THE RELATIONSHIP BETWEEN JUST INTONATION AND GESTURE: TRACKING THE EVOLUTION OF SOUND TO INFORM THE CHORAL REHEARSAL

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ABSTRACT

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A great deal of writing currently circulates on the preferred system of tuning for music and musicians, as well as the methods for achieving that ideal. Most musicians and theorists would agree that singers, specifically those who are well trained and singing unaccompanied music, will naturally tend toward a system of a more pure or "just" intonation. Further, recent texts by authors such as W.A. Mathieu have proposed the specific mathematics for such an intonation system as well as methods by which to achieve it. The result is a methodology and desired result for tuning, without the explanation for why it is functional other than the statement that it is somehow "more correct."

In a strongly correlated field of study, the rapidly developing field of music cognition presents a great deal of information regarding neural structure and the musical development of the brain. These studies include the idea of cognitive development both as it relates to the course of human evolution, as well as from birth to adulthood.

In this report, the author will present information from each of these fields of study, linking them to draw new conclusions which thusly advocate for the inherent

efficiency in just intonation. Additionally, hypotheses will be presented on how this tuning system is directly linked to score study and audiation, how this informs gesture in choral conducting, and the resulting effects of intonation in the choral setting.

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Introduction

Statement of Problem

In the discourse surrounding temperament and choices in the choral rehearsal, some relegate "just intonation" as a concept best left to theorists and mathematicians. For most choral conductors, particularly at the high school level, the idea of having students sing at pitches other than those clearly delineated by the piano seems challenging at best. However, the sonority of contemporary a cappella music sung in just intonation is far superior to the limited sounds available from the equal temperament of the piano.

It would seem that the problem for conductors in rehearsal is not a lack of desire for a purer intonation, but rather a disconnect between the information available and the ability to effectively disseminate this information to the singers. Thus the problem is: how does one create a rehearsal in which just intonation is a functional part of preparation and performance? Furthermore, how does just intonation inform one's gesture and audiation? And how will using informed gesture be received and interpreted by a choir?

Purpose of Study

The purpose of this study is to explore concepts from two major areas of study—just intonation and music cognition—to support the idea that a purer or just intonation is not only a more natural method of tuning, but also a more efficient way of music making in the choral setting. The literature available in the area of just intonation and more recently in the area of music cognition, when viewed in tandem, lead to a broader idea about the specific need for just intonation as it relates to gesture, audiation, and efficiency.

Limitations

For the purposes of this study, the research and novel ideas presented will be applied most specifically to rehearsal and performance at the high school level. As it will be presented across all levels of music making in the high school setting (including non-auditioned choirs) there is little expectation that each singer in the choir will achieve precisely pure intonation. There is an expectation for varied success in each level of choir, and indeed within each student. However, the study is presented as an aide to the choral conductor to inform score study, gesture, and audiation. This will ultimately lead to a more efficient choral rehearsal.

Related Literature

The study of just intonation is as old as the study of harmony. Hermann Helmholtz famously discussed this topic in *On Sensations of Tone*[1] in the late 19th century. Many have gone on to cite the work of Paul Hindemith and his explanations of the overtone series in his series *The Craft of Musical Composition*[2] and *Traditional Harmony.* For the purpose of this study, the specific design of just intonation will be taken from *The Harmonic Experience* by W.A. Mathieu[3]. Mathieu lays out the specifics not only for the theory behind just intonation, but for personal rehearsal methods for the discovery of these pitches as they unfold in the five-limit harmonic lattice. Furthermore, Mathieu goes on to suggest some specific ideas for gesture and tone color as it applies to the notes in the lattice.

Music as an art often bleeds into the world of science, as technology leads us further into the still vastly unexplored region of the human brain. In his quest for understanding music cognition, Daniel Levitin began with the question "Why does this song give me goosebumps?" His book *This is Your Brain on Music: The Science of a*

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[1] Hermann Helmholtz, *On the Sensations of Tone*. (New York: Dover Publications), 1954.

[2] Paul Hindemith, *The Craft of Musical Composition: Theoretical Part - Book 1 (Tap/159)*. (1942. Reprint, New York: Schott), 1984.

[3] W. A.Mathieu,.,*Harmonic Experience: Tonal Harmony from Its Natural Origins to Its Modern Expression*. Second Printing with Additions and Corrections ed. (New York: Inner Traditions), 1997.

Human Obsession is a study in music cognition for the masses[4]. He presents the field of music cognition in an accessible read for the choral conductor in the general music setting. He touches on a vast number of concepts but writes in the sort of prose that serves popular culture and avoids the perhaps more dense scientific concepts required to understand all of the studies available on the topic. These concepts were previously discussed in *Music, The Brain, and Ecstasy* by Robert Jourdain[5]. Jourdain too writes in common vernacular and begins to link concepts of cognition to the everyday enjoyment and practice of music.

After completing his first book, Levitin went on to study the history of song in a new book. His next book *The World In Six Songs: How the Musical Brain Created Human Nature* traces the history of song as a function of human evolution and its place in modern society[6]. In his study, Levitin quotes Steven Mithin and his book *The Singing Neandertahls*[7] which suggests singing as a precursor to language. Mithin goes on to pose singing as invariably tied to gesture from its onset; furthermore, Mithin propositions that singing is a function of evolutionary necessity—not an evolution of the spoken language.

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[4] Daniel J. Levitin, *This Is Your Brain on Music: The Science of a Human Obsession*. (New York: Plume), 2007.

[5] Robert Jourdain, *Music, The Brian, and Ecstasy: How Music Captures Our Imagination.*(1997. Reprint, Breattleboro:Harper Paperbacks), 2002.

[6] Daniel J. Levitin, *The World in Six Songs: How the Musical Brain Created Human Nature*. (New York: Plume), 2009.

[7] Steven Mithen,. *The Singing Neanderthals*. (Cambridge, Ma: Harvard UP), 2007.

Need for Study

It is from the sources explored above that this study begins. While each of these authors has presented a relatively comprehensive overview of their field, it is the link between these ideas that creates the most compelling evidence for just intonation in the choral setting. From the evolution of song as it relates to gesture to the current research being done in the field of music cognition, this study will show that just intonation is more complex than numeric theory in music. It is this information used in tandem that presents compelling evidence for ideas that will inform score study, gesture, and thus music making in the choral rehearsal. Relative to the concepts presented in most conducting methods materials and the limitations of equal temperament, the ideas presented in this study will lead to a greater level of efficiency and purer intonation.

CHAPTER 2

The Evolution of Song

Before one is able to consider an approach to music preparation, it is important to understand how music and the musical mind have evolved in the course of human history. This is particularly true in the case of vocal music which will hereafter be identified simply as "song." While it is impossible at this point to define with 100% certainty the true origin of song, many of the current studies suggest that music developed *before* language, accompanied by gesture, to form a sort of "musi-protolanguage." The how and why of this assertion has direct implications on song and gesture, and further on how the brain interprets this information.

Developing A Voice

The ability to create song as we have come to understand it is a purely human trait. While songbirds fill the air with sound, primates hoot throughout the jungles, and whales sing to each other in the ocean, no other creature has the ability to create song in the sense that humans can. The question of how and why humans developed "their voice" is important when considering how the brain processes music in the modern man. Was music a part of the evolutionary process and thus a necessary part of our development? Or was it simply a byproduct of our expanding minds and the physical changes to our vocal apparatus and respiratory systems?

In his studies of music cognition, Daniel Levitin suggests that

> Music's evolutionary origin is established because it presents across all humans (meeting biologists' criterion of being widespread in a species); it has been around a long time (refuting the notion that it is merely auditory cheesecake); it involves specialized brain structures, including dedicated memory systems that can remain functional when other memory systems fail (when a physical brain system develops across all humans, we assume it has an evolutionary basis); and it is analogous to music making in other species.[8]

By asserting that music is indeed a product of evolutionary selection rather than merely an effect of other evolutionarily developed traits, one can recognize that music is not simply a skill learned by those who choose to pursue it; rather, voice is a facet of human nature, a hardwired component of the human brain. This idea alone, however, does not provide sufficient information about the link between intonation, gesture, and sound. We can examine theories behind when and why song developed to begin to shed light on this idea.

Out of the Trees and Into the Desert

The science of how and when the ancestors of modern humans and those of modern apes branched off from their common primate ancestors is a vast science, too vast to be explored in detail in this report. However, several facts must be established about the human existence in the time prior to, and during, vocal development. Evolutionary scientists conclude that man's earliest ancestors came from East Africa, eventually leaving the cover of the African jungle for the open Savannah. "Darwin

[8] Levitin, *This Is Your Brain on Music,* 265.

proposed that man's music evolved from the vocalizations of sub-human primates like the apes (Darwin 1873, Chapter XIX) which served as 'emotional' signals."[9] Current research suggests that early human vocalizations were similar to those heard by modern primates.

If these earliest vocalizations were limited to the type of hoot and howl sounds we hear from modern primates, how and why did these vocalizations develop into language and music? Hard evidence in the fossil record is hard to come by, yet current research suggests that as the human brain evolved, it was "self-awareness" that created this possibility. Human beings appear to be the only species to have the ability to ask the question: "Why am I here?" Furthermore, we are one of the few species with the ability for abstract thinking and future planning. This transition in thought process allowed the humans to move beyond the trees, thus requiring new means of communication for survival.

As early man developed the ability to plan—to think ahead—hunting became more sophisticated. Humans likely worked together in groups in order to hunt their prey. This would have necessitated the ability to communicate to each other in new ways. Man would have needed abstract or metaphoric communication to communicate about objects and creatures not present: "This is how and when we will kill the deer." Rather than a grunt of reaction ("Look! Deer!") which may have been representative of nothing more

[9] John A. Sloboda, *The Musical Mind: The Cognitive Psychology of Music (Oxford Psychology Series, No. 5)*. (New York: Oxford University Press), 1986, 265.

than alarm, man now needed to represent "deer" with a specific sound. These sounds may certainly have been coupled with iconic gesture to represent certain items. Steven Mithin argues that these early communications would have been "Holistic, manipulative, multi-modal, musical, and mimetic."[10]

This concept, which Mithin refers to as "HMMMM" communication, is a model of a musical protolanguage which modern researchers believe accurately describes the way music and language *co*-evolved. As stated previously, this communication was created as we developed a sense of self-awareness: "The biological basis of our musical experience is related to the biology of human intelligence; that is, to our capacity to know the external world."[11] Darwin suggested that this primarily began as a simplistic means of conveying emotion for early human ancestors like *Homo habilis*. "*Homo habilis* most likely used vocalizations and body movements to express and induce emotions."[12] However, the expanding hominid habitat would have necessitated the expansion of vocal vocabulary. Along with many other factors, new techniques in group hunting would have fostered a more sophisticated system of communication. It is important to note that scientists believe words and specific language had not developed at this time. Instead, as Mithin suggests, a more holistic sound structure would have been used. There may have been a sound for "the deer are this way." This sound, accompanied by specific iconic

[10] Mithen,*The Singing Neanderthals*, 172

[11] *The Origins of Music*. (London: The Mit Press), 2001, 178.

[12] Mithen, *The Singing Neanderthals*, 234.

gesture, would have been a means for communicating thoughts or phrases in musical context.

> The musicality of 'Hmmmmm' would also have facilitated this process, because pitch and rhythm would have emphasized particular phonetic segments and thus increased the likelihood that they would have become perceived as discrete entities with their own meanings . . . The musicality of 'Hmmmmm' would, moreover, have also ensured that holistic utterances were of sufficient length, so that the process of segmentation would have some raw material to work with. And such utterances would certainly have been constituted of segments without and presupposition of their comprising words. They would have derived from the oral gestures . . . the physical movements of the lips, tongue tip, tongue body, tongue root, velum and larynx that create the phonetic segments of any utterance – holistic or compositional."[13]

Early Hominid Parenting

As hominids continued to evolve and adapt, several other features would have likewise emerged. As early hominids began to walk upright, they would likely have stood and reached upwards with both hands to pick fruit from trees. This ability would have been coupled with the need that as we grew in physical size and mental capacity, our bodies and brains would have required greater nutrition to survive. Leaving the cover of the trees would have also meant that there was a greater distance to cover when gathering food. It is likely that the female who was gathering food, picking from a tree or gathering from the jungle floor, would have to set down her infant as she is working. The "Hmmmmm" communication described by Mithin would have become useful in allowing a mother to comfort her infant from a greater distance. This sound may have been similar

[13] Ibid., 254.

to infant directed speech (IDS) present in all modern day cultures. "The general character of IDS will be well known to all: a higher overall pitch, a wider range of pitch, longer 'hyperarticulated' vowels and pauses, shorter phrases and greater repetition than are found in speech directed to . . . adults."[14] Just as in modern society, this communication would have been very musical.

This "putting down" of a baby was a byproduct of the need for the Early Human mother to do more work, concurrently influenced by several other necessities that came about during Early Human evolution. The first need for "putting down" would have coincided with the advent of bipedalism. "Labor is difficult for women because the shape of our ancestors' pelvises changed to accommodate the rearrangement of the muscles used for upright walking, which caused the birth canal to get smaller."[15] Although babies were larger in general, coinciding with the overall growth of Early Humans, the narrowed birth canal would have led to slightly less developed babies. This led to a change in the way mothers were able to care for their child. "Because of their physical immaturity, these newborns lacked the ability to cling unsupported to their mothers, a skill that monkey and ape infants very quickly develop. Before the invention of baby slings, women would have had little choice but to carry their helpless babies on their hips or in their arms. More important, they would have been forced to put their infants down as

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[14] Ibid., 69.

[15] Dean Falk, *Finding Our Tongues: Mothers, Infants, and the Origins of Language*. 1 ed. (New York: Basic Books, 2009), 20.

they gathered food."[16] So babies may have retained the grasping reflex but would likely have had much less physical strength or coordination. Change in grasping reflex coupled with another change that likely developed around this time. "It seems likely that hand in hand with the evolution of bipedalism came the loss of body hair, leaving just the few patches that we have today. Such loss would have been another physiological adaptation for keeping cool when foraging on the open savannah. The Early Human infants are likely to have had a grasping reflex, but this would have become increasingly limited in value as their parents became less hairy."[17] This further places physical strain on the mother. "A . . . solution to the big, helpless, demanding baby problem is the frequent 'putting down' of the infant for short periods within sight and sound of the mother . . . This would allow the mother to use both hands to pick fruit, butcher a carcass, drink from a river or knap stone. . .When she was ready to move on, perhaps to a new patch of berries . . . she could simply scoop up the baby from the ground, as she could whenever the child became distressed."[18]

Therefore, the increased "putting down" of baby would have led to an increase in the need for IDS (infant directed speech). "Long before baby slings were invented, mothers put their helpless babies down nearby as they went on about their daily tasks . . . I believe that at this point in evolution, mothers started maintaining *vocal* contact with

[16] Ibid., x.

[17] Mithin, *The Singing Neanderthals,* 199.

[18] Ibid,. 201.

their infants."[19] Mothers at this time needed to comfort their infants and attend to them but keep their hands free for labor. "Such utterances would have been essential because human babies do not like being 'put down' . . . Early Human babies are unlikely to have been any happier at being separated from their mothers than are those of modern day . . . humans. Similarly it is reasonable to suppose that infant crying created the same feelings of distress for Early Human mothers as we feel today when our own babies cry."[20] It is likely that these vocalizations would have been highly musical. "Above all, motherese is known for its musical quality, or prosody, which provides the melody or tone of voice in adult speech, coloring it with nuance and revealing emotions."[21] Mithin believes that ". . . those mothers who had a biologically based propensity to attend to their infants when they had been 'put down', by making use of vocalizations, expressions and gestures, were strongly selected; their genes, and hence such behaviours, would have spread in the population. [Falk] argues that the IDS that evolved was initially prelinguistic and was constituted by types of melodic and rhythmic utterances that lack symbolic meaning but that have the emotional impacts . . . which I have placed as a central feature of 'Hmmmmm.'"[22] It is probable that this mother-infact communication included iconic gesture.

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[19] Falk, *Finding Our Tongues,* 37.

[20] Mithin, *The Singing Neanderthals,* 201.

[21] Falk, *Finding Our Tongues,* 72.

[22] Mithin, *The Singing Neanderthals,* 201.

The Physical Evolution of the Voice

We know humans were moving from the ability to make simple sounds towards the ability to articulate unique sounds and tones; we must be established how early Humans physically transitioned to evolve this ability. Furthermore, this voice evolution helps demonstrate evolutionary transitions were perhaps more directly related to the ability to sing than for language. ". . . It is not unreasonable to think that evolutionary changes in the human vocal tract were adaptations for singing rather than for speaking, or perhaps even adaptations for joint musical and linguistic vocalization processes in the form of tone languages."[23]

As stated previously, the capacity for music came with a developing brain "because music and language are so neurologically intertwined, it is reasonable to speculate that they evolved together as brain size increased during the past two million years of evolution of the genus *Homo.*"[24] However, increased brain size was not enough to create the ability to sing—other physical adaptations had to be made. "As singing depends on an open vocal tract and thus vowels, it demands fewer articulatory constraints than speech. To the extent that the hyoid bone and external cranial base of early *Homo* fossils show modern configurations, then it is quite likely that these hominids were

[23] *The Origins of Music*., 2001, 9.

[24] Ibid., 213.

capable of forming the vowels necessary for singing"[25] This period of evolution also saw the advent of a lowered larynx which would have been extremely important in the ability communicate vocally. ". . . [A] lowered larynx increases the range and discriminability of speech sounds because it gives the tongue room to move both vertically and horizontally in the vocal tract, allowing for a more distinctive palette of formant patterns."[26]

As the instruments of the vocal apparatus evolved to use for singing, the respiratory system would have also developed. Increased lung size was a necessity for delivering oxygen to the bloodstream of a population increasing in body size and brain mass. As a result, "both the articulatory capacity to form vowels and the respiratory capacity to maintain high-volume airflow were present in our hominid ancestors, and therefore, most likely, the capacity to sing as well."[27]

Something to Sing About

New physical adaptations of early hominids and the necessity for new types of communication both would have contributed to the advent of song in the earliest humans. However, musical practice of the Early Human was not simply based in necessity. As man continued to evolve, there was now, more than ever, a reason to sing.

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[25] Ibid., 232.

[26] Aniruddh D. Patel, *Music, Language, and the Brain*. 1 ed. (New York: Oxford University Press), 2010, 360.

[27] *Origins of Music,* 232.

Ritual, Dance, Gesture, and Song

As the Early Human brain developed, several changes would have occurred. Among these changes came an increase in brain size and a need and ability to communicate metaphorically. Along with continued development in new hunting strategies there was also a rise in group and communal living. Song may have been the means by which early human communities met the need for metaphoric communication. Furthermore, each of these concepts would have led to the earliest human rituals. Anthropologists have documented that art and music were likely an integral part of early human development; cave paintings and artifacts such as bone flutes have been discovered as a part of the earliest archeological findings. It is not unreasonable then to assume that song was also an integral part of these communities.

"Music has helped to create human nature. There were some changes in the homo sapien early on, changes that gave rise to a drive to communicate metaphorically."[28] In continuing human development, this metaphoric communication would have led to ritual, mysticism, and to the earliest forms of religion. "In the late 1980s, French archaeologists explored prehistoric caves in southwestern France in a unique way – by *singing*. They discovered that the chambers with the most paintings were those that were most resonant. This startling insight suggests that caves were the sites of religious ceremonies involving

[28] Daniel J. Levitin, Interview by Dr. Drew Pinsky. "Dr. Drew Live 09/09/08." Dr. Drew Podcast Web site. MP3 File. http://www.westwoodone.com/podcast?categoryID2=515 (accessed April 12, 2011).

music. The incantations of the Cro-Magnons may have been as sophisticated as the surrounding artwork, accompanied by flutes and drums and whistles."[29]

It is unlikely that these rituals and celebrations were linked exclusively to the idea of mysticism, particularly in the beginning. It is most likely that these earliest celebrations and rituals were linked to what Daniel Levitin would call "songs of joy." These songs were perhaps performed around the fire to celebrate the kill of the day's meal, the birth of a new baby, or any other number of important events in the daily lives of the Early Human. "The prominence, if not dominance, of joy songs in the commercial sphere today points to a plausible role for them during evolutionary time frames."[30] As it seems such rituals would not only have existed but were likely prevalent in Early Human communities, they would have served an important role in the development and evolution of song and gesture. "In musical rituals, gesture and vocalizing function as coordinated, mutually reinforcing processes at both the individual and group levels, rather than serving as sequential or alternative manifestations of communicative intentions. Extension of these ideas might offer important insight into the origins of language-based communication. And in fact it seems quite plausible to assume that gesturing and

[29]Jourdain, *Music, The Brain, And Ecstasy: How Music Captures Our Imagination*., 2002, 305.

[30]Levitin, *The World in Six Songs,* 88.

vocalizing occurred in parallel during language evolution just as they most certainly did during music evolution."[31]

Grooming, Trust, and Sexual Selection

Song evolved alongside of and in conjunction with several other Early Human adaptations, namely grooming, development of trust, and sexual selection. Each of these adaptations would have been very early developments for our ancestors, and each was absolutely necessary for our survival; song was probably an integral part of human cultural evolution

Modern primate and prehistoric hominids used grooming as a function of both health and social interaction. Communal grooming would have been necessary for and would have developed along with larger community living. In addition to physical grooming, our ancestors may have developed certain sounds that acted as a kind of vocal grooming. "The social cohesion hypothesis occurs in various forms. One variant, proposed by Dunbar (2003), is that group singing resulted in endorphin release, thus mimicking the neural effects of physical grooming in primates (cf. Merker, 2000). (This forms part of Dunbar's larger argument that language evolved primarily to convey social information, thus allowing our hominid ancestors to replace physical grooming with "grooming at a distance" by means of verbal communication, and thus to achieve larger

[31] *Origins of Music*, 10.

group size. Dunbar argues that group singing preceded the evolution of language)."[32] The individual in the group best at grooming would have been valued and subsequently been in a position to be the most successful group member. "The group member who could make others feel good, either through grooming, sexual activity, providing more food, and so on, was one who became valued and could ascend to the position of group leader, in which case the community would work to meet his needs for him. Communication by sound allowed a potential leader to spread his influence around to many more at a time than could be done by one-on-one grooming"[33]

This vocal form of "social grooming" likely allowed for the building of trust between members of the hominid community. Song, therefore, was the ideal method of communication.

> What you want for a communication medium is one in which honesty can readily be detected, what ethnologists call an *honest signal*. For a number of reasons, it appears that it is more difficult to fake sincerity in music than in spoken language. Perhaps this is because music and brains co-evolved precisely to preserve this property, perhaps because music by its nature is less concerned with the facts and more concerned with feelings (and perhaps feelings are harder to fake than supposed facts are). Music's direct and preferential influence on emotional centers of the brain and on neurochemical levels support this view.[34]

Not only would trust have increased among individuals in a community where song was prevalent, but this would have created a much healthier and happier community

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[32] Patel, *Music, Language, and the Brain,* 370.

[33] Levitin, *The World in Six Songs,* 88.

[34] Ibid., 141.

in general. “Second, it is known that music can be a powerful force in mood regulation, suggesting that group music making could result in a shared mood state. Third, it seems plausible that a common mood state would enhance the subjective sense of a bond between individuals.”[35]

This bond between individuals may have been expressed further in the roles of sexual selection. “Might music play a role in sexual selection? Darwin thought so. In *The Descent of Man* he wrote, ‘I conclude that musical notes and rhythm were first acquired by the male or female progenitors of mankind for the sake of charming the opposite sex. Thus musical tones became firmly associated with some of the strongest passions an animal is capable of feeling, and are consequently used instinctively…’”[36]

Song and Gesture

Song, as we have defined it, was likely a very early development in the evolution of man. What began as a limited set of sounds which resembled the hoots, grunts, and cries of the animal world, naturally developed into our earliest system of communication: a musi-protolanguage. While is impossible to determine whether speech or song came first, the evidence would indicate that our earliest communication was highly musical, that it developed so early in our evolutionary history, and that its development was based

[35] Patel, *Music, Language, and the Brain,* 370.

[36] Levitin, *This is Your Brain on Music,* 251.

on necessity for survival. All of this suggests that music is not simply a byproduct of human development, but a trait hardwired into human existence.

In all modern systems of vocal communication, gesture is clearly linked to the sounds that we make. In everyday speech we can easily recognize several forms of gesture such as facial expression, "body language" and movements, and gestures made by our hands. It is likely that gesture was linked to song from the very beginning of Early Human vocalisms. Initially these gestures would have been more specific—certain gestures combined with certain sounds may have stood for holistic messages such as "there is food on the other side of the hill." However, as man developed the ability to think metaphorically, gestures and sounds likely became more representative than exact.

Song and gesture have been present since the earliest beginnings of man; it is therefore reasonable to consider hardwired into our existence. That music is present in all cultures, in all societies that have existed in history, suggests that it is a natural and necessary part of our existence. This natural hardwiring of song and gesture plays an important role in the communication between the conductor and his or her choir.

CHAPTER 3

Music and Cognition

Experts believe the human brain represents the last great frontier in science. To suggest that it is a complicated system is no doubt an understatement. However, the field of music cognition is continuing to reveal new information about how the brain processes and understands music. Together with what we know about music as it has developed through humanity, as well the way in which music manifests itself in man from birth to adulthood, the area of music cognition provides a great deal of information useful to the choral conductor. Several specific concepts including the science of mirror neurons, tonotopic mapping, the relationship between speech and language processing in the brain, and the way in which the human brain processes and understands auditory information create a set of information that allow the choral conductor to make choices in his or her rehearsal strategy and gesture which will lead to efficiency and a high level of musicality.

Monkey See, Monkey Do

In a relatively recent study, Gallese and Rizzolattie discovered that monkeys possess a type of neuron called mirror neurons. "Mirror neurons are a particular class of visuomotor neurons originally discovered in a sector (area F5) of a monkey's ventral premotor cortex. Their defining functional characteristics is that they become active both when the monkey makes a particular action (like grasping an object or holding it) and

when it observes another individual (monkey or human) making a similar action."[37] When a monkey engages in an action such as grasping an object, certain neurons are active in this process. Gallese and Rizzolattie discovered that these same neurons are engaged when the monkey is viewing this action being completed by another monkey. Upon making this discovery, scientists were interested in whether or not similar processes were involved in the human brain. "Recent neuroimaging studies in humans seem to support this view that a similar mirror system in humans may be located in or at least near Broca's area [the part of our brain associated with speech] (Rizzolattie et al 1996; Grafton et al. 1996; Iacoboni et al. 1999). Consequently, it has been hypothesized that mirror neurons in premotor cortices may have played a pivotal role in the evolution of human language and communication (e.g., Rizzolattie & Arbib 1998)."[38]

If this is true, it is likely that mirror neurons would have also played an active role in all early human communication, including gesture and song. This would have likely manifested itself in the imitation and replication of gesture, particularly those of the facial area.

> First, mirror neurons exist in humans as components of mirror systems that support recognition and replication (i.e. imitation) of the actions of a conspecific. Second, facial imitation, a capacity unique to humans, is supported by a specialized mirror system. Third vocal imitation, also unique among primates to

[37] Maksim Stamenov and Vittorio Gallese. *Mirror Neurons and the Evolution of Brain and Language*. (Amsterdam: John Benjamins Pub.), 2002, 15.

[38] Ibid., 77.

> humans, coopted and perhaps coevolved with the facial mirror system. Finally, I assume that the organization of a mirror system is both somatotopic and functional; that is to say, specific parts of the motor anatomy (e.g. hand, finger, lips, tongue) engaging in specific modes of action (e.g. grasping, twisting, smacking, protruding) activate a mirror system.[39]

With this assertion, the implications for a conductor become readily apparent.

If a conductor makes a choice about the shape of his or her hand when conducting, the mirror system present in the singer's brain can help the singer to understand and process this choice at a very instinctive level. "If the function of mirror neurons is, as Rizzolattie and Arbib (1998) have proposed, to represent the actions of others in the process of recognizing, understanding, and (perhaps) imitating them, we must suppose that these neurons are components of a system that mediates between a perceived movement or gesture, and activation of the coordinative structure that controls execution of that movement or gesture."[40] In other words, these systems aide in processing of information present in our gesture and can aide in a singer accurately responding to this gesture without the need to specifically define the gesture. This is important not only in a choral rehearsal, where part of efficiency can surely be described as the ability to communicate meaning without providing verbal explanation, but also in a performance where one must make music in real time. "Meaning to be negotiated in a highly developed dialogic interaction is so complex that *not everything can be expressed*

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[39] Ibid., 208.

[40] Ibid., 220 – 221.

explicitly. Not everything needs to be expressed verbally, taking account of the integration of different means."[41]

Recent science, in fact, suggests that mirror neurons are involved in other parts of the musical processes. "The purpose of mirror neurons is presumably to train and prepare the organism to make movements it has not made before . . . it may also explain why musical rhythm moves us both emotionally and physically."[42] It may also have an effect on the way in which we learn music. In recent studies ". . . neuroscientists speculate that our mirror neurons may be firing when we see or hear musicians perform, as our brain tries to figure out how those sounds are being created, in preparation for being able to mirror or echo them back as part of signaling system. Many musicians can play back a musical part of their instruments after they've heard it only once. Mirror neurons are likely involved in that ability."[43]

In his speech at the 2010 ACDA Western Regional Convention in Tuscon, Arizona, Dr. Weston Noble spoke on this very subject. He quoted portions of an email between himself and Dr. Geoffrey Boers (University of Washington) in which they discussed the subject of mirror neurons related to choral conducting. They each spoke with wonder, curious to know if "[we can] develop a set of conducting gestures that assist in firing a mirror neuron through our patterns, physical cues and other suggestions that

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[41] Ibid., 234.

[42] Levitin, *This Is Your Brain On Music,* 266.

[43] Ibid., 267.

can fire mirror responses in others?" The goal in finding such a system would be "so that our singers can feel what we are experiencing physically and emotionally."[44] While science has not yet defined mirror neurons as behaving in quite this fashion, it certainly does provide a plausible explanation for the interaction between a conductor and his or her choir. Noble, in his speech, went on to describe a specific experience between himself and one of his singers: "I had activated mirror neurons in Joan and conversely the choir. Together they had experienced what I felt physically and emotionally. The barrier between the choir and me was gone! My source of energy, my vulnerability had ignited their mirror neurons. And they began to identify with what I felt physically and emotionally! I was free to rehearse, to be open and vulnerable in every way. I allowed the choir to see me not only externally, but internally as well." [45]

In his eagerness to give meaning to his personal experience, Dr. Noble may be filling in holes in the research of mirror neurons that scientists are not yet willing to define. Further in his speech Noble identifies what is perhaps a more accurate representation: "I vividly remember noticing great instrumental and choral conductors being non-traditional in their conducting patterns. Why was/is this so? Were their conducting gestures further enabling the release of mirror neurons, as opposed to the more traditional beat pattern? What was paramount was the power of communication, the

[44] Weston Noble, "ACDA 2010 Western Division Conference Weston Noble Speech." *Tactus,* 34, no. 3 (Spring 2010): 10 – 12.

[45] Ibid.

beat patter being secondary. Never negate the power of your face. Your face, especially your eyes must be part of gesture. Eyes never lie!"[46]

Science has shown that one place mirror neurons are found to functioning is in imitation, and most notably in human facial imitation. Thus Dr. Noble's assertion that the face, and more specifically the eyes, was an impactful part of the conducting gesture is very important. Because audiation guides gesture, and gesture can be expressed through facial indicators, mirror neurons are likely involved in the reception of that audiation by the choral ensemble.

Based on the research being done with modern primates, we are able to infer that similar qualities were likely present in the brain of our common ancestors. As the human brain developed and became capable of higher level thinking, the gestures our ancestors utilized developed beyond being gestures of action to also be gestures of representation. Gestures would have begun to be symbolic for predator or prey, and later for non-tangible concepts such as love or God. With the need for these gestures came the need to interpret them. As mirror neurons likely played their part in this understanding, so do they play a role in communicating concepts found in music.

Making Music Together

Choral singing provides the opportunity for individuals to come together as a group to make music. As stated in chapter two, this has always been an important part of

[46] Ibid.

human culture—and likely an important part of our survival as a species. Despite the fact that this is likely no longer a necessity for survival, group music making remains a prominent part of human life to which members of our species are more or less well adapted to. ". . . Musicality is not the property of individuals but an essential attribute of the human species. The implication is not that some men are music while others are not, but that man is a musical animal, that is, a being predisposed to music and in need of music, a being that for its full realization must express itself in tones and owes it to itself and to the world to produce music."[47]

As stated in chapter two, singing likely played a major role in our evolutionary success, and there are several aspects specifically related to group music making that reinforce this fact. According to Daniel Levitin, "Singing together releases oxytocin, a neurochemical now known to be involved in establishing bonds of trust between people."[48] The ability to trust your neighbor was surely an important aspect of group music making in the early development of our species. Today, the development of trust in ensemble singing is an important factor in the ability for music making. This ability to trust can only enhance the force of empathy between conductor and choir that is already augmented by the firing of mirror neurons.

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[47] Victor Zuckerandl, *Man the Musician*. (Princeton, New Jersey: Princeton University Press), 1973, 7.

[48] Levitin, *The World in Six Songs,* 51.

The release of oxytocin forges bonds between people, strengthened during group music making; however, experts suggest that the simple release of endorphins shows that "music can be a powerful force in mood regulation, suggesting that group music making could result in a shared mood state. . . it seems plausible that a common mood state would enhance the subjective sense of a bond between individuals."[49] When the music is done well, in fact, "synchronized singing positively affects the psychological state of individuals."[50] Thus, the human mind is affected positively, and because chemicals are being released to the brain which enhance our ability to trust those around us, the positive feelings can become a shared group experience.

The positive effects of singing together or being sung to are often felt at an age well before children are able to sing themselves. Mothers in all cultures sing to their children which results in the release of prolactin in the infant brain. Prolactin is a chemical which causes feelings of comfort.[51] Children grow up hearing songs of comfort and go on to engage in group music making at a very young age. Trust and comfort can then be considered a very important part of why we engage in singing and how and why mirror neurons are active in this process. Feelings of trust and empathy are engaged in the human brain, and in turn mirror neurons aide in the ability to respond to the gestures of a conductor without the necessity for an explicitly stated meaning.

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[49] Patel, *Music, Language, and the Brain,* 370.

[50] Levitin, *The World in Six Songs,* 184.

[51] Levitin, Interview by Dr. Drew Pinsky.

W.A. Mathieu suggests that this ability for unspoken connection in choral music is about something bigger than the individual.

> When you sing in a choir, the intimacy of communal bond is palpable. For instance, if you are singing alto along with other altos, not only do your unisons with the other altos have to be true, but the alto section has to blend with the basses, tenors, and sopranos in order for the music to work. Furthermore, the altos are typically somewhat submerged in the overall texture, separately discernable to only the keenest outside listener. Why would anyone want to sing alto? Because the reward is extreme. To be a single cell inside such a human construction goes beyond sound waves into the essence of evolutionary cooperation. By temporarily giving up your individuality, you become more than yourself by far.[52]

Overtones and Mapping Music

One of the great advantages to just intonation, as opposed to the equal temperament employed by the piano, is that when singing in just intonation, a choir is able to exploit the natural overtones present in a tone. A great deal of science supports the fact that the brain will more efficiently process harmonic structures that are in line with overtone series.

Just intonation, perhaps more aptly identified as proportional or tonal harmony, is able to readily exploit the efficiency of human brain. Humans have the ability to discriminate between incredibly small variations in pitch; our hearing, in fact, is quite dynamic. "When we listen to musical tones, we divide the range of pitches in an octave (its *pitch space*) into only a dozen or so positions or 'categories.' Although under

[52] W. A. Mathieu, *Bridge of Waves: What Music Is and How Listening to It Changes the World*. (Boston: Shambhala, 2010), 129.

laboratory conditions we can distinguish perhaps thirty shades of pitches within a category, in the rough and tumble of music performance we hear most such pitches as being the same note. When a note comes in dead center, we deem it to be perfectly in tune."[53] When sung alone (without relation to any other pitch), a sung note is most likely to be perceived as "in tune" by its tone, timbre, or relative strength; it will sound in tune if it is well sung. However, in the context of harmony, a pitch finds "dead center" or a sense of being in tune in relation to the other pitches present.

Any pitch, when sung with the appropriate resonance, naturally produces other pitches which can be perceived by the human ear. "We refer to the pattern of energy at different frequencies as the overtones series. There is evidence that the brain responds to such harmonic sounds with synchronous neural firings – the neurons in the auditory cortex responding to each of the components of the sound synchronize their firing rates with one another, creating a neural basis for the coherence of these sounds."[54] One not only perceives the sounds of the overtones aurally, but is processing them on a neurological level, perhaps even without cognizing this fact. Furthermore, the brain is actually processing these specific pitches, perceiving them in much the way our eyes see the piano keyboard.

> The auditory cortex also has a tonotopic map, with low to high tones stretched out across the cortical surface. In this sense, the brain also contains a 'map' of different pitches, and different areas of the brain respond to different pitches.

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[53] Jourdain, *Music, The Brain, and Ecstacy,* 64.

[54] Levitin, *This is Your Brain on Music,* 42.

> Pitch is so important that the brain represents it directly; unlike any other musical attribute, we could place electrodes in the brain and be able to determine what pitches were being played to a person just by looking at the brain activity. And although music is based on pitch relations rather than absolute pitch values, it is, paradoxically, these absolute pitch values that the brain is paying attention to through its different stages of processing.[55]

The human brain is continually processing and recognizing specific and exact pitch values, represented in a map laid out in a manner not dissimilar to the piano's keyboard. Within a given pitch, the brain further processes multiple frequencies and registers them as the pitches presented in the overtone series. Further efficiency is found in the way these sounds are grouped in our processing of them. "Our auditory system exploits the harmonic series in grouping sounds together. Our brains coevolved in a world in which many of the sounds that our species encountered – over the tens of thousands of years in evolutionary history – shared certain acoustical properties with one another including the harmonic series as we now understand it."[56]

Speech, Song, and Gesture

Chapter two of this document explored the process by which early hominids developed the ability to sing. Scientists believe that this ability likely developed alongside the ability for speech, and several would contend that song is likely a precursor to speech. That song and speech are closely related is undeniable. Due to this obvious

[55] Ibid., 29.

[56] Ibid., 79.

relationship, along with information about how the brain processes each of these abilities, the choral conductor can begin to further understand the relationship between just intonation and gesture.

Speech and Song

The need for spoken language in early human development, as stated in chapter two, developed with a general state of self-awareness amongst our earliest hominid ancestors along with the need for future planning and increased communication. We have shown that speech likely developed alongside song and an increased vocabulary of symbolic gesture to form a holistic musi-protolanguage. According to Falk, "music and language evolved in lockstep with each other over millions of years of evolution as the musical and linguistic sides of the brain (right and left, respectively) gradually became larger and better at processing complex sound."[57] It is important to recognize that because they developed from necessity, and at essentially the same time in the evolutionary process, "both language and music are characteristics of the human species that seem to be *universal* to all humans and *specific* to humans. To say that language and music are universal is to say that humans have a general capacity to acquire linguistic and musical competence."[58]

[57] Falk, *Finding Our Tongues,* xi.

[58] Sloboda, *The Musical Mind,* 17.

Given that the capacity for song is a universal trait among human beings, it is important to understand how the brain processes song and how this is different from the way it processes speech. "The natural medium for both language and music is auditory-vocal. That is, both language and music are primarily received as sequences of sounds and produced as sequences of vocal movements which create sounds. Thus, many of the neural mechanisms for analyzing input and producing output must be shared."[59] However, this is not to say that the brain is processing language and music in the same fashion, or even with the same parts of the brain. "There are good reasons to believe that the brain treats spoken and musical sound systems differently."[60] Though from a physical standpoint, song is essentially elongated speech, "the brain's music system appears to operate with functional independence from the language system – the evidence comes from many case studies of patients who, post injury, lose one or the other faculty but not both."[61]

Non-Verbal Communication

Though they are processed differently, speech and music can both serve as forms of communication and, as has been previously stated, were closely linked in their earliest forms of development. However, "human communication is not just vocal, but also has a

[59] Ibid., 18.

[60] Patel, *Music, Language, and The Brain,* 72.

[61] Levitin, *This is Your Brain on Music,* 127.

large component based on gestures."[62] The statement above is not unusual as we see people speak with gestures on a regular basis. As choral conductors, we rely on gesture to communicate music to our choirs. This is effective because "unlike most words, gestures can be so transparent that one can understand (or invent) them without ever having been taught their meaning."[63] That gesture is so closely linked to both verbal methods of communication is important and perhaps may have a direct tie in to mirror neurons and their ability to aide in choral conducting. "Referring to mirror neurons and the conclusion that the evolution of language and communication started with gestures, there must have been a dialogic purpose or claim being carried out by means of the gesture. It is a dialogic action at the very outset which is signaled by the firing of the neurons."[64]

Mirror Neurons and Communication

This document has already discussed the potential role of mirror neurons in communication and conducting, but readers should note how the close the relationship between speech, song, and gesture ties with mirror neurons to produce a concept for how the modern human brain processes all of this information. "Based on their work with mirror neurons, Rizzolatti and other believe that human language evolved from a basic mechanism that was originally related to the capacity to recognize actions in others and

[62] Falk, *Finding Our Tongues,* 147.
[63] Ibid., 139.

[64] Jourdain, *Music, The Brain, and Ecstasy,* 240.

that manual gestures paved the way for speech to evolve."[65] This chapter previously identified a place in or near Broca's area as the likely location for a mirror system in the human brain. "Broca's area is an area in which not only speech but also hand movements are represented."[66] Thus, the mirror system in the human brain is likely involved in both language acquisition as well as the ability to communicate through gesture.

[65] Falk, *Finding Our Tongues,* 169.

[66] Stamenov, *Mirror Neurons and the Evolution of the Brain and Language,* 43.

CHAPTER 4

Sound Informing Gesture

In the previous two chapters, this document has laid out several ideas about how and why music has become a hardwired part of the human experience. That sound and gesture are connected is undeniable, and this is seen in the way people communicate on a regular basis. For a choral conductor, the ability to employ gesture that "looks like the music" is an important path to efficiency. It is clear that the music itself must inform the gesture of the conductor and that fitting all choral music into a fixed pattern is not effective. This chapter will suggest methods of music preparation and score study which will lead to gesture choices. These choices can lead to efficiency and increased musicality.

Harmony

Through human history, song has gone through many transformations. With new ideas and new technology have come many novel ideas about harmony and intonation. Through the study of evolution, scientists believe that music in humans was a necessary development for human survival, and thus it is a hardwired component of the human condition. There is also a great deal of current scientific evidence which further indicates that the ability to hear and understand harmony is naturally hardwired into the human brain. Because humans have a natural ability to process harmony, it follows that a system based on the natural frequencies of overtonal and reciprocal energy is the most efficient

one to use in the performing or interpretation of harmonic music in the canon of music in the Western-European lineage.

The Five-Limit Harmonic Lattice

At the center of this study is the assertion that gesture informed by just intonation, or proportional harmony, will lead to more efficient (and indeed more sonorous) music making. While just intonation is somewhat scientific in nature, it is not necessarily explicit in nature: different music theorists have different ideas about exactly how just intonation should be studied and employed. According to W.A. Mathieu, "Harmony is . . . the way the ear relates pitches to one another in every dimension."[67] This study will specifically address the harmony laid out by the five-limit harmonic lattice detailed in *The Harmonic Experience.*

The Generating Tone

Music theory concerning any tonal music is based on the definition of a tonic, root, or keytone. Mathieu refers to this central tone as the "generating tone." This is the pitch from which the harmony of a piece or section of music is generated, and "music is made . . . from the center *out.*" [68] Overtones or partials are the high upper frequencies naturally found in a given pitch frequency (the fundamental) when that pitch is sung

[67]Mathieu, *The Harmonic Experience*, 10

[68] Ibid., 61

perfectly in tune and with ample resonance (singer's formant). *The Harmonic Experience* proposes not only that there is ". . . harmony implicit in the overtone series,"[69] but that we must also understand the reciprocal energy—that which some refer to as undertonal.

Third and Fifth Partial Relationships

The harmonic lattice is based on the relationships of third and fifth partials, both to the generating tone and to each other. By utilizing the harmony of low ratio prime numbers, one can achieve a pure intonation that is both functional and efficient. The path to each of these harmonies extends from the generating tone in logical relationships. The figure below shows the basic outline of the lattice, including the mathematic ratios of each pitch in relation to the generating tone and its derivation in cents (+ or -) from the pitch found in equal temperament.[70]

[69] Ibid., 15.

[70] Mathieu, *The Harmonic Experience.*

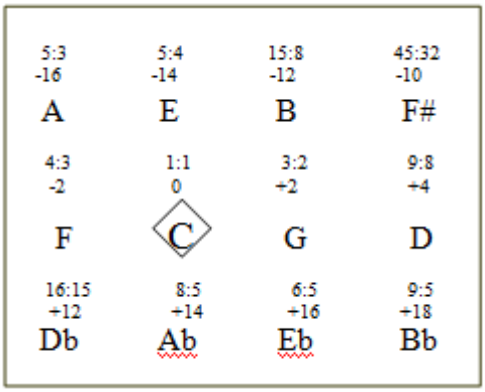

Figure 1. (Donald Brinegar, "In Tune: Principles of the Five-Limit Harmonic Lattice" power point, California State University-Los Angeles, Los Angeles, CA, July 27, 2010.)

This document will not address each of the specific mathematic relationships of the lattice as this information can be found in *The Harmonic Experience*. It is important, however, to recognize the relationship each pitch has to the center and also to the other pitches present in the lattice.

Each pitch of the chromatic scale can be found via third and fifth partial relationships. This represents the shortest distance, harmonically speaking, between two pitches. Because every pitch can be found through these relationships, harmony must be viewed in a new way. Where C is the generating tone, B is no longer a major seventh, but the fifth partial of a third partial (or up a perfect fifth, then up a major third). This now becomes an issue related to audiation. If a choir is singing a chord C-G-E-B, the lattice shows that the B is an overtone to all three of the other pitches. It has the function of being a third partial and of being a fifth partial—it has several energies and several colors

available. The conductor can audiate this pitch through its harmonic path (up a fifth, then up a third) and create a gesture informed by this audiation which includes the energy inherent in the harmony.

Cents, Function Change, and Commas

The harmony discussed in this document, and presented in *The Harmonic Experience*, requires the understanding that the most minute intervals can be easily identified by the human ear and can also be readily employed by a quality musician. In choral music, conductors often teach the smallest interval in western music is the semitone or half-step. However, when the semitone is divided into one hundred equal parts, we are left with an interval called a *cent.* Though this interval is very small, "a variation of two cents . . . can be heard as a change of pitch and can be felt harmonically." [71] As the harmony of a piece of music expands, intervals measured in cents play an important role in creating a more pure harmony.

As previously stated, a given pitch may serve several different functions within the harmonic context of a given piece of music. The result of such function change can result in a literal rising or falling of the pitch, a change in color or tone quality, and even a varied quality of physical implications. Through score study and personal rehearsal, a conductor can discover a variety of colors and harmonic shifts that can create a sense of

[71]Ibid., 112.

life and motion in the music without a need for imposing any extra (and sometimes unnecessary) expressive ideas.

Consider a song where C is the central tone. Where C is the generating tone, G becomes an overtonal third partial. The perfect fifth (C-G) of pure harmony will be slightly wider than the perfect fifth of equal temperament; this is the difference of two cents. Thus, in chords which include both a C and a G, singers will generally feel a higher or lifted feeling when singing the G. However, G can also provide a different harmonic function within the context of the music. If the music moves from an I chord (C-G-E) to a V chord (G-D-B), the G has moved from the function of a fifth (or third partial) to the root or tonic. In the example seen below, the tenors sing a G that serves different functions in two chords:

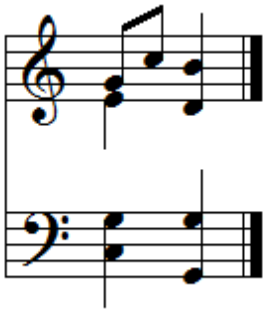

Figure 2.

The resulting change in harmonic function will result in a change from a lifted feeling of the fifth to a more settled feeling of being a root. This change must be audiated by the

conductor and can be visually represented in through gesture. One might choose to represent this by moving from a slightly more open hand shape to a more covered gesture. It may also be represented by moving the gesture from a higher to a lower plane. More specific gestural implications will be presented in chapter five. It should, however, be understood that the function of specific pitches change as the harmonic context changes. The change in function of a given pitch results in a physical change felt by the singer.

This type of shift in harmony may be expressed as intervallic pressure. This sensation of physical change occurs perhaps not as quantifiable change in pitch, but rather a change in color or a change in quality. The sensation of singing a root is different from that of singing a fifth or a third. Any given pitch may serve each of these functions in a different key. It is the harmony which surrounds the pitch that helps give it color within the context of the harmony. Therefore, while an E may always be an E on the piano, the E which represents the justly tuned third of the triad C-E-G is quite different from the E which creates the root of the triad E-G-B.

In music a *comma* represents an interval that is very small and very specific but that can be heard distinctly. More specifically it is the "intersection of more than one harmonic possibility for a single tone."[72] One of the earliest commas to be defined is the Pythagorean comma. Pythagoras believed that music "should consist only of tones that

[72] Donald Brinegar, "In Tune: Principles of the Five-Limit Harmonic Lattice" (power point, California State University-Los Angeles, Los Angeles, CA, July 27, 2010.)

combine in ratios compounded of the lowest primes, namely, two, and three . . . In other words, Pythagorean harmony is a strict universe of perfect fifths."[73] By this theory we discover that stacking twelve perfect fifths results in a span slightly greater than seven octaves. If one was to play these intervals on a piano beginning on C, one would appear to end up back at C. Stacking in perfect fifths, however, we have actually come to B#. The interval created by this difference in pitch (twelve perfect fifths versus seven octaves) is the difference of about twenty-four cents.

Though the Pythagorean comma was one of the first to be defined, it is not the one most commonly found in music. There are several other functional commas that can be found in music, including the Didymic comma, the Great Diesis, and the diaschisma. While this document will not detail the mathematics of each of these, it is sufficient to say that understanding these changes and their function in the context of harmony changes the sound ideals available in music. Further, "it is not the relative height of tones that is musical nourishing. What's vital are the harmonic paths, the resonances they produce, and the way those resonances live in the body."[74] These are changes that can be physically felt, aurally understood, and thus visually represented through a conductor's choice in gesture.

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[73] Mathieu, *The Harmonic Experience*, 237.

[74] Mathieu, *The Harmonic Experience*, 114.

Creating a Sound Ideal

With new ideas about harmony, one can make choices about the sound ideal he or she has for his or her choir. With a specific sound ideal tailored to each song and considering appropriate performance practice, a conductor can utilize audiation to inform his or her gesture. This is a skill useful not only to a conductor, but also to their choir, and necessary for communication between the two.

Audiation

As outlined in the writing of Edwin Gordon, audiation is "The ability to hear **and to understand** music for which the sound is not physically present or may have never been physically present. Persons may audiate when they are listening to . . . performing . . . reading and writing . . . composing music, and improvising music."[75] Audiation is a way of understanding music that goes beyond inner hearing. This process can be utilized by both the conductor and the performer alike. "Audiation take places when we recall in our minds familiar patterns in music and perform them vocally . . . conduct them, or simply listen in silence."[76] A conductor therefore is able to engage in the process of audiation during score study, and then to utilize and adapt this audiation in both rehearsal and performance.

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[75] Edwin Gordon. *Preparatory Audiation, Audiation, and Music Learning Theory: A Handbook of Comprehensive Music Learning Sequence*. (Chicago: GIA Publications), 2001, 3.

[76] Ibid., 13.

When a conductor is in front of his or her choir, strong audiation has the ability to directly impact the gesture being utilized. "We give meaning to music by audiating the context of music."[77] Because a conductor is audiating not only the music that is currently being sung, but also audiating what music is about to happen, the conductor has an opportunity to hear a sound ideal rather than simply receiving the sound that the choir gives. As such, gesture can always reflect the music that the conductor hopes to help create.

Audiation reflects gesture and can be easily observed in quite simple ways. Should a conductor want a brighter sound on a specific vowel, the conductor can choose a gesture that may impart that quality. For instance, a curved hand facing palm down may suggest one vowel color, and by turning the hand away from the body (so that the palm begins to face more upward) the conductor may be able to suggest a brighter tone color. This type of decision must be made through audiation in advance, utlizing gestures which are meaningful to the context of the music. Chapter five of this document will provide more specific detail regarding how gestures (both general and specific) are reflected in the sound produced by the choir.

Proportional Harmony in Audiation

After understanding how audiation has the ability to impact gesture, one can begin to utilize proportional harmony to help create the sound ideal in one's audiation.

[77] Ibid., 5.

This functions both in conducting a melodic line as well as creating gesture for chords rich in texture and harmony. Understanding the principles of the harmonic lattice allows a conductor to approach score study in a new way. Once the conductor has made specific choices about the function of the harmony, he or she begins to choose gesture that reflects this sound ideal.

As an example, the opening melodic line to "O, My Luve's Like a Red, Red Rose" by David Dickau, begins with an ascending 4th (Bb – Eb) from Sol to Do.

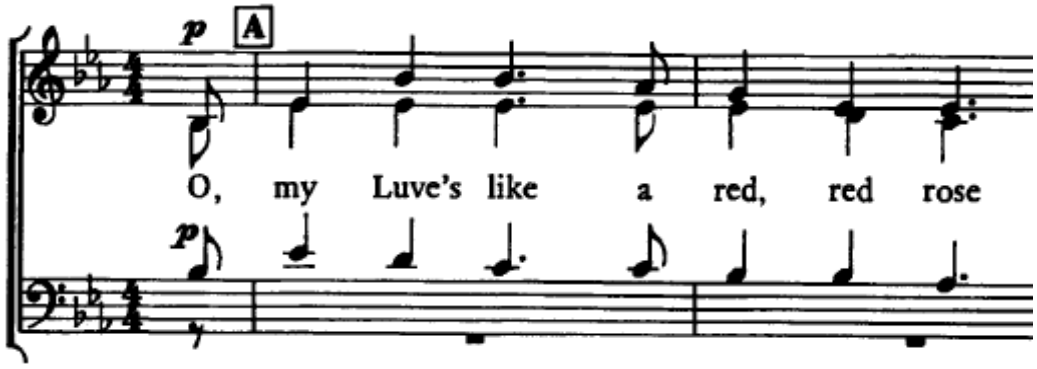

Figure 3. (Permission to use this sample granted by Hal Leonard Publishing)

If a conductor were to analyze that motion linearly, he or she might say that it goes "up." However, given the harmonic function of that motion, a conductor understands that this is actually a descending motion. The conductor can then make a choice to audiate that interval as a descending fifth (harmonically speaking) rather than an ascending fourth. The music moves from the overtonal third partial to the root or generating tone. The conductor has an opportunity to reflect this motion through

audiation, and subsequently through gesture. The downbeat then may have a lower ictus space than does the pick up.

In a similar manner, commas and function changes in music provide an opportunity for a conductor to effect the sound of the choir through gesture. One of the powerful tools that a conductor can utilize through the use of proportional harmony is a choice in function. In Daniel Gawthrop's "Sing Me to Heaven," the chord at mm33-34 represents an opportunity for the conductor to make a choice about function of pitches within the context of the given harmony.

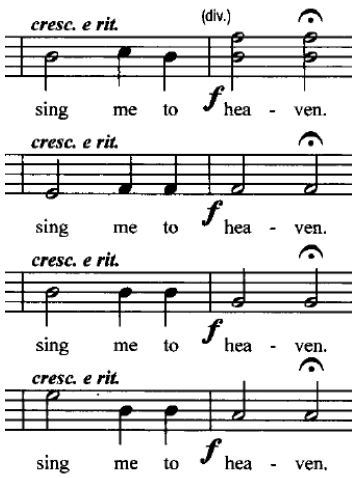

Figure 4. (Permission to use this example granted by Dunstan House)

Given E as the generating tone for this portion of the piece, the conductor has two possibilities for the function of the C# and G# sung by the men. If the conductor is to stay as close to the harmonic center as possible, the C# is heard as an undertonal third partial and the G# as an overtonal fifth partial. This creates a sound of rest and stability, creating

in the upper chord sung by the women a brighter more overtonal feeling. However, there is also the option to hear the C# and G# as overtones built in a Pythagorean manner about the F# (in this case, the central spine of the lattice is extended to show E-B-F#-C#-G#). The new function of the men's pitches is as bright, overtonal harmonies actually built *above* the pitches being sung by the women. The conductor now must consider gesture which reflects this functional change, and the shift must be audiated by both the conductor and the singers.

Gestural Language

There is little doubt that the gesture a conductor chooses has a direct impact on the sound that the choir produces. Dr. Rodney Eichenberger regularly tells choir directors "What they see is what you get." The implication is simple: the choir will provide a sound that directly reflects the gesture shown by the conductor. For most conductors, gone are the days of a simple pattern that fits all music. Gesture must look like the music. The information presented in this document leads to gestural choices that incorporate proportional harmony, audiation, mirror neurons and iconic gesture.

Iconic Gesture

Conducting gestures that are iconic are those that directly represent the music and those which can be applied in similar musical contexts throughout many pieces of music. That these gestures come as a natural process through music is necessary in order for

them to be communicated without explicit verbal definition. These gestures should be informed by proportional harmony, realized through audiation, and communicated with the aid of mirror system. Some of these gestures are inherent in what we might do naturally, and some are created through musical ideas and processes invented over time.

The system of hand signs created by John Spencer Curwen to accompany the tonic sol-fa syllables have some implications that may be utilized in conducting, which immediately reflect the harmony of the harmonic lattice. The hand sign corresponding to the syllable Do, seen below, is a rounded shape. It seems to indicate a depth and spaciousness of sound as well as a certain strength and centered feeling.

Figure 5.

Similarly, the hand signs corresponding to the syllables Mi and Sol, belonging to the overtonal fifth and third partials respectively, have properties similar to their harmonic function.

Figure 6 and 7

Mi suggests perhaps a lower more relaxed sound, particularly if modified to include a slight curvature of the hand. In relation to the third of equal temperament, the overtonal fifth partial of proportional harmony is lower by about one-seventh of a semitone. W.A. Mathieu states that "In Indian music [it] has been associated with the quality of compassion. One of the *mudras* (hand positions) used to realize compassion calls for both palms down, parallel with the earth, fingers outstretched."[78] Whatever the reason, this hand gesture seems to evoke the warm sound associated with the overtonal fifth partial. In contrast, the Curwen hand sign associated with Sol is more open, perhaps indicating a brighter sound. It suggests the overtonal, sunny sound associated with a justly tuned third partial.

It is not to be suggested that Curwen hand signs always be used in conducting or that they are the best method for showing these sounds. However, particularly because these hand signs are prevalent in choral rehearsals, and thus a common part of the gestural vernacular, there may be opportunities to utilize these hand signs (or variations thereof) to provide an iconic gesture which implies specific harmony. This could be readily utilized in a piece or section of music that ends on an open fifth. A conductor may show Do with their left hand, and above that indicate Sol with their right hand. In this way, the pure harmony is implicit in the gesture.

[78]Mathieu, *The Harmonic Experience*, 50.

There are many other opportunities for gestures which can be considered iconic. It is not the intent of this document to delineate an entire lexicon of iconic gestures, nor to suggest that any one gesture is definitive in suggesting any sort of specific intonation. However, through an understanding of proportional harmony and creativity based on audiation of musical context, a conductor may develop of set of gestures that is both meaningful to the music and representative of the harmony of just intonation.

Audiation and Gesture

In a choral rehearsal, conductors often suggest that the choir conduct "with them" or that they "conduct themselves." In the average choral rehearsal, most singers in the room are not, themselves, conductors. And yet, the gestures chosen by the singers are often very musical and reflect the music in a very honest and efficient way. This is the product of strong audiation and possible partly because the singers are not limited by learned patterns or preconceived notions about gesture. From this, the conductor may come to realize that gesture is often not about the actual physical motion of hands and arms, but rather the intent with which these gestures are made.

Audiation requires that a conductor be in the moment of the music. The conductor must be responsive to music as it is being made and audiate the music that is about to be made. Gesture must be flexible enough to adjust within the moment, perhaps to adjust the tuning of a sustained chord. However, gesture must not be reactionary in nature. It is important that a conductor show the gesture for the sound which he or she expects to

hear. This sound is created through the audiation of the sound ideal which the conductor has prepared through score study and an understanding of proportional harmony. The result of these choices will be explored in chapter five.

CHAPTER 5

Gesture Informing Sound

Chapter four of this document suggested that when audiation is informed by proportional harmony and gesture is informed by audiation, the result is a conducting gesture which is both efficient and musical. Efficiency, in this case, suggests that verbal explanation of the gesture is not necessary because the information being communicated is inherent in the gesture itself. This is possible because music is a hardwired part of the human condition and has likely been connected to gesture since our earliest ancestors began to sing. In contrast to equal temperament, proportional harmony exploits the natural harmony found in music and the way our brain processes this harmony. If a choral conductor has prepared in this manner, the resulting question is: how will this gestural language be realized by the choir?

Developing a Rehearsal Pedagogy

While this document suggests that gesture informed by just intonation can make an immediate impact on the sound produced by an ensemble, the music making process for a choir begins in rehearsal. In most cases, a choir performs with the conductor with whom they rehearse (the exception being guest conductor, clinician, or honor choir settings). There are several simple ways to bring the principles of proportional harmony into any choral rehearsal. Furthermore, this can be accompanied by a number of specific

gestural language to enhance the connection between conductor and choir in the performance setting.

The Choral Warm Up

There are a number of ways in which proportional harmony can be introduced into the choral warm-up that are both simple and efficient. As the choral warm-up often utilizes the piano as a means of stability for intonation as well as harmonic context, a conductor must be aware of the ways in which the piano can best reinforce just intonation. Many conductors play triads on the piano while the choir sings varied vocal patterns. Initially, while preparing to hear and learn the relationships of proportional harmony, the playing of an open fifth will create less harmonic ambiguity than a triad or other more full chord. Because the fifth of equal temperament is relatively close in tuning to that of just intonation (a difference of only 2 cents), the drone of an open fifth creates a relatively stable sound. It also requires the singer to hear and process less of the overtone series, making it easier to tune to.

Though all intervals in equal temperament are slightly out of tune (with the exception of the octave), there are intervals which are much closer to the relationships of proportional harmony than others. The third of equal temperament is 14 cents sharp of the third of just intonation. This is a relatively large harmonic difference. The second of equal temperament is 4 cents flat, while the fourth is 2 cents sharp. These are much smaller distances and, therefore, more easily reconcilable by the ear. As such, they

provide a more stable and accurate harmonic context for the singer. Thus, while playing the piano in support of choral warm-ups, the conductor is well served to omit the third of the chord in any triad and to instead choose either the second, fourth, or both.

Singing Modes and the Chromatic Scale

Many choirs sing a major scale as a part of their warm-up process. This is certainly a valuable process which in its varied applications creates harmonic context to which the students can later refer. However, not every song includes pitches exclusively found in the major scale, and not all of the pitches of the harmonic lattice are represented in the major scale. Rather than simply singing the major scale, a choir is well served to sing each of the six basic church modes as they represent each pitch of the (non-extended) harmonic lattice.

Lydian mode with its raised fourth is the brightest and most overtonal of the modes. Singing the modes in order of feeling from brightest to darkest, or darkest to brightest, helps provide a context of color. Because Lydian mode is closer to the familiar tonality of the major scale than Phrygian mode, it is probably more accessible for singers to begin with the brighter tonality. One option for the use of the modes is to sing the modes against a drone of an open fifth. Accompanied by Curwen hand gestures, the choir sings the mode and is able to negotiate the intervals of each pitch in relation to the generating tone. Another way to experience the modes is to have the choir sing the pitches of the drone as the conductor sings the mode. With this, the choir experiences the

function change and color shifts created by intervallic pressure present in each mode. Each of these creates a set of transferable skills that are directly applicable to rehearsing new pieces and to performance. The order of the modes arranged from most overtonal to the one which includes the most reciprocal energy is: Lydian, Ionian, Mixolydian, Dorian, Aeolian, and Phrygian.

While the chromatic scale as a scale is perhaps not often directly represented in music, by singing each of the modes, a choir acquires the tools to understand each of the pitches present in the chromatic scale of proportional harmony. In this case, the chromatic scale can be viewed as having the same pitches ascending and descending. Though this scale is often shown with sharps while ascending and flats while descending ,this may or may not truly represent the indicated pitches. Because these pitches are enharmonic on the piano, and because not all of these pitches are represented directly in the (non-extended) harmonic lattice, it is perhaps more efficient to represent the chromatic scale as seen here:

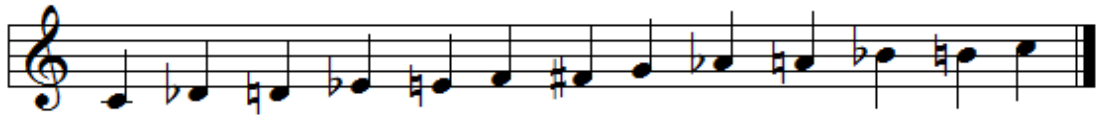

Figure 8.

Understanding Chord Function

Within the context of choral rehearsal, it is important for singers to have a concept for the function that their voice part serves within a given chord. While it may not be necessary to explain the entire harmonic lattice and the function of each pitch within any and all contexts, a basic understanding of function can allow for beautiful intonation and greater efficiency. Simply understand the shape and design of any major triad, for example. Regardless of its relationship to the keytone, any major triad is built with a root, an overtonal third partial, and an overtonal fifth partial. When building these chords within the choral rehearsal, the pitches should be sung in that order (or the root, then the fifth, and finally the third of the chord). This should be done regardless of the score order of the parts (even if the third is sung by the basses, it should be the first pitch sung). By singing the pitches in this order, the singers are taking advantage of the pitches inherent in the overtone series. A root that is sung well in tune will create the upper partials and thus provide something for the other voices to tune to.

There may also be dynamic considerations within this idea. Regardless of how it is written (and structured) in the piece, it may be suggested that the pitches of the chord decrease in volume as singers get further from the generating tone. Though the relative strength of the overtones is largely based on vowel formants, the idea is that the higher the overtone, the less present it is within the fundamental. Thus singing chords with this dynamic idea in mind mimics the function of the overtone series.

A Different Sound

What is of core importance to the information laid out in this document is that understanding this information and being able to apply it to conducting will result in a better and more musical sound. The reasons for why this is true have been delineated in different aspects throughout this document. The "why," however, is ultimately not as important as the actual experience of a better sound. What difference can gesture make? What does the choir experience differently? How does this type of performance effect the audience's perception of music making? How much different is this than singing in equal temperament?

Gesture Makes a Difference

Though it may seem obvious to note, conducting gesture does in fact have a direct and important impact on the sound that a choir produces. According to Rodney Eichenberger, "You can listen to a group under one conductor, then put another conductor in front of it, and it will have a different quality because of the way the conductor stands and gestures. When I work with a choir that has a bad intonation problem, I watch careful what the conductor is doing. I can usually relate the out-of-tune singing directly to the conductor's gestures."[79] Just as this document has previously stated, it is not that one gesture works and that another does not, but that it is important to

[79] Alan C. McClung, "The Relationship Between Nonverbal Communication and Conducting: An Interview with Rodney Eichenberger," *Choral Journal* 36, no. 10 (1996): 17-24.

consider the impact gesture has on tuning. Gesture that is informed by the audiation of proportional harmony has the ability to communicate intricate details without verbalizing them. Eichenberger goes on to say, "The conductor's nonverbal messages affect every musical facet of a performance. My premise is that nothing is right and nothing is wrong, but everything you do has an effect. Whether conducting a choral or an instrumental ensemble, I'm convinced that a conductor can use certain nonverbal messages to achieve a particular sound."[80]

What The Choir Experiences

Previous chapters in this document have discussed a variety of reasons that group music making has become an essential part of the human existence. Our earliest ancestors likely participated in this socially as means of "grooming at a distance,"[81] and also in connection with group rituals and ceremonies. Science has since confirmed that specific chemicals which are beneficial to our well-being are released into the brain while participating in group music making, such as oxytocin—a chemical related to trust. Singers who choose to participate in choral singing, particularly in an academic setting, are not involved because of facts such as these; rather, they make a choice to sing because it creates an experience. This experience is probably felt in a variety of ways, but

[80] Ibid., 17.

[81] Patel, *Music, Language, and the Brain,* 370.

singing with attention to tuning, and specifically with consideration for proportional harmony, heightens this experience.

"When you're in a choir and you're in that special mix, you are saying something that is quintessentially human—as human as it is possible to get. It defines what's human because it's proportional."[82] There is no doubt that there are other species which are, in a sense, musical. One need not step further than their own backyard to hear the chirp of crickets or the song of a bird. These musical expressions may certainly possess both rhythmic and melodic elements, but the human musical experience is unique. "We keep time in duple and triple meters, and we sing proportional relationships. That's everywhere without exception. And it's probably been there for tens of thousands of years. And who else does it? Nobody else does it. We do it. So, if you hear proportional harmony you're one of the human race, so I think that defines us. And I think that there is a tremendous sense of human community."[83] Asking a choir to sing with the harmonic relationships of proportional harmony is encouraging them to participate in an experience that helps to define their humanness.

In addition to the choir having a different personal, emotional, and perhaps physical experience, they will likely have a different visual experience watching a conductor whose gesture is based on the audiation of proportional harmony. The actual

[82] W.A.Mathieu, Telephone interview by author, July 25, 2010.

[83] Ibid.

difference in gesture may be slight and often will be subtle enough that a choir perhaps cannot articulate exactly what has changed. This difference is further blurred by the fact that this gesture will present itself differently for different conductors. The gestures used will not be a specific lexicon of gestures; rather, it is a quality of gesture that has an effect on the sound the choir produces. A conductor hopes that the choir experiences the difference with a feeling of ease or efficiency. The conductor will be "easy to sing for." This change is aided and received by the mirror system present within the conductor and singer, and shared between them. The complex system of mirror neurons in the human brain allows for making music in real time to truly be a function of choral conducting. This system allows for imitation and emulation, and works as a functional system of empathy.

What the Audience Experiences

The audience for a choral music performance is likely to be quite varied in their musical experience and knowledge. Each audience member likely brings their own qualifications for how they will evaluate the performance. The average audience member will surely be able to differentiate between a choir that sings basically "in tune" and one who is singing at the extreme "out of tune" end of the spectrum. A more refined audience member may be able to describe the altos as "a bit flat" in a certain section, or to be able to hear a chord that "locks." Further still, those who are listening for it will be able to describe hearing overtones in a performance of music which is well in tune and sung with

sufficient singer's formant. To what extent will any audience member hear or notice a difference in tuning when a choir is singing for a conductor who's gesture is informed by proportional harmony? W.A. Mathieu suggests that perhaps the audience *never* really hears equal temperament. "Frankly, to the degree that music is tonal, I don't think that one *can* hear in equal temperament. I don't think that's possible."[84] While one can physically play pitches on the piano and the brain can understand that the sounds coming from the piano is in fact equally tempered, this is not what the brain is actually hearing. "When you hear equal temperament, to the degree that music is tonal, you're put in mind of something that you recognize. That is, you don't hear the music so much as you recognize what the music *stands for*. That's why temperament works: because you don't hear it, you hear what it's trying to say. And I don't even think it's *hearing*, I think it's *decoding* – pre-hearing."[85]

That a choir is singing in just intonation may or may not be processed by the audience, partly because the brain is already processing harmony in this way. What the choir achieves is tapping into music that is essentially more human and, because it is a more efficient means of vocalizing, will achieve a higher level of beauty and musicality. The natural harmony present in the overtone series (and its' reciprocal energies) resonate within humans in a physical way that cannot be achieved by equal temperament.

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[84] Mathieu, Interview.

[85] Ibid.

CHAPTER 6

Music and the Recital

In support of the research laid out in this document, I worked with students at Desert Oasis High School to prepare a recital which was given on Friday, April 8, 2011 at. This recital performance featured three choirs from the Desert Oasis choral program. The following chapter will discuss the music featured in this recital and will detail specific ideas about each piece regarding how it relates directly to this document. The sections which follow will be presented in the same order in which music was performed on the concert. Following the information detailing the musical selections will be a brief reflection of the recital itself.

Musical Selections

Each piece in this concert was selected for variegated and specific reasons. The performers in the concert were members of a high school choral program; therefore, music was selected to match their ability levels while room for allowing skill growth throughout the academic school year. Additionally, the choir director took programming into account throughout the year to try to include a variety of musical styles from a wide range of eras and composers.

“Ecco mormorar l’onde” / “Flora Gave Me Fairest Flowers”

“*Ecco mormoroar l’onde*” by Claudio Monteverdi and “Flora Gave Me Fairest Flowers” by John Wilbye were selected as music representative of the madrigal and late Renaissance style. This music was written at a time before the invention of equal temperament. Additionally, during the late Renaissance composers first began to think in terms of modern tonality—where major and minor began to dominate moving beyond tonalities of the church modes. Because the convention of equal temperament was not yet established, composers were writing for a more natural tuning system. The properties of proportional harmony are suited to take advantage of this style of music.

In the late Renaissance, the full triad (root – third – fifth) was utilized for a complete harmonic sound. Neither just a third, nor an open fifth is often found in cadential figures. This structure, now common in essentially all popular western music, allows musicians to develop an appreciation for understanding proportional harmony—it represents both types of overtonal energy (third partial and fifth partial). As triads are almost always found at the cadence points within the song, a similar hand gesture can be utilized for each cadence. Conductors should consider changes in gesture based on the structure of the chord and the overall presence of each pitch of the triad. In a five-voice madrigal such as these, there are several options for how to construct the triad. A triad which includes the root in three voice and the third partial and fifth partial only in one (*Ecco*, m92) may necessitate a different gesture than one which is evenly balanced

between voices (*Ecco, m39).* In most cases, a conductor may choose to show the root and the fifth in his or her gesture, while audiating the quality of the third.

Points of imitation in Renaissance music provide an opportunity for the choir to realize proportional harmony. In "Flora", the second section ("These I plac'd…) begins with a Bb tonality (m16) restated around an Eb (m19). Rather than being viewed as a perfect fourth up, a conductor is better served to audiate this motion as a descending perfect fifth as it is moving to the undertonal third partial. Thus, a gesture which is lower and perhaps slightly warmer and or darker would be appropriate. The Eb of proportional harmony will be just slightly lower than that of equal temperament (2 cents). Gesture which reflects these harmonic differences allow the choir to realize this intonation more efficiently.

"O, My Luve's Like a Red, Red Rose"

One of the features of "O, My Luve's Like a Red, Red Rose," by David Dickau which lends itself to this study is the functional drone written into the voice parts. Within the entire A section of the piece (mm1 -8), Dickau has written only five beats which do not include an Eb in at least one voice. As such, this voice acts as a drone to which the other voices can tune. The conductor is able to audiate the Eb within each chord and to use gesture to suggest the harmonies and colors created around it. Measure two provides a good example of how gesture can represent the harmony directly, even within a "standard" four pattern.

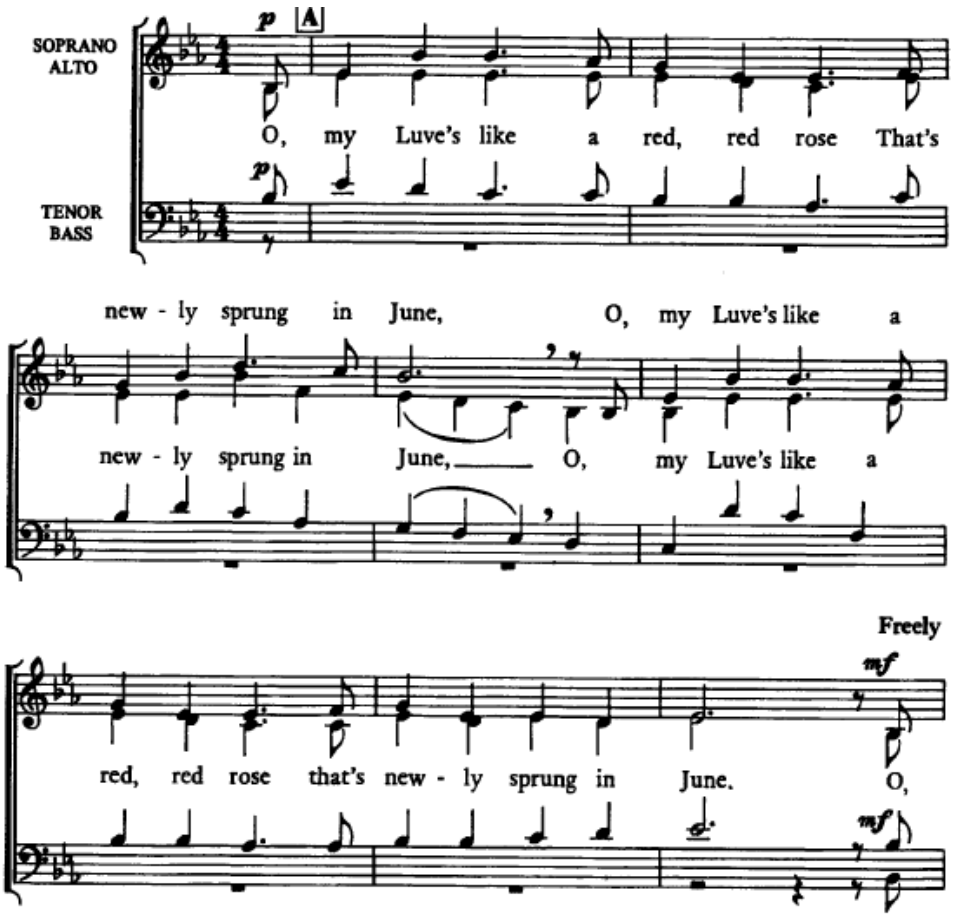

Figure 9. (Permission to use this example granted by Hal Leonard Publishing)

The first beat "red" is a triad built on the root. This beat can be shown in a centered and comfortably low position. Beat two on "red" moves to a greater overtonal energy (the fifth partial of the root is replaced by the fifth partial of the third partial). The corresponding gesture on beat two can be shown in a slightly higher plane and with a more open hand shape. Finally, on beat three on "rose" the chord moves to the reciprocal energy of the undertonal third partial. While the chord structure is similar to beat one, the

overall tone color in relation to the keytone is slightly darker and warmer offering, perhaps, a more grounded feeling.

The Eb, while serving as a drone, will not necessarily maintain a feeling of stability throughout this section. As the harmony surrounding the Eb changes, this pitch undergoes the function change—acting as both the root and the fifth. The Eb will also succumb to feelings of intervallic pressure. As different energies are brought into the air through new harmonies, the Eb will have gently rock as it comes into agreement with the harmony around it. These are changes the conductor must be aware of which can be established through audiation.

"in time of daffodils"

As in the previous song, David Dickau utilizes a drone figure in "in time of daffodils," although it is much more direct in this piece. The basses (and later the tenors) open the piece with an open drone on the third partial. The harmonies sung above the drone move through a myriad of colors as the text unfolds. With each repetition of the text "in time of daffodils," the final chord modifies in tone color. By exploiting different parts of the overtone series, Dickau creates a sense of excitement for the drone. As the drone experiences varying intervallic pressure from the parts above it, the energy of the drone changes. Musicians understand that a note held for any great length needs to have some sort of "energy" to maintain musicality; it is a common practice for that to be interpreted as a crescendo or decrescendo. However, as this is not marked by the

composer in the score, this is likely an imposition by the composer in an effort to "create" this energy. Through understanding proportional harmony, a conductor is able to realize that the energy being sought after is inherent in the pitch itself.

To exploit this energy, a conductor has an opportunity to show a gesture for the different tonalities being sung by the upper voices and to audiate the change in function sung by the drone. Each time the word "daffodils" is sung in the first section of the piece includes fewer pitches than the one preceding it. This leads the word to get less harmonically complex, eventually containing more overtonal energy. The conductor may consider a slightly higher and more open gesture for each repetition of the word. The left hand can be utilized in a relatively low and relaxed position to represent the drone. As it is sung on the third partial, a hand gesture similar to the Curwen hand sign for "sol" may be appropriate.

This piece also features a frequently changing tonal center. David Dickau has suggested that the text of this piece, to him, represents relationships—and perhaps the perfect relationship[86]. The flowers and their corresponding tonal colors represent different stages of the relationship. Because the tonal center is constantly in flux, proportional harmony is best suited for the performance of this piece, rather than the harmony of equal temperament. This is true for two reasons: first, that the shift in tone color between sections can be more appropriately realized when given a choice harmonically between multiple pitches available in relation to the keytone; and second,

[86] David Dickau, telephone interview by author, January 24, 2011.

because the challenges of maintaining perfect intonation through key changes is made more difficult when referencing the piano, but slight imperfections will be made more forgivable if the voices are well in-tune in relation to one another.

To address the first point, one need look no further than the first key change at mm16-17. The piece moves from G as a tonal center to E as a tonal center. Conductors can choose to move up a third then down a fifth, or to move up three fifths. The first option will result in a sound which W.A. Mathieu suggests has a "softness and a gentility."[87] Selecting the E (which is up three fifths) is about 22 cents higher than the E which is up a third and down a fifth.

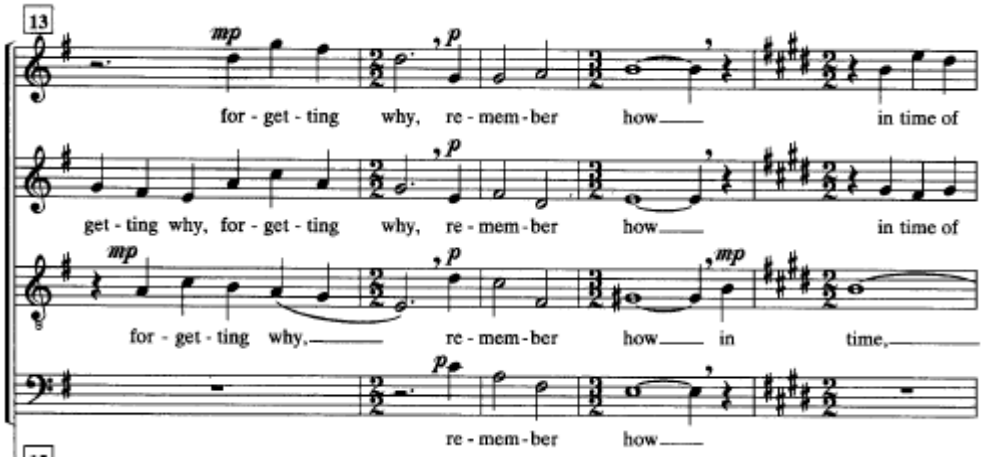

Figure 10. (Permission to use this sample granted by Walton Music)

The higher, slightly brighter feeling of the Pythagorean major sixth seems to fit better the feeling of hope and optimism present in the text of the second verse. The

[87] Mathieu, *The Harmonic Experience,* p53.

conductor then should choose a gesture which reflects this lifted feeling, particularly for the bass line which, while it appears to be descending, is actually moving upwards harmonically. In rehearsal, the choir can be helped to find the new pitch center by understanding the relationship between the G of the soprano line (m15) moving upwards to the fifths above it (the D of the alto line and the A in the soprano line on the following beat) and finally coming to rest on the E sung by the altos and basses in m16 – a pitch three fifths above the original pitch center.

As a means of clarification on the second point, conductors hope a good choir will be able to achieve high precision on each key change and maintain excellent intonation. This is a challenging piece, perhaps especially for high school singers exact tuning is a stretch as they move through the varied harmonic domains. Proportional harmony allows for singers to find pure resonances of the overtone series created by the fundamental. Thus it is perhaps less necessary to achieve perfect intonation within the key change as it is important to understand the relationship between the notes within each chord. By audiating these relationships and understanding the function of each pitch, the conductor can help the choir to navigate these key changes. This can be addressed in rehearsal so that singers understand the relationship (and subsequent harmonic paths) between each tonal center, but also so that once a new key center has been reached, the singers understand the function of the pitches they are singing in relation to the new keytone.

"The Voice of the Rain"

"The Voice of the Rain" by Stephen Chatman, like the two selections by David Dickau, utilizes drone like figures to help establish tonal center while exploring different tonal colors throughout the piece. Chatman has said that just intonation is "not on my radar really. I trust singers to do what they have to do. Intuition is a funny thing."[88] While Chatman may not compose with just intonation specifically in mind, it would seem that he prefers singers to sing with natural resonances and sensibilities. Utilizing the natural tuning of the overtone series and relationships of proportional harmony seems to be the most efficient way to sing naturally and with "intuition." This piece moves through two basic tonal centers, beginning in C and shifting to G for large portions of the piece (mm18 – 25 and mm61 – 68). The voices are writing such that one voice is almost always singing the keytone. In the first section (mm1 – 8) the C is present in almost every beat of the alto voice and then is traded to the tenors for the remainder of the section (mm9 – 12). This gives the choir a drone to tune toward and an area of stability for the conductor to focus his or her audiation.

[88] Stephen Chatman, telephone interview by author, November 5, 2010.

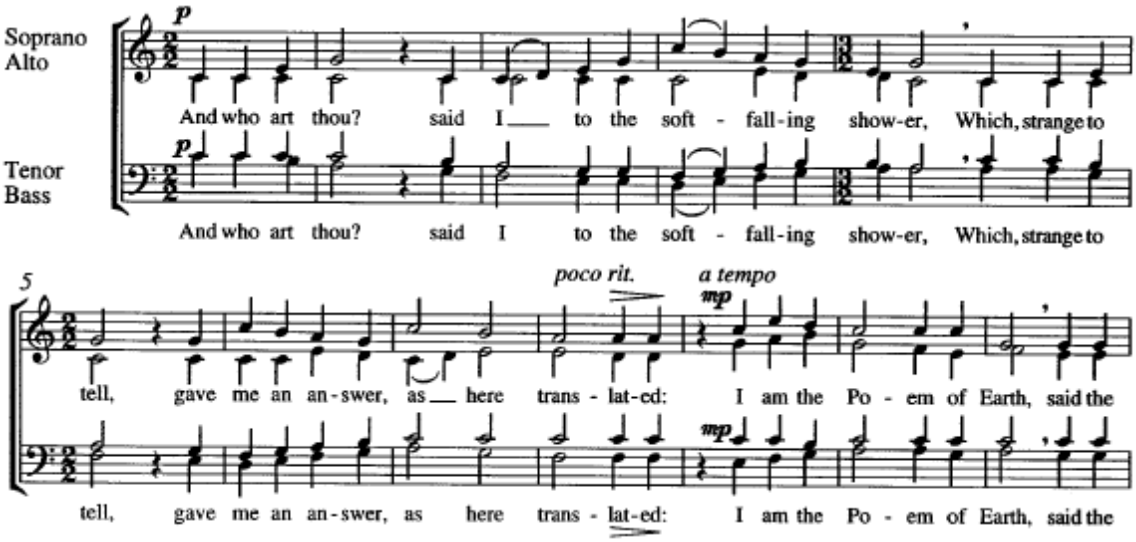

Figure 11. (Permission to use this sample granted by ECS Publishing)

A more literal drone is created by the voices in the second major section of the piece (mm18 – 42). The long notes, first in the tenor and soprano and then in the bass and soprano parts, act as a point of stability for the opposing voices. For rehearsal purposes the choir may sing to a drone played by the piano (G – D in this section). This drone is then audiated by the conductor during performance. As the voices move through the text, the conductor may show a gesture reflecting the motion of the long notes and the relationship between these pitches and their relationship to the generating tone. For example, when we examine the tenor and soprano line in mm18 – 25, each voice serves different functions in relation to the generating tone (G).

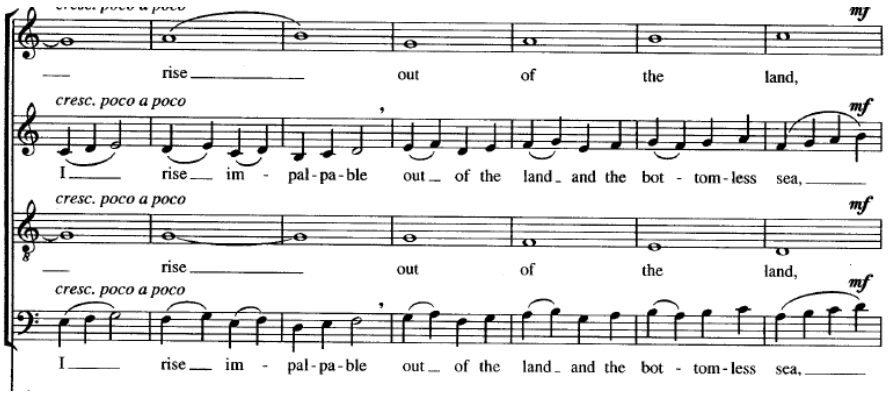

Figure 12. (Permission to use this sample granted by ECS Publishing.)

The tenor line moves from the root to the major seventh (12 cents lower than the piano), to the major sixth (16 cents lower than the piano), and finally to the fifth above (2 cents higher than the piano). The conductor may choose a gesture which is low and relaxed for the duration of this vocal line, perhaps offering a slight lift as the song reaches the word "land." The soprano line, on the other hand, moves from the root to the major second (two fifths up, 4 cents higher than the piano) to the major third (14 cents flat of the piano), repeats this pattern, and then comes to rest on a the perfect fourth (harmonically a fifth down, 2 cents flat of the piano). It requires constant adjustments from the soprano singers and an understanding by both choir and conductor of the harmony implicit in the overtone series. Understanding the function of each of these pitches allows the crescendo written in by Chatman to be achieved partially through the shifting of energy as the harmonies shift.

One moment in this selection when the gesture of just intonation is quite functional occurs on the words “eternal” (mm13-14) and “to make pure” (mm56-57).

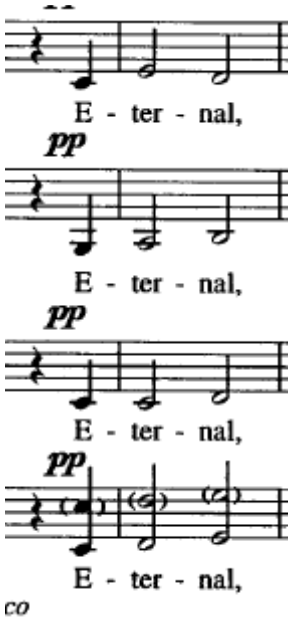

Figure 13. (Permission to use this sample granted by ECS Publishing)

Here the harmony shifts from reciprocal to overtonal energy, jumping over the generating tone. The first chord (F-C-A-E) bypasses a chord centered on C and moves to a lifted overtonal energy (G-D-B). As a conductor, one might show a covered lower gesture for the first chord and actually lift the gesture—turning the hand outwards to expose the palm—for the second chord. That this harmonic motion is present several times throughout the piece allows this hand motion to become an iconic gesture utilized in rehearsal and performance.

"Two Love Songs"

"Two Love Songs" by Robert Young includes rich harmonies throughout and lends itself well to the understanding of proportional harmony. One tool that Young frequently uses is the 4-3 suspension, particularly at cadences. The function of this harmonic motion is that of reciprocal third partial energy, moving to overtonal fifth partial energy. Because the undertonal third partial is 2 cents flat of the piano and the overtonal fifth partial is 14 cents of the piano, a gesture which reflects this change in energy is essential. As previously stated, the ideal gesture for the overtonal fifth partial is one which shows the palm facing down, similar to the Curwen hand sign for "mi" but with more curvature of the hand (creating warmth). The motion of the harmony indicates that the gesture may move from a slightly higher plane to a lower more relaxed plane when conducting this suspension. Because this is a melodic device favored by Young, this gesture can become "iconic" within this piece, utilized throughout to suggest the implicit harmony.

"Sing Me To Heaven"

Daniel Gawthrop's "Sing Me To Heaven" has recently become what can only be called a "staple" of the high school choral lexicon. In an email exchange on October 22, 2010, Gawthrop shared several of his ideas about interpreting his music[89]. "My tonal centers are constantly in motion, shifting with considerable frequency, and I absolutely

[89] Daniel Gawthrop, Email interview by author, October 22, 2010.

depend on 21st century ears for that to work. Do what seems best to you. If YOU are persuaded by it, chances are that I will be too. Interpret the lyrics, not the pitches." Gawthrop creates a harmonic fabric which creates several functional shifts and commas within the music. This constant feeling of motion within the harmonic structure allows the text to be realized with a powerful sense of emotion.

One of the important harmonic interpretations is a matter of choice within the lyric interpretation. The second section of the piece (beginning at m9) is written with a key signature of B Major. However, if E becomes the tonal center, there is an immediate shift in the tone color of this section, and it has ramifications for the interpretation of the text.

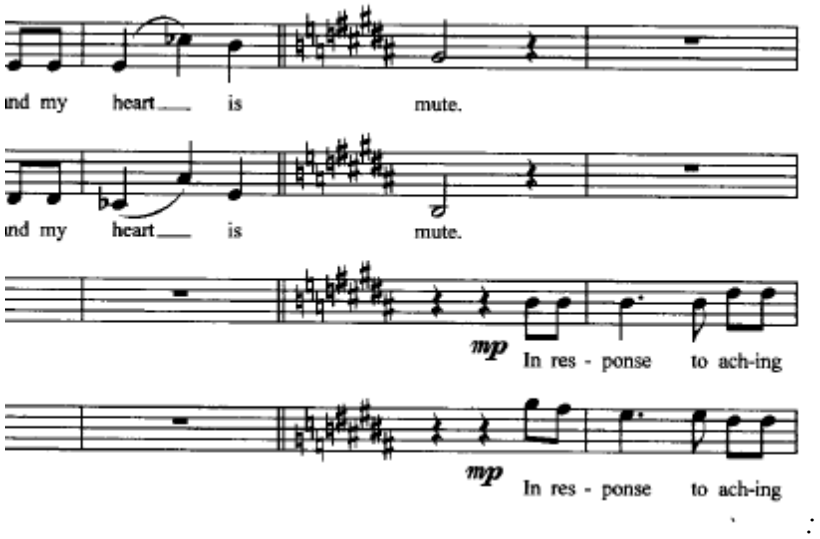

Figure 14. (Permission to use this sample granted by Dunstan House)

With E as the tonal center, the A# in the key signature becomes a raised fourth, indicating Lydian mode. This brightness illuminates the text of the "lullaby" and of ideas of "comfort," "love," and "passion." And while the poetry is a requiem, the idea that the song can "sing me to heaven" is generally one that is hopeful and positive. Thus, selecting E as the tonal center seems to be in accordance with the ideas laid out by Gawthrop.

With this idea of a tonal center, the F-natural in m10 becomes a lowered second with a harmonic path found by singing down a fifth and then down a third.

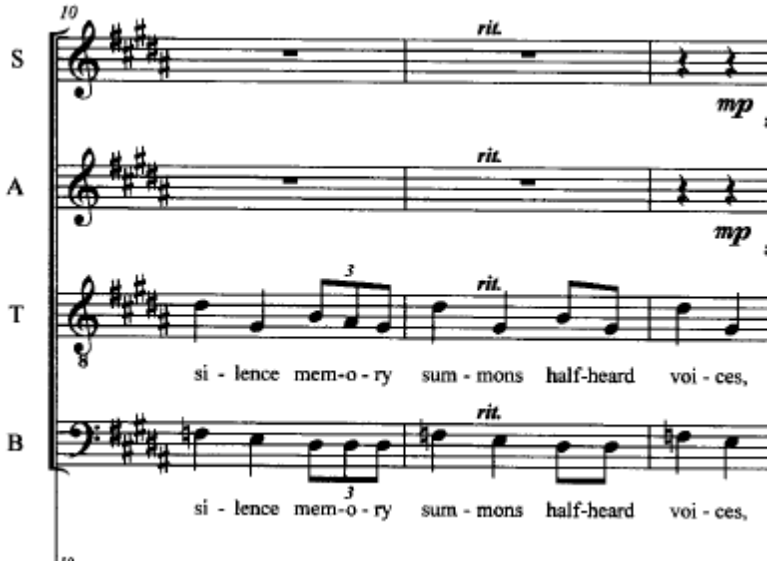

Figure 15. (Permission to use this sample granted by Dunstan House)

This pitch is sung 12 cents higher than the pitch given on the piano. While it is a darker pitch in color, it requires a certain lift in pitch. This can be shown with a gesture at a slightly elevated vertical plane and a hand shape which is slightly more covered. By

singing this pitch in the context of proportional harmony rather than the pitch given by the piano, the resolution from F-natural to E is more dramatic. The pitch has further to travel, and when the E is sung, the pitch feels that much more at rest.

In m38 the sopranos and altos each sing a line which descends melodically, but harmonically is moving up a perfect fifth. These lines are moving to an overtonal and perhaps brighter quality. The conductor may select a gesture which reflects this motion. Beats one and three are shown in a lower vertical space, while beats two and four are shown higher than the beat which precedes them. This will encourage even an inexperienced choir to think "up" as they are singing "down."

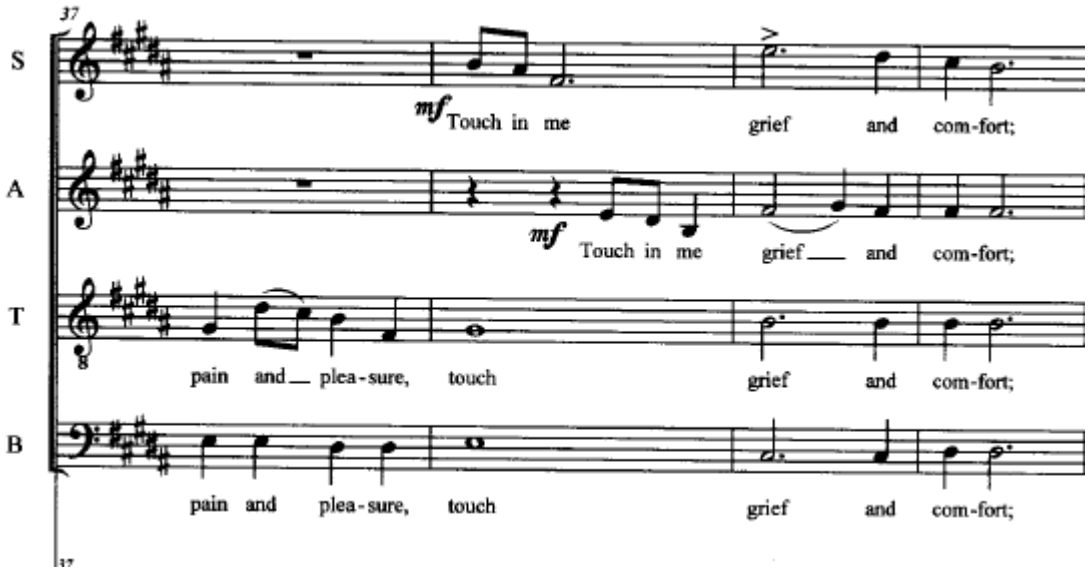

Figure 16. (Permission to use this sample granted by Dunstan House)

The most interesting harmonic motion in the piece is presented in the final two chords. While it is not explicitly shown in the music, it is easy to see that tenors can sing a different C# on the second syllable of "heaven" than they do on the first.

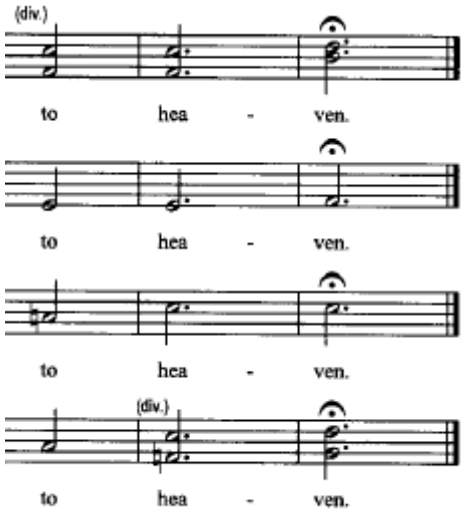

Figure 17. (Permission to use this sample granted by Dunstan House)

The chord in measure 57 is built A-E-B-F#-C#, where C# is the upper fifth partial to A. The following chord is built E-B-F#-C#-D# where C# is an overtonal third partial, three fifths up from the generating tone E. In this harmonic motion, the tenors experience a syntonic comma. The C# which begins a major third away from A is now four fifths away from A. The energy of four fifths stacked is 8 cents sharp of the piano, and the major third is 14 cents flat. This results in a total deviation of 22 cents where the C# feels a significant lift from one chord to the next.

Within this context, the other voice parts are also undergoing harmonic shifts. The basses, baritones, and altos each move up two fifths (harmonically) from one chord to the next. The soprano twos motion in the opposite direction. Considering this framework, it is clear that the overall motion rises and the piece should feel a lift, but because this is not true of every voice part, a gesture which shows only lift may be confusing or inaccurate.

To show the lifting motion, a conductor may begin with his or her hands near the waist and use a lifting motion through each beat of both chords. The left hand begins with the palm outward facing the choir (showing the soprano line) while the right hand begins palm down. As the hands rise they simultaneously begin to turn showing not only an overall lift to the chord, but also the harmonic shift among all parts. With strong audiation, the overall rising motion coupled with the opening quality of the right hand will encourage the syntonic comma experienced by the tenors.

"Mon Coeur Se Recommande A Vous"

This selection composed by Orlando di Lasso was chosen for similar reasons to the previous Renaissance pieces. In the staggered entrances of mm9-11, the conductor finds a specific opportunity. Each entrance is moving melodically and harmonically down a perfect fifth to reciprocal energy which is then less overtonal. While I have previously in this document suggested that lowering the plane of gesture may help show the feeling of moving to this more reciprocal energy, this is a challenging point in the music as the gesture for the soprano entrance at m9 would ideally be in a lower plane to start. For young female singers, showing this entrance with a gesture too high in the conducting plane may encourage clavicular breathing or a disconnect with the breath. As such, the ideal gesture may be one which shows a hand shape that begins slightly more open and moves to encompass a quality that encourages a darker quality tone. Securing these entrances with the pure resonances of proportional harmony may allow the choir to

further enhance the meaning of the text—which sings of sorrow—by creating a slightly darker sound.

"Come Pretty Love"

"Come Pretty Love" is a traditional Shaker song arranged by Joan Szymko. In this setting, the simple melody is sung first by itself, then in cannon, and later in simple harmonies which readily exploit the natural resonances of the overtone series. Because the piece is conducted in one and moves at a fast tempo, it is not possible to show an exact color or shape for every pitch of the melody—though this may be an exercise a choir may utilize during rehearsal. The melody generally exchanges resting points between the generating tone and the upper third partial. When the melody is being sung by itself, the conductor is able to show these resting points with gestures that reflect the harmonic function of these two points of stability. In mm130-144, the conductor may show the drone of the generating tone with the left hand, creating a gesture which reflects stability and strength.

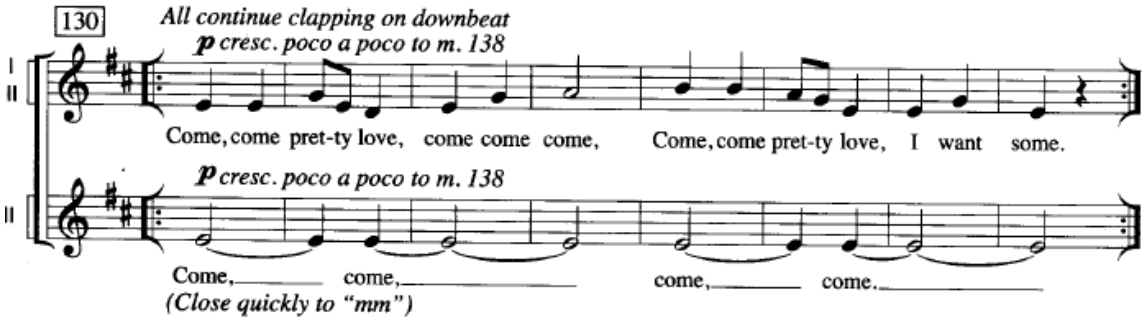

Figure 18. (Permission to use this sample granted by Santa Barbara Music Publishing, Inc.)

The right hand gesture should reflect the harmonic function of the upper voice while the conductor would be well-served by focusing audiation on the varied intervallic pressure experienced by the drone. This will help to create energy and line for the voices singing the drone without the need to impose any extra dynamic variance.

"Weep No More"

This piece by David Childs is set for SSAA voices and piano accompaniment. As the first accompanied piece in the recital, this selection begs the question: "How does one sing in just intonation, when performing with a piano accompaniment tuned for equal temperament?" There is a great deal of music in the choral lexicon written with accompaniment tuned for equal temperament and, therefore, this is an important issue to address. The brain is a very complex system, and just as it adapted early in human evolution to understand, decode, and utilize the natural harmony of the overtone series,

the modern human brain has developed the ability to decode equal temperament. When listening to music played on the piano "you're not hearing what you're hearing."[90] The ears hear the music of equal temperament as the brain is able to process this music within the context of proportional harmony. ""That's the magic trick of temperament. It's able to put you so closely in touch with something you're not getting that you think you're getting it."[91]

If the brain is processing equal temperament and understands how to put pitches in context of just intonation, why is it important or useful to try to sing in proportional harmony at all? Does it make sense to try to sing with different tuning than the piano, in effect singing out of tune with the instrument accompanying the piece? The concept seems difficult, but the human brain has the ability to process this information and find agreement between the two systems of tuning. "We use both systems at once. This solution depends partially on a serendipitous psycho-acoustic phenomenon: although the ear demands that the musical *foreground* be well in tune, it more easily forgives tuning approximations in the *background.* This means that the discrepancies between (for example) a perfectly in tune singer in the foreground and the equal-tempered piano accompaniment in the background will be more or less easily forgiven."[92] Within this

[90] Mathieu, Interview, 8

[91] Ibid.

[92] Mathieu, *Bridge of Waves,* 133.

context, it is easy to apply a working understanding of proportional harmony to a piece accompanied by the piano.

In this selection, the recurring melody of the text "weep no more" is set against a constantly changing harmonic context. Consider mm37-40:

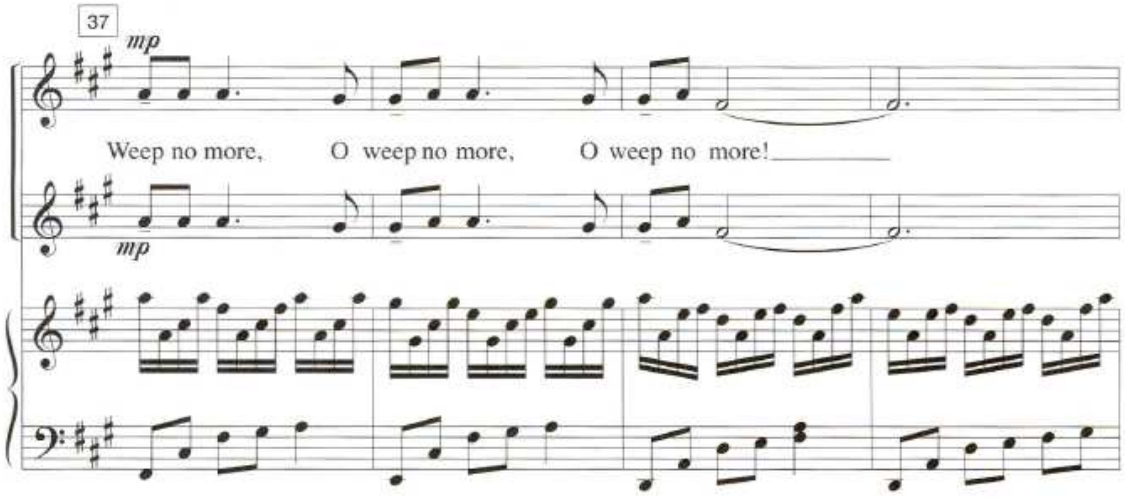

Figure 19. (Permission to use this sample granted by Santa Barbara Music Publishing, Inc.)

In m37, the A is the minor third of the triad. However, if A is considered the generating tone for the entire piece, the C# and F# become the overtonal fifth partial and the fifth below it. These are tones that Mathieu would describe as having sounds of compassion. This seems to fit well with the text which Childs has set. Though the A is the generating tone, the intervallic pressure of the F# and C# create a sense of lift on the A. In m38 the harmony includes the pitches A-C#-G#-E; A is now the true generating

tone for all harmonies in the air. This A will have a sense of centeredness and will feel lower in relation to the A of the previous measure. The melody comes to rest on F# in m39, in the context of a D major chord. This F# represents both overtonal energy (relative to the D) and reciprocal energy (relative to the generating tone A). It once again represents a feeling of compassion and will have a sense of feeling low or relaxed (its pitch will be sung 16 cents flat of the piano).

While the accompaniment includes each sung pitch within the piano part, the conductor should encourage the choir to sing the pitches within the framework of proportional harmony. Not only is this more natural, but, as I stated above, it can only enhance the meaning of the text. With this in mind, the conductor should choose gesture that corresponds to the mood and relative height of each pitch. Though the piano clearly cannot adjust tuning to reflect this change, if it is sung well in-tune, the audience will process these changes and cognize the more pure harmonies of proportional harmony.

"Kumbaya"

The familiar text of this folk song set by Nicholas McKaig is an ideal vessel for the harmonies of proportional harmony. As folk music is traditionally learned through aural transmission rather than reading notation, it makes sense that any setting of folk music takes advantage of low-prime harmonic relationships. McKaig opens this setting with the sopranos and altos singing a drone of an open fifth (the generating tone and its upper third partial) as a backdrop for the soloist. Though the conductor is likely to choose

not to conduct this solo, the ability to audiate the drone will further support the intonation of the soloist. The singers singing the drone should also be aware of the slight rising or falling of pitch that might be created by the intervallic pressure brought on by the soloist, particularly when he is holding the B.

The basses and baritones set the harmonic framework for this piece, and they primarily sing two different harmonic shapes. The first is the root of the chord and its third partial, the second is the root of the chord with its upper fifth partial. Though this is set in a variety of ways in relation to the generating tone, the basic structure of these harmonies remains consistent. When the basses and baritones are singing the open fifth, the conductor should select a gesture which encourages a brighter, more open sound in relation to those sections constructed primarily of thirds.

"A Christmas Carol"

Like the previous selection, this piece is set for voices and piano accompaniment. Composer Joshua Shank sets the Charles Dickens text over a piano part that effectively serves as a drone for much of the piece. Though the piano part includes varied rhythms, the pitches include only F# and C# for the first 65 measures (with the exception of a brief doubling of the melody at mm41-42). This drone of the piano allows the singers to sing every other pitch with an ear towards proportional harmony. The opening tenor line is an ascending Lydian scale to the fifth which sets the tone for much of the harmony to follow. The open sound of the generating tone and its third partial reach in m4 is a

common figure throughout the piece. Because the harmony here is relatively simple, gesture which utilizes Curwen hand signs (Do and Sol) is functional and iconic for most singers. Additionally, as there are often only two parts performing at one time (or two pitches, doubled at the octave) the conductor often has an opportunity to represent both parts within his or her gesture. In many cases one of the voices is singing the F# (serving as a drone) as the other voice sings the harmony. The conductor can show a gesture which reflects the changing upper harmony while audiating any changes implicit to the drone voice as a result of intervallic pressure.

As the text unfolds and the hope and optimism of the text continues to evolve, Shank begins to move to a more overtonal and brighter feeling. The G# sung at m71, and even to a greater extent at m95, seems to represent the changes Scrooge undergoes in the story. This G# should be sung brightly, as the pitch two fifths up from the generating F#. This G# will be pitched 4 cents sharp of the piano. Once again, the Curwen hand sign for Re may help to provide an accurate representation of this slight difference in pitch.

As the piece finds closure, Shank begins to move to a darker sound, filled with more reciprocal energy. Starting at the very overtonal C#-G# from mm120-122, the singers return to a more grounded energy at m123. At m128 we move down another fifth harmonically as the undertonal third partial B is used in the final section of the piece. These final measures bring a sense of warmth and closure to the music. The conductor may choose to move through these final sections of the music selecting gestures which

are moving to a lower more centered conducting plane and which directly represent a darker and warmer tone.

"Beati Quorum Via"

This selection by C.V. Stanford presents a number of challenges to the conductor. Due to its nature as a polychoral work, the conductor may choose to perform this piece *cori spezzatti* (split choir). This choice alone forces the conductor to make different choices about gesture than one might with a choir singing in a more common standing arrangement. Additionally, although the piece is written in three, it is most effective in a feeling of a modified one. Because this gesture has few points of arrival (a relatively consistent downbeat) and because it is slightly more demonstrative to account for a choir which is slightly more spaced out, there is less room for intricacy of gesture than for many of the other pieces performed on the recital. Points of imitation such as mm76-81. create the greatest point of opportunity for the influence of proportional harmony within the song.

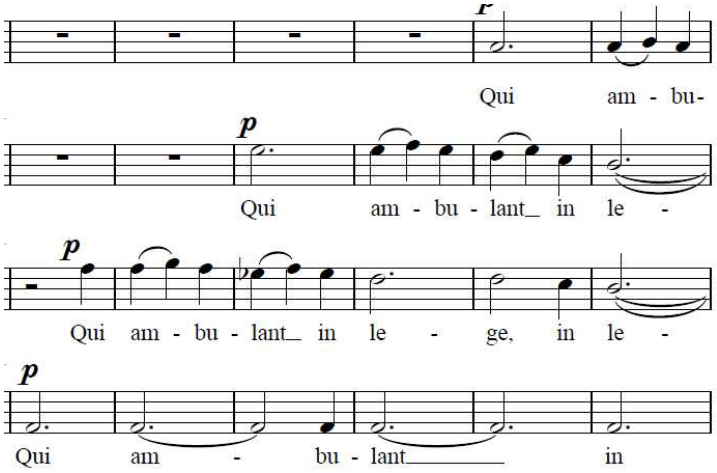

Figure 20.

The Eb of the tenor entrance represents the overtonal third partial, and should therefore be represented with a gesture which promotes a slightly brighter feeling than each of the preceding entrances, and the one immediately following. That just intonation is appropriate for the choral pieces of C.V. Stanford is not in question, as he was plainly in favor of just intonation rather than the "colorless world" of equal temperament.[93]

"Jubilate Deo"

As with the previous piece by David Childs, "*Jubilate Deo*" is a choral work with piano accompaniment. The principles of proportional harmony are primarily employed between voices of the choir rather than always in relation to the piano. This is especially challenging as the piano is in constant motion and often includes every pitch sung by the

[93] Stanford, C.V. *Interludes: Records and Reflections*. London: John Murray, 1992, 58.

choir. Despite its difficulties, the opening melody allows the conductor to show gesture which reflects the motion of proportional harmony.

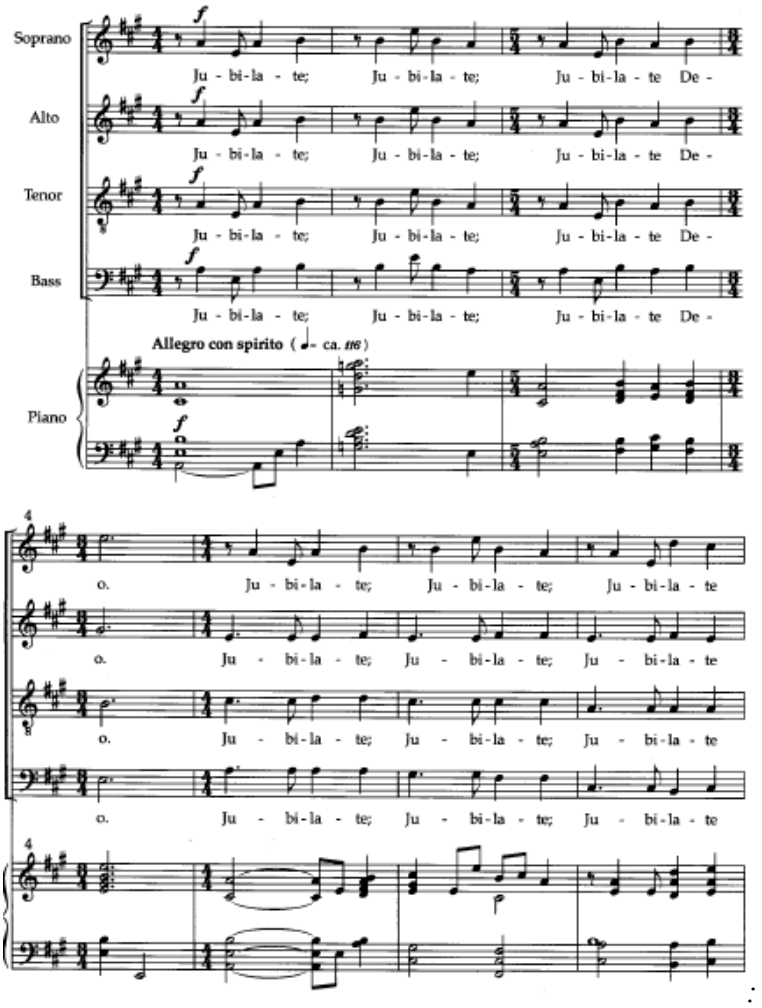

Figure 21. (Permission to use the sample granted by Walton Music)

The motion of A-E-A-B melodically is down a fourth, up a fourth, and up a second. However, harmonically this melody is up a fifth, down a fifth, up two fifths. Understanding the harmonic path of this melody shows that this seemingly simple

melody actually has a great deal of motion. Using a strong downbeat to prepare the breath, the gesture for two in a higher plane will imply upward motion followed by the harmonic path. Showing beat three with more strength in a lower plane not only encourages appropriate tuning, but also the appropriate text stress. This type of function will occur by a light and slightly lifted gesture for beat four. The figure above shows that similar ideas run throughout the main theme.

"How Can I Keep From Singing?"

The text of the final selection set by Z. Randall Stroope seems to fit well with the idea that singing is a natural and necessary part of the human condition. That early humans could not and did not keep from singing likely played a role in our survival as a species. The opening unison melody represents an immediate opportunity for gesture which directly reflects the harmonies of just intonation. This is another melody which lends itself well to gesture influenced by Curwen hand signs, particularly on the longer second beat of each measure.

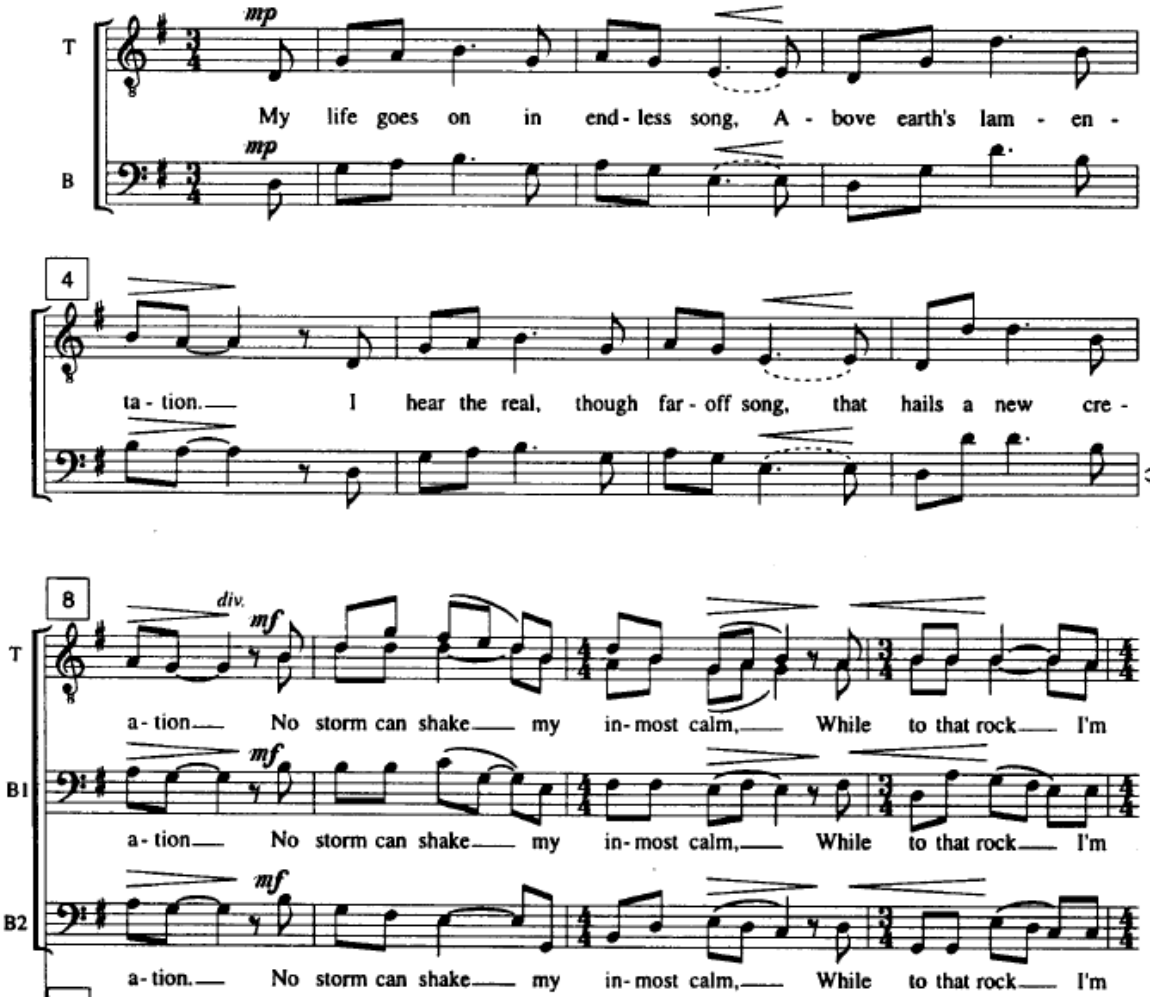

Figure 22. (Permission to use this sample granted by Alliance Music Publications, Inc.)

The first four resting points of the melody (pitched on B, E, D, and A) correspond to the solfeg syllables mi, la, sol, and re. As stated previously, the gesture for mi should be modified slightly to include a slight curvature of the hand rather than the complete flat gesture prescribed by Curwen. This will allow for more warmth and color of tone. La may be slightly modified as well to encourage a slightly lower tuning (16 cents flat of the

piano), but this can be achieved by maintaining a gesture low in the conducting plane. Because this melody repeats several times throughout the song, these iconic gestures can be used throughout the piece to maintain intonation.

The Recital

The recital given in support of this document was performed by the Chamber Choir, Advanced Women's Choir, and Concert Choir from Desert Oasis High School. The music was prepared throughout the course of the school year beginning in August and culminating in our recital performance in April. The research in this document states that conducting influenced by the study of just intonation leads to efficiency and beauty in choral singing. This is certainly true and can be experienced by a choir singing for a conductor for the first time. There are also, many ways in which this information can be employed in the choral rehearsal in preparation for performance.

The Choirs

The choirs that participated on this recital represent wide ranges of age, skill level, and experience level. The Advanced Women's Choir is an auditioned choir of 28 young women, primarily made up of incoming freshman and ladies who are new to the choral program at Desert Oasis High School. The Concert Choir is auditioned choir of 41 singers which includes all grades. The women are auditioned and include sophomore through seniors, most of whom have multiple years of experience at DOHS. The men in

this ensemble are non-auditioned and include freshman and several young men who have never sung in a choral setting. The Desert Oasis Chamber Choir is the premier vocal ensemble on campus. This auditioned group of 18 singers meets at 6:00am every morning, and every student is also enrolled in either the Advanced Women's Choir or the Concert Choir.

The students in our choirs represent what is considered to be the typical high school students: they are involved in sports and clubs on campus, take AP and Honor classes, have after school jobs, and maintain a busy social life. Like many high school choral students, very few of them play an instrument, and only a small handful are able to take voice lessons outside of the school day. For this recital, the students were asked to perform a great deal of music at a very high level and to approach this music with an understanding of high level concepts.

Rehearsal Techniques

In addition to the gestural work by the conductor in rehearsal and performance, the students spent a great deal of time discussing and learning about the concepts presented in this recital. These concepts were consistently reinforced through warm-up activities. Rather than beginning the year singing a major scale, which is a tonality students are generally already familiar with, the students first learned the Lydian mode. When singing modes, students always reinforce tuning through the use of Curwen hand signs. As this document states, these gestures often directly reflect the tuning of

proportional harmony. Further, this gives students a framework for gesture that will later be shown by the conductor. Having experienced these gestures personally and internalizing them allows them to be later reinforced by the mirror system in the human brain. In performance, students see gestures which have now become iconic, and their mirror system allows these gestures to be interpreted by the singers. It also allows the students who would be categorized as kinesthetic learners to achieve at a higher level than they might through other methods of instruction.

After internalizing the intonation of Lydian mode, the students go on to learn the six Church modes in order from the brightest and most overtonal to the ones with the most reciprocal energy (Lydian, Ionian, Mixolydian, Dorian, Aeolian, Phrygian). Each of these modes is sung against a drone played by the piano. The drone played is the tonic or generating tone, and its upper third partial. Through the learning of all six church modes, students are exposed to all of the pitches available in the basic (non-extended) five-limit harmonic lattice. These students began to understand the color and function of each pitch in relation to the generating tone. The singers also spent time singing the drone while the conductor sang the modes. This allowed students to experience the intervallic pressure created by each pitch as it affects the generating tone.

Another major rehearsal technique in preparation for this recital was the building and tuning of specific chords. When building chords using the harmonies of proportional harmony, new pitches are rarely sung in score order. Rather, pitches are sung in harmonic order; that is to say, the note furthest to the left in the harmonic lattice is sung first, then

the upper third partials for that pitch, followed by its upper third partials, and finally by the reciprocal third partials. Students begin to hear the overtones present in the air before they actually sing their pitch. As a result students are hearing and tapping into natural harmonies. The singers were forced to rely on their own hearing rather than pitches being played at the piano. Additionally, the choirs were required to learn their function within the chord (whether they sang the root, fifth, etc.) and the quality of that function (overtonal or reciprocal energy). These are relatively complex and high level skills for high school students, and they are concepts that were new to the majority of the students in these choirs.

Limitations

While this document suggests that gesture informed by just intonation will result in a high level of intonation, it goes without saying that perfect intonation is a lofty goal for high school singers. Even an above average high school choral program will face difficulties in tuning. There were several men who entered the concert choir in August who had never sung in a choir, and a few that initially had problems simply matching pitch. For these students, the concept of proportional harmony is a huge leap in learning. We must also take into consideration that these students are expected to rehearse and make beautiful music at a time of day that is challenging, to say the least. Research shows that high school students do not learn well or find high levels of success this early in the

morning. Additionally, the physical challenge of engaging the body and the voice this early in the morning has its own set of limitations.

The Performance

After viewing the video recording of the recital performance, I am very pleased with the results of our efforts as a choir and with the choices of gestural language made as the conductor. The choirs were able to make music in real time and responded well to what I asked of them as the conductor. There are still many changes that I would make to my gesture and the way that it looks, but a great deal of this document is about the intention behind the gesture. Audiation is a skill developed over a long period of time, consistently evolving and improving. The gestural toolbox developed based on strong audiation and proportional harmony is still evolving. Because there is no predetermined or limited set of gestures which have the ability to show these slight changes in intonation, it is easy to review the recital video and consider different and potentially better options for conducting any given moment of the recital. In the end, the impact that this study had on these young singers was evident in their performance. These young and relatively inexperienced singers were able to make many small changes and adjustments to their understanding of music to perform a concert which accurately reflected the information presented in this document.

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APPENDIX A

Recital Repertoire List

Flora Gave Me Fairest Flowers	John Wilbye	(1:20)	SATB
Ecco mormorar l'onde	Claudio Monteverdi	(3:20)	SATB
O, My Luve's Like a Red, Red Rose	David Dickau	(2:57)	SATB
in time of daffodils	David Dickau	(3:35)	SATB
The Voice of Rain	Stephen Chatman	(4:00)	SATB
Two Love Songs	Robert H. Young	(3:58)	SATB
1. *For Thy Sweet Love*			
2. *Sequel*			
Sing Me To Heaven	Daniel Gawthrop	(3:53)	SATB
Mon Coeur Se Recommande À Vous	Orlando di Lasso	(1:49)	SSA
Come, Pretty Love	Joan Szymko	(2:36)	SSA
Weep No More	David Childs	(3:47)	SSAA
Kumbaya	Nicholas McKaig	(4:10)	SATB
A Chrsistmas Carol	Joshua Shank	(7:01)	SATB
Beati Quorum Via	C.V. Stanford	(3:02)	SATB
Jubilate Deo	David Childs	(2:45)	SATB
How Can I Keep From Singing	Z. Randall Stroope	(2:40)	SATB

Appendix B

The following is a transcription of a phone interview between Brad Pierson and W.A. Mathieu, conducted on July 25, 2010, and subsequently edited for print by W. A. Mathieu.

MATHIEU: Do you know a guy named Brad Vines?

PIERSON: I do not.

MATHIEU: I'm gonna put you in touch with him.

MATHIEU: How 'bout a research guy named Arnie Cox?

PIERSON: No

MATHIEU: You gotta look up these guys.

PIERSON: OK.

MATHIEU: Do you know William Eckhardt?

MATHIEU: Yeah, I know that name.

MATHIEU: Well, he looks into movement in music…. I've looked at something called *Music and Gesture*. Arthur Gritten and Elaine King, do you know them?

PIERSON: No.

PIERSON: The only reason I know these names is that I just finished writing a book, called *Bridge of Waves*, in which I went into the subject a little bit. Not much of it got into the book, but I was fascinated so I did a little research. Here's a quote by Mark Tolinson, who said in *The Body and the Mind,* "Reason, imagination, and meaning stem

from repeated patterns of bodily experience. They are universal since we all have bodies in space, with many images and schematas." I'm just trying to affirm that this subject is something substantive that's really out there.

PIERSON: Sure.

MATHIEU: These authors are in a branch of science allowing them to study music and gesture together. Here's a quote from *The Metaphoric Logic of Musical Motions in Space* (University of Oregon, June 1995): "Music discourse relies on concepts of musical motions in space, despite the fact that tones do not actually move in ways that we describe. This study employs Lakoff and Johnson's theory. . ." Do you know those guys?

PIERSON: Yes, I have several studies published by them.

MATHIEU: I think George Lakcoff is one of the most important living thinkers; I quote him extensively. In my book I deal with questions about how music lives inside us. For instance, I ask the question and discuss it in some detail: Why does frequency that is *fast*, seem *high* to us? One doesn't seem necessarily to follow from the other.

PIERSON: Right.

MATHIEU: And why a frequency that's slow seems low to us. This question asks us to consider the metaphorical nature of music: Music exists in the body, and the body somatizes it, but *in a certain way*. It's interesting to recognize, for instance, that we have legs that are more or less a certain length, and since we walk at a more or less certain tempo, musical pulses corresponding to our walking tempo mean a certain thing to us.

PIERSON: Sure.

MATHIEU: Lakoff among many others thinks about this; a lot of work has been done, and there's a lot more to do. I'm gonna give you Brad Vines' number; call him and say I set you up to it. He's an ex-student of mine, a working neuroscientist whose primary or central interest is gesture in music.

PIERSON: Great.

MATHIEU: He has studied what performers go through when they are performing, and that would be right down your alley too. I see one limit in the field, though: the scientists doing the work know a little music, but usually not much. If you're gonna do that work, of connecting music to gesture through what is basically psychoacoustics, then you really should know the music side of things. Many of the people who are doing this work are, you know, sort of pop, folk, rock, often pretty much on the surface. This is bothersome to me because they don't have enough musical depth to be able to cognize and interpret the work that I'm doing in terms of the work that they're doing. Brad Vines happens to be a good musician who understands the stuff in *Harmonic Experience*, the lattice of tones and the perception of commas that arise in equal temperament and so on. He's an interesting person to talk with, and he really knows the field. He was doing research at Harvard and then he was up at McGill for a while with umm…

PIERSON: Daniel Levitin?

MATHIEU: Yes, I think so. It was Levitin. That's correct. He also got me in touch with Peter Janate. Do you know that name?

PIERSON: No.

MATHIEU: Petr Janate is a colleague of Daniel Levitin, and he works up here at the University of California at in Davis where there happens to be a quite prestigious neurological science research center. My personal suspicion is that Petr Janate's research is a little bit narrow. He thinks he's doing music and neuroscience, and he is to some extent, but I don't like the way he measures things, especially musical things. But, he's very knowledgeable in the field. You'll have to Google him. . . I had kind of a run-in with him public—it was good natured. Just a wee bit tense. I didn't like the way he was presenting musical data, and I had some pithy musical questions he didn't want to hear from the audience.

PIERSON: Sure.

MATHIEU: But we're friends anyway, and he might be a source for you.

MATHIEU: I think you're coming at all this from a conductor's point of view, is that right?

PIERSON: Sure, yeah.

MATHIEU: I think this is fascinating. OK, so tell me more about your paper.

PIERSON: Well, I entered this Master's program with Don Brinegar three years ago, and your book *Harmonic Experience* is essentially our textbook for harmony in the program. Don Brinegar relates a lot of conducting issues and tuning issues in the choral classroom to things that you've written about. Since going through *Harmonic Experience* my first time, I read the other two books that you've published, and that led me to some other

stuff. I've read Daniel Levitin's books: *This is Your Brain On Music* and *The World In Six Songs*.

MATHIEU: What did you think of *The World In Six Songs*?

PIERSON: I love his stuff. I think it puts a lot of things into easy-to-read, very accessible language, so I kind of got fascinated with that. That led me to a book by Steven Mithin: *The Singing Neanderthals*. I just found some fascinating parallels between what people in different fields were saying about the brain's natural inclination towards music and how we're hardwired for sound, and certain sounds, and certain music-making kinds of things. So that's what has led me to the question about why we're hardwired for certain things and how we can — I don't know if *exploit* is the right word — but exploit the efficiency of that for high quality music making.

MATHIEU: Well that's an interesting question. I read a recent article that says we are, what's the word, *pre-adapted*, to hear harmony. That is, as civilization became more and more complex, human beings had more and more to learn how to get along together, and thus developed the capacity to make very fine linguistic distinctions. So, it's all about language. The ability to cognize, and create with, and make a useful tool of language became a condition for survival. As our discernment became more and more keen, we commensurately developed the equipment that allowed us to distinguish the timbral subtleties of vowel sounds and the pitch variations of tonal speech. In other words, we didn't evolve to hear chords changes. We evolved to hear something which allowed us to hear chord changes. It's so incredibly amazing that we can enquire into just how it could

it have occurred that we hear harmony — to realize that we adapted to linguistically understand each other, and the capacity to learn harmony, you know, chords and *modulations* and all, appeared as a result of needing to distinguish vowels sounds from one another.

PIERSON: Right.

MATHIEU: Here, I found the quote I was looking for. I'll just read you a couple of paragraphs from a chapter in *Bridge of Waves,* "Music as Story." That chapter first considers music as if it's your own personal story: you can daydream or you can think it's about you; then *our* story, about us, and then as a sort of anthropology; and at the end of the chapter there's a heading called "Human Music."

> Humankind has its own musical expression, long before there was a concept of music. If there exists a human body, mind, and heart, a human aesthetic will arise. I think the same may be true for zebras and chimpanzees. Even if our music is traceable back only thirty or forty-thousand years, I suspect what we would recognize is musical impulses: our attraction to periodic pulse, pitch, and resonance goes back more than a hundred-thousand years — maybe even to the rise of homo-sapiens. Clearly what we now call music is a very old tool. By studying the hair cells in the cochlea of the inner ear, it has been shown that hearing related genes have been evolving with human speech. Civilization brings with it increasing population density, and the commensurate need for cooperation. The human ear has evolved to better understand what we need to say to one

another. Incidentally, the capacity to hear proportional harmony, that is, tonality, is probably a fortuitous by-product of this aural upgrade. We are pre-adapted to hear tonal harmony. Thanks to the demands of living closely together, we have acquired the equipment and the smarts. Subsequently, tonal harmony arose as we needed it; and we did need it. Tones remove the barrier between persons and things. To quote musicologist Victor Zuckerandl: "Music is the most natural solvent of artificial boundaries between the self and others.

PIERSON: Your book is coming out in December?

MATHIEU: Yeah, 2010.

PIERSON: Very exciting.

MATHIEU: We'll see. Incidentally, the best neuroscience book for the general reader I've read in a long time isn't on music, but it's extremely illuminating to me. It's called *The Body Has a Mind of Its Own: How Body Maps in Your Brain Help You Do Almost Everything Better,* by Sandra and Matthew Blakeslee.

PIERSON: Great.

MATHIEU: So tell me more about your paper.

PIERSON: Well, I'm still really early in the process for all this, but again, the basic idea is linking all of these studies together and trying to figure out, most specifically, how they relate to choral music. Some of the questions that I have for you that I am interested in are about the group dynamic of singing, because in singing through exercises in

Harmonic Experience and experiencing them for myself, I've wondered how you'd relate that to group singing, choral singing.

MATHIEU: Well, that depends. Ask me a question.

PIERSON: For example, there's a statement you made in *The Musical Life* about the difference between "alone and together, continually adjusting the boundaries between where the self ends and the rest of the world begins," and I was curious where you think the conductor enters into that relationship.

MATHIEU: Well that's a very interesting question. Do you know the joke about the violist who conducted the orchestra?

PIERSON: No.

MATHIEU: I'll have to tell you it. So there's a viola player who works in the opera orchestra. He plays second desk, second stand. One night, just before a performance of *Carmen*, the conductor became extremely ill, and fifteen minutes before the performance, the manager addresses the orchestra. He says, 'We're going to have to cancel the performance this evening, our conductor is indisposed — he's at the hospital now — and we don't have another *Carmen* conductor." So, this violist raises his hand and says, "I am a conductor actually, by intention, and I just conducted *Carmen* this last year, and the score is still fresh in my mind, and I would like to have permission to conduct this orchestra in *Carmen*. I know it really well, and you won't have to lose a lot of money and disappoint a lot of people." And the manager thinks "I'll be damned." So he lets the violist conduct *Carmen*, and the violist does conduct *Carmen*, and he does a splendid job.

Everybody applauds and he's the hero of the hour. The production is saved; it's a good night's work. The next night he comes into work, unpacks his viola, takes his seat in the second desk, second stand, and his seatmate – the first desk, second stand – looks at him and says, "So where were *you* last night?" [l*aughs*]

PIERSON: [*laughs*] That's good.

MATHIEU: So that partially answers your question! [*laughs*]

PIERSON: Right.

MATHIEU: It actually does answer your question — you could even tell the joke in your paper, because the role of the conductor is….. well, I've played in symphonies where everybody is better than me, and I don't quite see how the best players do it. But since I am a choir conductor, I know how I do it, and I know what I demand of my singers — and memory is crucial. I've found it most challenging to conduct effectively when singers are reading music. It is way more possible when the music is internalized — not just that they're looking at *you*, but because they know the music better.

PIERSON: And you've talked about adjusting as a singer in group singing. . .

MATHIEU: In respect to the conductor?

PIERSON: Right.

MATHIEU: It's a three-way relationship: it's the music, the performer, and the conductor. And in a certain sense — in choral conducting as well as symphonic playing — it's the section; you have to blend with the section. So you have to sing your part, you have to blend with the section, you have to blend with the choir, and you have to follow

the conductor. I suppose if you were drawing a series of concentric circles, you'd draw music-and-self the center, and in the next circle music-and-self and my sections-mates (because you've got to sing in tune with everybody), and then in the next, music-and self and section mates and the altos (that is, a neighboring section), and then include the whole choir, and then finally the choir and the conductor. But where the conductor actually belongs in that, I think, is a very individual matter. It's different between every choir and every conductor. When I was conducting choirs — and I spent three decades doing it — the times that were best for me were when I could stand in front of my choir absolutely motionless. Which means that everybody was hearing so incredibly well that, although I was very alert and was ready to raise my arms, or my eyebrows, or make eye contact, or do whatever I needed to do at any moment, on any eighth-note, what I was really doing was deeply listening to a choir that had become a self regulating entity. It's like riding a bike with no hands. There weren't a lot of moments like that, but those moments were absolutely perfect. Of course that means you have gotten your choir to sing right, so naturally the music is taking care of itself. The kids are playing in their room and they're just such little angels, ya know? That's my favorite time of conducting: when I don't do anything. It means that somehow everything has paid off.

PIERSON: Sure.

MATHIEU: Now in terms of tuning……well, my confession is, I'm a novice choir singer. And the reason is because I've rarely sung in choirs — I've always been standing out in front of then. I can sing alone very well in tune, but I don't know how ensemble

singers do what they do, the best ones, anyway. But I do know how I expect them to do it when I'm conducting. The conductor has to be subservient to the music, the musicians have to be subservient to the music, and then it is the music itself which guides the relationship between the conductor and the choir. So I can't answer that question from the point of view of the singer because I've spent way more time on the other end of the equation. But I can answer it from the point of view of harmony. In my experience, it is often the harmony itself—the spontaneity of tones, and their communal affect — not just the rhythm, not just the tune, and not the words, but the harmony itself —that is conducting the show. Of course the harmony needs to be heard which is, perhaps, the deepest of all musical experiences.

In choir singing, incidentally, for me the words are supreme. The words are everything: text rules. I conduct for text, and I spend as much time trying to get singers to say and mean what they're singing than on the actual music. If one singer doesn't actually say the words with the intent behind the words, I'll bust 'em. It's my first rule.

OK, back to harmony. Other musical elements, like dynamics, are very much influenced by harmony. For instance, if you have an extremely consonant chord, the tendency is for things to swell because the resonance fills up the singers. As the singers find their bearings and the chord tunes, it tends naturally to want to swell — so you can use that or not. A good conductor, it seems to me, wouldn't have to . . . Well, maybe we can put the whole subject in this little example. Let's say you come to a place where you're conducting a pure minor triad. It's being beautifully tuned, and beautifully

balanced, and there it is. It's absolutely in tune – the fifths and thirds all agree, and it's just hanging there in space and you want it to swell. As a conductor, do you make a gesture saying "I want this chord to swell?" Or do you, yourself, get inside the quality of the sound, and you, yourself, find the swell from inside of that and let the singers find you? In other words, the conductor has to be conducting from inside the swell of the music, not from his agenda or program *about* the music. Everything has to come from the music itself. Not that you might *not* have an agenda or a program. But if you're not feeling the music, fuh-*get* it. It's not gonna happen. You have to be conducting from inside the music. And if you do, I don't think it matters — now Don Brinegar might not agree with me — I don't think it matters what gestures you make. Well, maybe, you know, over the long haul, it does matter. But speaking from first principles, if you're feeling the swell of a minor triad, and you're really feeling it, you're going to find the right gesture and the choir is going to understand what you mean.

PIERSON: Right.

MATHIEU: Now, you might have a preset signal for crescendo. I mean obviously we do, although it's different for some conductors. Some conductors raise their arms, some conductors spread their arms apart, I mean there are a thousand things I could think of doing, but if you're really hearing the resonance of that chord and it's swelling in you, you will find the gesture that communicates to the choir.

PIERSON: We refer to that inner-hearing of the chord as "audiation."

MATHIEU: OK.

PIERSON: And the idea that when you look at a piece of music you can hear it without singing it, and that you can communicate that to the choir through audiation. That's, I think, what you're saying . . .

MATHIEU: That is what I'm saying, yeah.

PIERSON: And we talk a lot about that in the program, that audiation informs gesture.

MATHIEU: Well there ya go! See! I invented your program, just now.

PIERSON: There ya go. Perfect.

MATHIEU: Well Brinegar's only ahead of me by three decades.

PIERSON: Well I don't know about that, but I'm sure he would love to hear that.

MATHIEU: Tell him.

PIERSON: I will, absolutely. Speaking of the music, you were talking about the music informing all of that. But let's say you have a composer who writes with an ear towards equal temperament, even if it's *a cappella* choral music – for example, the composer is writing *a cappella* choral music, even though he is a pianist whose ear is tuned more towards equal temperament — how might you reconcile that as a conductor or as a singer?

MATHIEU: Well, I don't know about "the composer's ear." Frankly, to the degree that music is tonal, I don't think that one *can* hear it in equal temperament. I don't think that's possible. That's what my book is about. Even when you're hearing a C Major chord on the piano, it works very much like you're seeing a telephone pole in the ground, and saying "That's vertical." It's not vertical; nothing's vertical. But it puts you in touch with

your inner sense of ninety-degree-ness, with gravity and the center of the earth, what I call an *inner norm.* And so you say: "That pole is vertical." If you measured it, you'd see it would be a little off – probably about as much off as a tempered "perfect" fifth. When you hear the overtone series on the piano, when you hear a major chord — or any kind of tempered major/minor triad, or progression of triads—you're not hearing what you're hearing. That's *the* most amazing thing. When you go to a movie you're not seeing what you're seeing. You see moving light images, but you think you're in a bedroom with two people fucking, or whatever the movie is about — and you should *definitely* stay away from those movies, son [*laughs*].

PIERSON: [*laughs*]

MATHIEU: So when you hear equal temperament, to the degree that the music is tonal, you're put in mind of something that you recognize. That is, you don't hear the music so much as you recognize what the music *stands for*. That's why temperament works: because you don't hear it, you hear what it's trying to say. And I don't even think it's *hearing.* I think it's *decoding* — pre-hearing. I think it's the brain responding to its own need to make the most perfect sense out of what it is hearing. That's the magic trick of temperament. It's able to put you *so closely* in touch with something you're not getting that you think you're getting it. It's like seeing round things. You never see round things; you just see things that look round. In piano music, you never hear major and minor chords; you just hear things that sound like they're major or minor. So if you stay pretty close to the five-limit lattice of tones and you don't move around too much, you don't

make too many harmonic leaps, and your chords don't have a lot of dissonant extensions, then you're not hearing the temperament. You're hearing what it means. As soon as you begin to have sufficient ambiguity in your tonality by harmonically leaping about, and commas begin to arise and be used, and ambiguous cross- purposes begin to occur in the music, the brain begins to fuzz out the image, and sooner or later you're in the landscape of symmetric scales, and onward all the way to atonality. Most of the music that we know is sort of in between. I think to the extent that composers are hearing tonally, they're not hearing the temperament. Now there are exceptions to this. There are some perfect-pitch singers who are trained on pianos, and they sing equal tempered music — and they usually don't sound very musical. It's true also perforce for instrumentalists who are studying to be orchestral instrumentalists. The perfect-pitchers can actually play equal tempered scales. But they're doing it intervalically. They're not really doing it harmonically. They've sensitized themselves to where those pitches are. Those are often people with very good pitch memory who can memorize the equal tempered places which is, for me, nearly impossible. I mean, there's no "there" there in an equal-tempered scale. There's no "there" in an equal tempered ratio, only a *sort-of-there-you-know-what-I mean*. I don't think we have the capacity to understand the harmony of an equal tempered ratio — that is, an irrational ratio. I think we can understand it intervalically, and we do hear when tones are symmetrically spaced — for instance, an augmented chord splits an octave into three equal parts, or a chromatic scale splits the octave into twelve equal parts — but that's not hearing tonally. That's hearing melodically, hearing distance, not ratio.

Addition is not multiplication, and melody isn't harmony. I think that to the degree that equal-tempered music is tonal, you just simply accept what it *means* as much as that is realizable. Beyond that, you negotiate the commas in the most musical possible way, and if the music moves towards greater and greater ambiguity, or even toward symmetry, the affect changes accordingly, and you change your conducting. There's a continuum between just-tuned tonal music and equal-tempered atonal music, and I think this is one of the things that conductors do very, very much have to be aware of — namely, how tonal *is* the music and how much are you going to go for the resonant aspect, and on the other hand, where does the ambiguity come in. This is what separates the men from the boys — and yes, the women from the girls. I think good conductors understand this intuitively, or perhaps analytically — especially if they read *Harmonic Experience* and their name is Don Brinegar. I think they understand intuitively where ambiguities are, where commas need to be negotiated, and how music can intentionally diffuse the tonal center and begin to be everywhere, that is, symmetrical or atonal. That's a crucial part of the real meaning of the music. So . . . I don't know if that answers your question . . .

PIERSON: Yes. Well, I don't know how much more time you have to talk.

MATHIEU: I'll try one more.

PIERSON: I was rereading through some things this morning, and one of the most profound things I found in *Harmonic Experience* was that you suggest that "our responses to the pure harmonies of just intonation define our humanity." I found that

really fascinating, and I was wondering if you might be able to talk about that idea a little bit.

MATHIEU: Well, you know, that's interesting. I went early in this conversation to that pre-adaptive quote. Check out "Evolution's Ear," by Bruce Bowe, the August 30, 2008 issue of *Science News*. *Science News* is a weekly, or bi-weekly magazine that goes to scientifically engaged lay-readers. It's really interesting. OK, so we're pre-adaptive. So, who else hears tonal harmony? Dogs don't. Even whales don't. You do have some exceptions in birds where there are overtone series that just happen. Whether the birds are actually singing musically, yes and no, maybe. It's like you're born with a penny whistle in your throat. So if you're breathing it's like you're [*imitates bird sound*]. So birds have that, and even owls do [*imitates owl sound*]. You know. You hear 6-5-4-3. You hear that in birds all the time. Not just the overtone series though. It happens in whales — that they have these shapes in their chambers that make the sound — and so yeah, that stuff comes out. Are they intentionally making music? Well yeah, probably, in some regard. Do they sing parallel fifths? No. Do they sing triads? No. So they don't do the things that we do. And some of the things we do are pretty universal. If you look everywhere in the world where there's people, you find certain musical practices going on. We keep time in duple and triple meters, and we sing proportional relationships. That's everywhere without exception. And it's probably been there for tens of thousands of years. And who else does it? Nobody else does it. We do it. So if you do something and nobody else does it, then it defines you. Baseball players are the only sportsmen who can make the statement, "I play

baseball." So if you hear proportional harmony, it means you're one of the human race, so I think that defines us. And I think that there is a tremendous sense of human community, notwithstanding man's inhumanity to man — six million dead Jews and thirty million dead Russians in recent memory thanks to Hitler and Stalin, plus unknown atrocities committed in our own name every day. Despite these things, I think that basically we look out for each other; that we sense ourselves as a human community. And there are certain things that give us our coordinates amongst each other. Music, which has been called the universal language, is probably one of those most defining things. Family is another. Some animals don't do that, but we do do that. We pair up and raise kids, and you'll find that everywhere — more or less successfully, more or less kosher to the model, but it does happen everywhere. I think that music is even more idiosyncratically recognized as what humans do. Now do the birds have the music of their flocks? Yeah they do, actually. Music can be most broadly defined — one can discern music at every octave of existence. I think every species — zebras, chimps too — everybody has their music. In fact, there is a species of moth, a subspecies actually, and they keep their little subspecies together because these moths emit these sixty-thousand cycle tones, and there's a lot of moths around that are emitting these tones. But the subspecies is kept as a subspecies because they respond only to sixty-thousand-four-hundred and thirty cycles per second, or something like that. And if it's a little sharp: get lost, baby. [*laughs*].

PIERSON: [*laughs*]

MATHIEU: And if it's a little flat, likewise. So they have this tremendous, like .001%, range, you know, up in the extremely high range, way too high for us. So, that's *their* defining music. That's the way that particular niche of evolution recognizes itself. But we were talking about proportional harmony. And I think that when . . . I love this thing that you guys have. What's it called, audiation?

PIERSON: Yeah.

MATHIEU: That word is closer to humans responding to the what defines us. When you're in a choir and you're in that special mix, you are saying something that is quintessentially human — as human as it is possible to get. It defines what's human because it's proportional. One of the reasons that atonal music — you know I've never said this before — one of the reasons atonal music never caught on is because if you look at it, atonal music and flying geese or howling hyenas aren't that different from one another. Atonal music doesn't have any proportional harmony to guide it. It's all pattern, patterns and gestures. You have to remember certain sequences if its twelve-tone. In any case, you're recognizing patterns, just like any language has patterns. So when the frogs are "frogging" in the pond, there's all kinds of patterns that are going back and forth there. When the lightning bugs are lighting up in the tree, there's all kinds of patterns that are going on. Animals communicate with each other through pattern. They especially do when you hear frogs in a pond or you hear the wolves howling. That's kind of the way atonal music sounds to me because if you take away the proportional harmony, then you have pattern recognition, but you have that in lots of places. In atonal music, the patterns

are, yes, very intelligent, often highly intellectual. The thing that defines atonal music as being human is that it's smart in a way that humans are smart. You're not going to find many wolves who can track those patterns, but then again, we can't track *their* patterns. But, nobody does proportional harmony. Nobody sings octaves except us. Not to make any value judgments, to say atonal music is better, or wolf music is better, or frog music is better. Proportional harmony is simply human, that's all. And when that is gone from the music, I don't think there are going to be a lot of people who will listen to it for very long, notwithstanding the fact that you live in Los Angeles, where Schoenberg dies hard. Incidentally, I've learned a lot of atonal music; I've benefited mightily from it, and I play it sometimes. But I play it mostly as a little aspect of what I know how to do. It's never where I would live.

PIERSON: Well that is fascinating.

MATHIEU: I think the ability to ferret out proportions is a highly specialized ability and results in a special kind of affect which allows us do a special kinds of things, like, you know, play jazz [*laughs*], or whatever. Our capacity to de-code and be *moved* by proportional wave-forms makes us who we are to a large extent, and if you take that thing away, people are gonna get pissed, as indeed they do.

PIERSON: Well, I feel like you've given me a ton of stuff.

MATHIEU: OK, Brad. A lot of people are working in the field you are choosing, and it's a tricky field because you don't listen to reason: that is, you don't build bombs or weapons of mass destruction, and you don't do mustard gas. Consequently, it's very

difficult to get funding. If only you built genocidal weapons, you could get a lot of money from the United States Government. But, psychoacoustics is a benign field. There's a lot of people doing it, and it's hard to get work. Not as a choir conductor, though. It's easy to get work as a choir conductor because people love to sing. America is still a healthy place in that regard. But the research that *is* done seems to me to have a real built-in problem, and this is the reason I'm taking this care to talk with you. The problem is that the scientists who do this work, with notable exceptions, aren't very good musicians. And, you know, that's a shame. Because if this work were being done by people who were better musicians, they would understand their subject so very much better, instead of looking at it as if assuming that elephants need to be dissected in order to understand them. This subject really tests the subjective/objective cusp of science. Is science subjective? "I feel this way" and that's my research? Or is it objective? Like, I can quantify this and make predictions and reproduce my experiments. The stuff that you're doing is really in-between. It's going to incite academic dissonance on the part of many because you're a musician, and music isn't science. Music isn't science, I'll tell you that much. If there's anything I can tell you for sure, it's that music isn't science. But I don't think science is science either. I think science is going to be a lot better science when it learns to be more musical, as indeed it is in this generation of science, when it more trusts the subjective. So one proceeds from things that can be understood only through experience, and I think that's the right approach. The secret is in the title of the book *Harmonic Experience*. "Harmonic" is an adjective and "experience "is the noun. The

book is about experience; only incidentally about harmony. It's a *particular* kind of experience, yes, but experience is the key. In that, it's a proud descendant of a book called *Art As Experience*, by John Dewey which was written in the 40s. As I cited in *Harmonic Experience*, before the time of John Dewey, the aesthetics of art had an objective paradigm. If your view wasn't objective, it wasn't aesthetics; it certainly wasn't academic aesthetics. John Dewey was the first one I know of to say "Hello? How do you feel about this?" a new and dangerous thought in the field at the time. That's where psychoacoustics is right now. I think that the people that are doing it are, to a large extent, on the right track. But instead of asking a bunch of freshmen who are wearing earphones and answering questions, by checking boxes on a piece of paper, what they think and what they feel, and trying to get some sort of statistical analysis so that they can write a paper to get recognition-cum-tenure, what these people should be doing is wood-shedding to become really good musicians. Then they would ask the right questions. So I hope you ask the right questions. The ones you've asked so far are pretty good.

PIERSON: Well thanks.

MATHIEU: Alright, keep me posted. If I can help you, I will.

PIERSON: Absolutely. I will get this all transcribed and send it to you for review and editing.

MATHIEU: That would be fabulous, but it's a long transcription. You don't have to be too literal about it. I'm not exactly being linear this morning. It's Sunday! You want me to be linear on Sunday? [*laughs*]

PIERSON: I know, it was asking a lot. [*laughs*] Thank you so much. I appreciate your time.

MATHIEU: Good luck, and my best to Don Brinegar.

Appendix C
Masters Conducting Recital Program

Just Intonation and Gesture

A Recital

Presented by the Desert Oasis Choir Program

Brad Pierson, Conductor

Barbara Buer, Accompanist

Friday, April 8, 2011
6:00pm

Desert Oasis High School
Las Vegas, Nevada

This recital is presented in partial fulfillment of the
Masters of Music in Choral Conducting
from California State University, Los Angeles

Masters Conducting Recital

Brad Pierson, Conductor

Barbara Buer, Accompanist

Featuring the Desert Oasis High School Choir Department

Chamber Choir

Flora Gave Me Fairest Flowers ..... John Wilbye

Ecco mormorar l'onde ..... Claudio Monteverdi

O My Luve's Like a Red, Red Rose ..... David Dickau

in time of daffodils ..... David Dickau

The Voice of the Rain ..... Stephen Chatman

Two Love Songs ..... Robert Young

Sing Me To Heaven ..... Daniel Gawthrop

Advanced Women

Mon Coeur Se Recommande À Vous ..... Orlando di Lasso

Come Pretty Love ..... Joan Szymko

Weep No More ..... David Childs

Concert Choir

Kumbaya ..... Nicholas McKaig

A Christmas Carol ..... Joshua Shank

Beati Quorum Via ..... Charles Villiers Stanford

Jubilate Deo ..... David Childs

How Can I Keep From Singing? ..... Z. Randall Stroope

Program Notes

The theme for this recital is the effect of just intonation on conducting gesture. The repertoire is selected to feature a variety of ways in which this applicable. Each piece utilizes this sense of proportional harmony either throughout the composition, or in specific chord structures and harmonic motions within the selection. The goal of this study is to show that through the preparation of choral music, based on an understanding of proportional harmony, the conductor will have the opportunity to utilize a gesture which maximizes efficiency and musicality.

Flora Gave Me Fairest Flowers **John Wilbye (1574 – 1638)**

Flora gave me fairest flowers,
None so fair in Flora's treasure,
These I placed in Phillis' bowers;
She was pleased
and she's my pleasure
Smiling meadows seems to say,
"Come ye wantons, here to play!"

Ecco mormorar l'onde **Claudio Monteverdi (1567 – 1643)**
Text by Torquato Tasso (1544 – 1643) Translation by Joan Catoni Conlon

Ecco mormorar l'onde	Hear the gentle breezes murmuring
e tremolar le fronde	and the leaves and young trees
a l'aura mattutina e gl'arborselli.	trembling in the morning air.
E sovra I Verdi rami I vagh'augelli	And, above, on leafy branches
cantar soavemente	beautiful birds sing sweetly,
e rider l'oriente	and, slowly, the eastern sky brightens.
Ecco già l'alb'appare	Now the dawn begins to appear,
e si specchia nel mare	and to cast a reflection in the sea,
e rasserena il cielo	and to lighten the sky,
e'imperla il dolce gielo	and to make pearls of delicate dewdrops
e gl'alti monti indora.	and to clothe in gold the high mountains.
O bella e vagh'aurrora	Oh, radiant and shining dawn,
l'aura è tua messaggiera,	this breeze is your messenger
e to de l'auara	and you are the messenger of the breath
ch'ogn'arso cor ristaura.	that restores each ardent and withered heart.

Notes: Music underwent a transformation in the time of the Renaissance. The madrigal was one of the most popular musical styles of the time. This style, initially crafted in Italy, uses polyphonic voicing (usually 4 – 6 parts) to depict a variety of themes. Here, each piece utilizes well-crafted melodic lines and several "madrigalisms" to depict beautiful pastoral scenes. John Wilbye and Claudio Monteverdi wrote their madrigals at the end of the Renaissance in a time when composers were just beginning to use what we understand as modern tonality. The pure resonances of proportional harmony create a beautiful natural harmony that reflects the performance practice of the time period.

O, My Luve's Like a Red, Red Rose **David Dickau (b. 1953)**
Text by Robert Burns (1759 – 1796)

O, my Luve's like a red, red rose
That's newly sprung in June,
O, my Luve's like a melodie
That's sweetly played in tune.
As fair art thou, my bonnie lass
So deep in luve am I,
And I will love thee still, my dear,
till all the seas gang dry.
Till all the seas gang dry,
And the rocks melt with the sun,
And I will luve thee still, my dear,
while the sand of life shall run.
And fare thee weel, my only Luve,
And fare thee weel a while
And I will come again, my Luve,
Tho' it were ten thousand mile.

in time of daffodils **David Dickau**
Text by e.e. cummings (1894 – 1962)

in time of daffodils
(who know the goal of living is to grow)
forgetting why, remember how

in time of lilacs who proclaim
the aim of waking is to dream,
remember so (forgetting seem)

in time of roses,
(who amaze our now and here with paradise)
forgetting if, remember yes

in time of all sweet things beyond
whatever mind may comprehend
remember seek (forgetting find)

and in a mystery to be
(when time from time shall set us free)
forgetting me, remember me

Notes: The poetry of "O, My Luve's Like a Red, Red Rose" was written by a very young Robert Burns. Later he set the text to music for a collection of Scottish folk songs. The beautiful words describe a strong and somewhat selfish love.

"in time of daffodils" uses the imagery of different colored flowers to describe what composer David Dickau says is the "idea of the perfect relationship."

As each piece changes keys, they explore the colors of the newfound harmonic territory. The first piece utilizes varied voices to create a tonal center as a point of reference as the poetry moves. "in time" uses a more literal drone of the words "in time" – perhaps an indication of continuing strength and passion throughout the passage of time in

The Voice of the Rain **Stephen Chatman (b. 1950)**

Text by Walt Whitman (1819 – 1892)

And who art though? Said I to the soft-falling shower,
Which, strange to tell, gave me an answer, as here translated:
I am the Poem of Earth, said the voice of the rain,
Eternal I rise impalpable out of the land and the bottomless sea,
Upward to heaven, whence, vaguely form'd, altogether changed, and,
yet the same,
I descend to lave the drouths, atomies, dust-layers of the globe,
And all that in them without me were seeds only, latent, unborn;
And forever, by day and night, I give back life to my own origin,
and make pure and beautify it;
(For song, issuing from its birth-place, after fulfillment, wandering,
Reck'd or unreck'd, duly with love returns.)

Notes: In a telephone conversation on Friday, November 5, 2010, Stephen Chatman shared with me several ideas about his song and his compositional style. Several times he indicated that text was the driving force behind his musical decisions. He suggested that the long lines of this song must be performed in a very legato manner. In regards to just intonation he said it is "Not on my radar, really. I trust singers to do what they have to do. Intuition is a funny thing." The images of earth and the elements presented in this piece seem to lead to an open sonority best achieved through the resonances of proportional harmony. Chatman writes in a manner that allows the tonality of the piece to remain well established as varied harmonic contexts are explored. Never veering far from the center, the altos and tenors seem to pass the "drone" back and forth in the A sections, while the long lines of the B section create a stability for the moving parts to sing through.

Two Love Songs **Robert Young (b. 1923)**

For Thy Sweet Love

Text by William Shakespeare (1564 – 1616)

When in disgrace with fortune and men's eyes,
I all alone beweep my outcast state
and trouble deaf heaven with my bootless cries,
and look upon myself and curse my fate;

Wishing me like to one more rich in hope,
featured like him, like him with friends possessed,
desiring this man's art, and that man's scope,
with what I most enjoy, contented least;

Yet, in these thoughts myself almost despising,
haply I think on thee, and then my state,
like to the lark at break of day arising from sullen earth
sings hymns at heaven's gate, sings hymns at heaven's gate;

For thy sweet love remembered; such wealth brings,
that then I scorn to change my state with kings.

I. Sequel **The Song of Solomon 8:6**

Set me as a seal upon thine heart,
as a seal upon thine arm.
For love is strong as death.

Notes: The juxtaposition of these two texts creates a powerful look at love and death. The first, a sonnet by Shakespeare, begins with all the sounds of pain and agony of a lost and jealous person. The speaker, realizing the beauty of a love once possessed, is moved to a state of joy and exuberance – comparing this love to the songs at heaven's gate.

The second text, taken from the Song of Solomon, creates and interesting harmonic ideas. For instance the word "death" consistently employs tones that move from a darker reciprocal energy, to a brighter more overtonal feeling.

Sing Me To Heaven **Daniel Gawthrop (b. 1949)**
Text by Jane Griner

In my heart's sequestered chambers life truths stripped of poet's gloss.
Words alone are vain and vacant and my heart is mute.
In response to aching silence memory summons half-heard voices,
and my soul finds primal eloquence and wraps me in song.

If you would comfort me, sing me a lullaby.
If you would win my heart, sing me a love song.
If you would mourn me and bring me to God,
sing me a requiem, sing me to Heaven.

Touch in me all love and passion, pain and pleasure
Touch in me grief and comfort; love and passion, pain and pleasure.

Sing me a lullaby, a love song, a requiem.
Love me, comfort me, bring me to God:
Sing me a love song, sing me to heaven.

Notes: In recent years, Gawthrop's "Sing Me To Heaven" has become a popular standard in choral music. Performed regularly at festivals and concerts around the country, the text and music come together to form a truly stunning piece.

In an email exchange on October 22, 2010, Gawthrop shared with me several of his ideas about interpreting his music. "My tonal centers are constantly in motion, shifting with considerable frequency, and I absolutely depend on 21st century ears for that to work. . . Do what seems best to you. If YOU are persuaded by it, chances are that I will be too. Interpret the lyric, not the pitches."

Gawthrop creates a harmonic fabric which creates several functional shifts and commas within the music. This constant feeling of motion within the harmonic structure allows the text to be realized with a powerful sense of emotion.

Mon Cœur Se Recommande À Vous **Orlando di Lasso (1532 – 1594)**

Ed. Jerry Weseley Harris Translation by Alice Parker

Mon cœur se recommande à vous My heart is offered still to you,
Tout plein d'ennui et de martyre; Full now of woe and deep despairing;
Au moins en dépit des jaloux, Be not to constancy untrue,
Faites qu'adieu vous puisse dire! Say one farewell, my sorrow sharing!*Ma bouche qui savait sourire*
My mouth which once could smile in gladness
Et conter propos gracieux And charming stories improvise,
Ne fait maintenant que maudire Now may only curse in its madness
Ceux qui m'ont bannie de vos yeux. Those who banished from your eyes.

Notes: Orlando di Lasso was one of the most diverse, prolific, and influential composers of the Renaissance. This piece, written in ABA form, has two basic tonalities. The second section takes on a sadder feel than the first section. One item of particular interest is the exchange between voices and the harmonic motion of the phrase "Faites qu'adieu vous puisse dire." The movement (F – Bb – Eb) moves towards increasingly darker, or more undertonal, energy. Though the melody in and of itself is perhaps not inherently "sad," the harmony helps to reinforce the feeling of sadness expressed in the text.

Come Pretty Love **arr. Joan Szymko**

Traditional Shaker Song

Oh my pretty Mother's home,
sweeter than the honey in the comb.
Come, come pretty love, come come come,
Come, come pretty love, I want some.

Composers Notes:

Shakers, a religious sect formally known as the United Society of Believers in Christ's Second Coming, splintered from a Quaker community in Manchester, England about 1747. The members were known as the Shaking Quakers and were viewed as radical for the impassioned shaking that would occur at their services. "Mother" Ann Lee (1736 – 1784) became the official leader in 1772, and in 1774 she moved the small, much harassed group of believers to America where they struggled, facing great persecution for being both English and pacifistic in the middle of the Revolutionary War. However, a wave of religious revivalism swept across New England in the last quarter of the century and Shakerism survived, reaching peak membership at around six thousand by the mid 19th c. before entering a major decline after the Civil War. Just a handful of Shakers remain today.

Unique aspects of Shaker Life included communal living, celibacy, simplicity, industrious labor, and highly ritualized ecstatic singing and dancing at worship services. Shakers became widely known for their distinctive craftsmanship and folk art, born of the commitment to a life of perfection and simplicity. At the center of all Shaker beliefs were the radical ideas of 1. gender equality and 2. God as a duality, both male and female. Mother Ann Lee was believed to be the Second Coming of Christ, embodying the loving spirit known to most Christians as the Holy Spirit.

While the first Shaker "songs" were wordless tunes, eventually over 12,000 songs were composed, more than any other religious communal society in America. Come Pretty Love, rousing and energetic, was most probably a dance or ritual song. It is just one of numerous Shakers songs and hymns celebrating spiritual Mother, Ann Lee.

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A Christmas Carol **Joshua Shank (b. 1980)**

Text adapted from Charles Dickens

"There are many things from which I might have derived good by which I have not profited, I dare say," returned the nephew, "Christmas among the rest. But when it has come round – apart from the veneration due to its sacred name and origin, if anything belonging to it can be apart from that – as a good time: a kind, forgiving charitable, pleasant time; the only time I know of, in the long calendar of the year, when men and women seem by one consent to open their shut-up hearts freely, and to think of people below them as if they really were fellow-passengers to the grave, and not another race of creatures bound on other journeys. And therefore, Uncle, though it has never put a scrap of gold or silver in my pocket, I believe that it has done me good, and will do me good; and I say, God bless it!"

It is a fair, even-handed, noble adjustment of things, that, while there is infection in disease and sorrow, there is nothing in the world so irresistibly contagious as laughter and good humour.

Scrooge was better than his word. . . He became as good a friend, as good a master, as good a man as the good old City knew, or any other good old city, town, or borough in the good old world.

"A merry Christmas to us all my dears. God bless us!"

"God bless us, every one!"

Composer's Notes: Dicken's masterpiece, *A Christmas Carol,* is a story about transformation and the chance for redemption which just happens to be set during the Christmas season. This holiday can mean a lot of things to a lot of different people but, in my case (as in Ebenezer Scrooge's), it's simply a time that serves as a reminder as to how we're supposed to be treating our "fellow-passengers" during the rest of the calendar year.

Notes: Though this piece is set against the equal temperament of the piano, Shank frequently uses chord structures that bring out the natural harmonies of the overtone series.

Beati Quorum Via **Charles Villiers Stanford (1852 – 1924)**

Psalm CXIX, 1. Ed. J. Cooke

Beati Quorum via integra est:
Qui ambulant in lege Domini.

Notes: As a part of the Cecillian movement of the late 1800s, C.V. Stanford was a proponent of just intonation. Referring to equal temperament as a colorless world, he suggested that a composer must understand the harmonic context of just intonation. Utilizing several different techniques from the Renaissance, this piece also incorporates some Romantic ideas to create a beautiful harmonic fabric with which the text comes to life. As a polychoral work, the piece presents several challenges for intonation in addition to the challenges of maintaining a sense of pulse under the overarching rhythmic structure.

Jubilate Deo **David Childs**

Psalm 100

Jubilate Deo
Make a joyful noise unto God, all the earth;
serve the Lord with gladness all ye people.
Enter into his presence with rejoicing.
Know that the Lord alone is God;
he has made us, and not we ourselves;
we are his people, and the sheep of his pasture.
Enter through the gates with thanksgiving,
and into his courts with praise;
give thanks to the Lord our God.
Praise his name, for the lord is gracious;
praise his name, his mercy is forever;
and his truth endures from generation to generation.

Notes: As with the previous piece by Childs, this selection is set for choir and piano. Though sung against the equal temperament of the piano, the chord structure and melody provide several opportunities to utilize a more pure proportional harmony. The structure of the chords, particularly at the end on the 'o' of 'Deo' are especially exciting for exploring how the natural overtones reinforce harmony.

How Can I Keep From Singing? **arr. Z. Randall Stroope**

Text by Anna Bartlett Warner, adapted by Z. Randall Stroope

My life goes on in endless song,
Above earth's lamentation.
I hear the real, though far-off song,
That hails a new creation.
No storm can shake my inmost calm,
While to that rock I'm clinging.
It sounds and echo in my soul.
How can I keep from singing?

Although the storms around me blow,
I know the truth will guide me,
Although the darkness 'round me grow,
My song's the light beside me.
No storm can shake my inmost calm,
While to that rock I'm clinging.
While Love is lord of heav'n and earth.
How can I keep from singing?

Notes: The beautiful melody and well-known words of "How Can I Keep from Singing?" send a powerful message about the importance of music in our everyday life. The simple harmonic structure, and the folk-like melodic line lend themselves well to the purity of proportional harmony. As the piece progresses, the chords expand to a more full range, in the upper tessitura of each voice, creating ample opportunity for a full sonorous sound, filled with a richness of overtones.

A Note from the Conductor:

In the discourse surrounding temperament and choices in the choral rehearsal, "just intonation" is often relegated as a concept best left to theorists and mathematicians. For most choral conductors, particularly at the high school level, the idea of having students sing at pitches other than those clearly delineated by the piano seems challenging at best. However, the sonority of contemporary a cappella music sung in just intonation is far superior to the limited sounds available from the equal temperament of the piano.

It would seem that the problem for conductors in rehearsal is not a lack of desire for a purer intonation, but rather a disconnect between the information available and the ability to effectively disseminate this information to the singers. Thus the problem is: How does one create a rehearsal in which just intonation is a functional part of one's preparation and performance? How does just intonation inform one's gesture and audiation? With informed gesture, how will this information be received and interpreted by a choir?

This recital is presented in support of the thesis for my Masters Degree in Choral Conducting. The topic for this document is "The Relationship Between Just Intonation and Gesture: Tracking the Evolution of Sound to Inform the Choral Rehearsal." While it is the assertion of the research that just intonation (or proportional harmony) is applicable to much of the choral lexicon, these pieces were selected as music that would specifically benefit from this study. Each piece either has specific features which support the choice of just intonation, have chord structures which reflect the natural order of the overtone series, or have other unique opportunities for the application of this information.

Brad Pierson is the choral director at Desert Oasis High School in Las Vegas, Nevada. Now in his sixth year with the Clark County School District, his choirs have received superior ratings in Nevada, California, and Arizona. In 2005, Brad founded the Las Vegas A Cappella Summit, an event bringing contemporary a cappella music to high school students. A graduate of the University of Nevada, Las Vegas, Pierson is currently completing a Masters Degree in Choral Conducting with the Three Summer Choral Masters program at California State University, Los Angeles. Brad has twice been asked to present at the Nevada Music Educators Association All State Convention, and in 2010 he was a presenter at the ACDA Western Regional Convention in Tuscon, Arizona.

Special Thanks

First and foremost to the students of the Desert Oasis Choir program - you are a constant source of inspiration and amazement. You have been asked to go well beyond the expectations typically required of a high school choral student, and you consistently go above and beyond what is asked of you. I am so fortunate to be able to spend my days making music with such amazing young people.

To my family – though you may not always understand exactly what it is I do (flapping my arms?) you have always been loving and supportive. You provide the greatest balance of crazy and calm that a person could ask for.

To my friends – thank you for always being willing to help me at a moment's notice.

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