effects of HeartMath heart coherence and I would like to invite you to join my study.

Participants must be 18 years of age or older and a college student who is enrolled in Alma College Choir (SATB choral ensemble) at Alma College. Are you 18 years of age or older and a college student in Alma College Choir at Alma College?

["Yes" response:] Participants will be asked to:

1. Participate in an in-person, audio-recorded interview that will take no longer than 20 minutes.
2. Measure your heart-rate variability (HRV) during Alma College rehearsal using the Inner Balance Coherence Sensor, which is clipped to your ear. You will be asked to record your HRV and coherence score throughout the class period - at the beginning of class (before the Heart Coherence exercises), immediately following the implementation of the Heart Coherence exercises, the middle of class (approximately fifteen minutes after the exercises were performed), and at the end of the class. This will continue for 3-4 weeks of class.
3. Participate in a Google Form survey after each class, which will take no longer than 10 minutes.
4. Participate in an in-person, audio-recorded interview that will take no longer than 20 minutes after the research has been completed.

Names and other identifying information will be requested as part of this study, but participant identities will not be disclosed and pseudonyms will be used.

["No" response:] Unfortunately, you do not meet my participant criteria, so I am unable to include you in my study. Thank you for your time.

Would you like to participate?

["Yes" response:] Great, can we set up a time for an interview and could you read, sign, and return this consent document to me? Here is the consent form. The consent document contains additional information about my research. If you choose to participate, you will need to sign the consent document and return it to me at the time of the interview.

["No" response:] I understand. Thank you for your time.

Thank you for your time. Do you have any questions?

Appendix D: Interview/Survey Consent

Title of the Project: The Emotional, Physical, and Mental Effects of Physiological Entrainment and Heart Coherence in the Choral Ensemble
Principal Investigator: Nicole Mattfeld, Doctoral Candidate, School of Music, Liberty University

Invitation to be Part of a Research Study

You are invited to participate in a research study. To participate, you must be 18 years of age or older and a college student who is enrolled in Alma College Choir (SATB ensemble) at Alma College. Taking part in this research project is voluntary.

Please take the time to read this entire form and ask questions before deciding whether to take part in this research.

What is the study about and why is it being done?

The purpose of the study is to research the physical, emotional, and mental effects on singers when incorporating HeartMath heart coherence breathing exercises into the choral ensemble classroom. The variables that will be measured will be heart rate variability, heart coherence score, anxiety, emotional self-regulation, focus, and overall sense of community.

What will happen if you take part in this study?

If you agree to be in this study, I will ask you to do the following:

1. Participate in an in-person, audio-recorded interview that will take no longer than 20 minutes. Questions will be centered around your personal experience in SATB ensemble, focusing on anxiety, community, focus, and emotional self-regulation.
2. Measure your heart-rate variability (HRV) during SATB ensemble class using the Inner Balance Coherence Sensor, which is clipped to your ear. You will be asked to record your HRV and coherence score throughout the class period - at the beginning of class (before the Heart Coherence exercises), immediately following the implementation of the Heart Coherence exercises, and approximately fifteen minutes after second reading was collected. This will continue for 3-4 weeks of class.
3. Participate in a Likert survey after each class, which will take no longer than 5-10 minutes. Questions will relate to anxiety, community, focus, and emotional self-regulation.
4. Participate in an in-person, audio-recorded interview that will take no longer than 20 minutes after the research has been completed. Questions will expand on your personal experience in SATB ensemble with the addition of the HeartMath coherence exercises, as well as the effects it had on anxiety, community, focus, and emotional self-regulation.

How could you or others benefit from this study?

Participants should not expect to receive a direct benefit from taking part in this study; however, participants could experience a more regulated heart rate variability, lowered anxiety, increased focus, increased ability to regulate their own emotions, or a greater sense of connection to their ensemble.

Benefits to society could include increased social (global) coherence, decreased sense of anxiety, improved emotional regulation, and increased focus. This may decrease the amount of violence and suicide experienced in society.

What risks might you experience from being in this study?

The expected risks from participating in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

How will personal information be protected?

The records of this study will be kept private. Published reports will not include any information that will make it possible to identify a subject. Research records will be stored securely, and only the researcher will have access to the records.

- Participant responses and scientific data will be kept confidential by replacing names with pseudonyms.
- Interviews will be conducted in a location where others will not easily overhear the conversation.
- Data collected from you may be used in future research studies and shared with other researchers. If data collected from you is reused or shared, any information that could identify you, if applicable, will be removed beforehand.
- Digital data will be stored on a password-locked computer, and physical data will be stored in a locked-desk drawer. After three years, all electronic records will be deleted, and all hardcopy records will be shredded.
- Recordings will be stored on a password-locked computer. The researcher will have access to the recordings. After three years, the recordings will be deleted.

Is the researcher in a position of authority over participants, or does the researcher have a financial conflict of interest?

The researcher serves as a professor at Alma College. This disclosure is made so that you can decide if this relationship will affect your willingness to participate in this study. No action will be taken against an individual based on her decision to participate or not participate in this study.

Is study participation voluntary?

Participation in this study is voluntary. Your decision to participate will not affect your current or future relations with Liberty University or Alma College. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

What should you do if you decide to withdraw from the study?

If you choose to withdraw from the study, please contact the researcher at the email address/phone number included in the next paragraph. Should you choose to withdraw, data collected from you will be destroyed immediately and will not be included in this study.

Whom do you contact if you have questions or concerns about the study?

The researcher conducting this study is Nicole Mattfeld. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at [redacted] or [redacted] You may also contact the researcher's faculty sponsor, Dr. Rebecka Rose, at [redacted]

Whom do you contact if you have questions about your rights as a research participant?

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the IRB. Our physical address is Institutional Review Board, 1971 University Blvd., Green Hall Ste. 2845, Lynchburg, VA, 24515; our phone number is 434-592-5530, and our email address is irb@liberty.edu.

Disclaimer: The Institutional Review Board (IRB) is tasked with ensuring that human subjects research will be conducted in an ethical manner as defined and required by federal regulations. The topics covered and viewpoints expressed or alluded to by student and faculty researchers are those of the researchers and do not necessarily reflect the official policies or positions of Liberty University.

Your Consent

By signing this document, you are agreeing to be in this study. Make sure you understand what the study is about before you sign. You will be given a copy of this document for your records. The researcher will keep a copy with the study records. If you have any questions about the study after you sign this document, you can contact the study team using the information provided above.

I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

☐ The researcher has my permission to audio-record me as part of my participation in this study.

_____

Printed Subject Name

_____

Signature & Date

Appendix E: Interview Script

Pre- and Post-Interview Questions

1. Do you feel that music or choir rehearsal helps with your stress or anxiety levels?
2. Do you currently feel a high level of connection to the other singers in your ensemble?
3. Do you currently feel an increased sense of focus when you are in your ensemble rehearsal?
4. Do you feel that you can successfully regulate your own emotions daily?
5. What do you love most about being part of a choir or music ensemble?

Appendix F: Survey Questionnaire

Survey Questions

Name: _____ Date: _____

I experienced less anxiety in/after rehearsal today.

1. Strongly Agree
2. Agree
3. Neither Agree nor Disagree
4. Disagree
5. Strongly Disagree

I experienced more focus in/after rehearsal today.

1. Strongly Agree
2. Agree
3. Neither Agree nor Disagree
4. Disagree
5. Strongly Disagree

I experienced a higher level of connection with my classmates in/after rehearsal today.

1. Strongly Agree
2. Agree
3. Neither Agree nor Disagree
4. Disagree
5. Strongly Disagree

I experienced a higher level of ability to regulate my own emotions in/after rehearsal today.

1. Strongly Agree
2. Agree
3. Neither Agree nor Disagree
4. Disagree
5. Strongly Disagree

Appendix G: Data Recording Sheet

Name:

Date:

	HEART RATE VARIABILITY	COHERENCE SCORE
TIME:		
TIME:		
TIME:		

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