

THE EFFECTS OF NONVERBAL BEHAVIORS EXHIBITED BY MULTIPLE  
CONDUCTORS ON THE TIMBRE, INTONATION, AND PERCEPTIONS OF THREE  
UNIVERSITY CHOIRS, AND ASSESSED RELATIONSHIPS BETWEEN TIME SPENT IN  
SELECTED CONDUCTOR BEHAVIORS AND ANALYSES OF THE CHOIRS'  
PERFORMANCES

By

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## Abstract

This investigation examined the effects of aggregate nonverbal behaviors exhibited by 10 videotaped conductors on the choral sound and perceptions of 3 university choirs ( $N = 61$  choristers) as they sang from memory the same a cappella motet. It then assessed relationships between time spent in selected nonverbal conducting behaviors and the choirs' sung performances and perceptions.

Examined nonverbal conductor behaviors were: (a) height of vertical gestural plane; (b) width of lateral gestural plane; (c) hand shape; and (d) emotional face expression. Dependent measures included Long Term Average Spectra (LTAS) data, pitch analyses, and singer questionnaires.

Among primary findings: (a) aggregate singer ratings yielded significant differences among the 10 conductors with respect to perceived gestural clarity and singing efficiency; (b) each of the 3 choirs responded similarly in timbre and pitch to the 10, counter-balanced conductor videos presented; (c) significantly strong, positive correlations between LTAS and pitch results suggested that those conductors whose nonverbal behaviors evoked more spectral energy in the choirs' sound tended also to elicit more in tune singing; (d) the 10 conductors exhibited significantly different amounts of aggregate time spent in the gestural planes and hand shapes analyzed; (e) above shoulder vertical gestures related significantly to less timbral energy, while gestures below shoulder level related significantly to increased timbral energy; (f) significantly strong, positive correlations between singer questionnaire responses and both pitch and LTAS data suggested that the choirs' timbre and pitch tended to vary according to whether or not the singers perceived a conductor's nonverbal communication as clear and whether or not they perceived they sang efficiently while following a particular conductor; (g) moderately

strong, though not significant, associations between lateral gestures within the torso area and both pitch (more in tune) and timbre (more spectral energy), and between lateral gestures beyond the torso area and both pitch (less in tune) and timbre (less spectral energy); and (h) weak, non-significant correlations between aggregate time spent in various hand postures and the choirs' timbre and intonation, and between identified emotional face expressions and analyses of the choirs' sound.

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## CHAPTER ONE

### Introduction

Scientific research of nonverbal communication and nonverbal behaviors began in earnest with the 1872 publication of Charles Darwin's book, *The Expression of the Emotions in Man and Animals* (Pease & Pease, 2004). Darwin posited that expression of emotions involves many systems including facial expression, behavioral response, and physical response.

Nonverbal communication may be the most effective means by which human beings interact with one another. It encompasses face expressions, body movements and posture, gestures, eye contact, touch, space, physical appearance, and even aspects of the environment (Julian, 1989).

Mehrabian (1971) speculates that nonverbal communication accounts for 93% of human understanding of others' feelings and attitudes. He argues that 55% of effective communication consists of facial expressions and body language and another 38% of communication involves tone of voice, while words per se account for only 7% of effective communication. He further contends that when the meaning of our words is inconsistent with feelings conveyed by our tones of voice, facial expressions, or body language, our words barely count as communication.

### Facial Expressions

The human face is extremely expressive and able to show countless emotions without words. Unlike some forms of nonverbal communication, facial expressions are universal. Ekman (2003) asserts that facial expressions are the most practical means of communication. There are six primary emotions that can be displayed by the face: happiness (enjoyment), sadness, anger, fear, surprise, and disgust. Each primary emotion has facial attributes that indicate the emotion. Ekman divides the face into three general categories of movement (brow, eyes, mouth). Changes

in forehead, eyebrows, eyelids, cheeks, nose, lips, and chin musculature readily convey emotional content. Given the multitude of muscles in the human face, humans are estimated to be capable of more than 10,000 very specific expressions. This versatility allows nonverbal facial communication to be extremely efficient in showing precisely the emotion of the communicator.

Navarro (2008) classifies facial displays of emotion as either positive or negative. Positive facial emotions include a loosening of the forehead, relaxed muscles around the mouth, and widening of the eye. Negative facial emotions stem from an increased tension in the muscle groups of the face with a tightening of the jaw, furrowed forehead, eyes squinted, and lip occlusion.

### **Body Movements and Posture**

Nonverbal communication occurs also through posture, bearing, stance, and other subtle body movements. The way people stand, sit, walk, or hold their heads may communicate a wealth of information about their attitudes, confidence levels, and feelings. According to Hall, Hall, DiMatteo, Rogers, and Archer (1979), “one’s walk and posture tell a great deal about one’s frame of mind” (p. 35).

### **Gestures**

According to the *New Oxford American Dictionary* (2001), a gesture is “a movement of part of the body, especially a hand or the head, to express an idea or meaning” (p. 712). Some nonverbal gestures are universal, as in a shoulder shrug. Other nonverbal gestures, like a “thumbs up,” can have very different meanings in different cultures. In general, the most readily understood gestures are those most familiar within particular cultures.

Krauss, Chen, and Chawla (2000) divide hand gestures into three groups: adapter gestures, symbolic gestures, and conversational gestures. Adapter gestures include scratching, rubbing, tapping, and touching, as well as manipulations of objects like pencils or clothing. These types of gestures do not communicate directly, although they could provide inferences about a person's emotion if he or she is nervous or bored.

The second category of nonverbal hand gestures includes symbolic gestures that are consciously used to communicate specific content. Typically, people employ symbolic gestures instead of speech, but they can be used in conjunction with speech. Two opposing examples of symbolic gestures are a thumb's up and an extended middle finger.

Conversational gestures, which accompany and relate directly to speech, comprise Krauss, Chen, and Chawla's third category of nonverbal hand gestures. These gestures fall midway between content-specific hand gestures (symbolic) and hand gestures employed for indirect communication (adapter). Animated speakers sometime comment on how they "talk with their hands" if, while speaking, they use a lot of hand movement to emphasize their intended points.

### **Eye contact**

Eye contact is an especially important nonverbal communication because sight is the dominant sense for most people. Davidhizar (1992) contends that people can communicate feelings and attitudes with eye contact (e.g., affection, interest, hostility, and attraction). Eye contact is also important in gauging another person's response.

Hodge (1971) addresses the importance of eye contact as nonverbal communication in educational settings. The classroom teacher both communicates messages and responds to student messages with eye contact. Hodge contends that the most important use of eye contact in



the classroom is in “interpersonal communication” where the teacher’s eyes are “locked in” on one student’s eyes and those two people, and only those two, share communication.

### **Space**

Hall (1966) employs the term “proxemics” (the use of space) as a subcategory for the study of nonverbal communication. He emphasizes the impact of proxemic behavior on interpersonal communication, suggesting that analysis of how people in particular contexts make use of space, such as the chosen distance two persons assume in relation to each other or the ways people organize the space in their houses and buildings, speaks just as loudly as words.

According to Hall, varying cultures and sub-cultures condition proxemic behaviors, so that they remain largely subconscious. The human senses of sight, smell, and hearing gauge the space determined appropriate for particular interactions. Hall classifies spatial differences either as intimate (0 to 18 in.), personal (18 in. to 4 ft), social (4 to 10 ft), or public (more than 10 ft). Results of an experiment by Daugherty and Latimer (2006) indicate that solo singers, without being instructed to do so and unaware that they had done so, alter their singing timbres and amplitudes when other persons not singing but posing as members of a choir stand closer than 18 in. to the singer.

### **Appearance**

Overall physical attractiveness, along with choices in clothing, hairstyles, and other matters of grooming and presentation also communicate nonverbally. Physical attractiveness often serves as an independent variable in studies of nonverbal communication (Byrne & Reeves, 1968; Farley, 2014; Mills & Aronson, 1965), because human beings typically use appearance to draw first impressions. Generally, the more physically attractive a person is, the more others react positively to that individual.

Some research indicates that certain body types evoke stereotypes of personality and temperament (e.g., Wells & Siegel, 1961). Such stereotypical perceptions may affect the way others perceive and respond to a person.

### **Roles of Nonverbal Communication Cues**

Wertheim (2008) suggests that nonverbal communication cues can play five different roles: repetition, contradiction, substitution, complementing, and accenting. In repetition, a nonverbal gesture simply repeats a verbal message. Contradiction occurs when a person's nonverbal message communicates an opposite meaning from his or her spoken message. Sometimes, a nonverbal cue takes the place of, or substitutes, for a verbal message altogether. Finally, nonverbal communication can either complement a verbal message (e.g., a pat on the back with a verbal compliment) or accent the message (e.g., a fist pounding on a table).

Some researchers contend that nonverbal communication can be taught (French, 1977; Schwebel & Schwebel, 2002). In teaching nonverbal communication, students gain knowledge about self and others and become more sensitive to nonverbal cues.

Montepare (2014) and Patterson (2014) discuss nonverbal behaviors in terms of past trends in researching these behaviors and with respect to emerging theories of nonverbal behavior. The Center for Nonverbal Studies provides an online dictionary of nonverbal behaviors (Givens, 2014). This dictionary contains definitions, uses, and identification of nonverbal gestures, signs, and body language cues.

### **Choral Conducting as Nonverbal Communication**

Choral conducting constitutes a very specific form of nonverbal communication. Conductors use their hands, faces, postures, and bodies to express their musical and vocal

intentions to an ensemble of singers, particularly in public concert contexts where verbal instructions conveyed to a choir while singing would detract from the performance.

In rehearsal contexts, where time is valuable, nonverbal conductor communication may be more time efficient than verbalizing particular instructions. For example, sustained eye contact with a seated ensemble, simultaneously accompanied by a gradual lifting of the arms, followed shortly thereafter by a visible alignment of the conductor's body and change in conductor lip and mouth postures, may communicate nonverbally and quickly the messages, "Let's stand up. Show me efficient posture for singing. Prepare to breathe with the first vowel already formed in the vocal tract."

Van Weelden (2002a) discusses the importance of effective nonverbal gestures in the choral rehearsal. She specifically addresses singers' perceptions of a conductor's nonverbal communication and the implications of those perceptions for the training of beginning teachers. She suggests that beginning conductors do not always realize the impact of their nonverbal behaviors, including posture, clothing, facial expressions, eye contact, and gesture, and that this lack of understanding could affect the initial perceptions of singers sufficiently to alter ensemble outcomes.

McClung (2005) also addresses the potential negative effects that may ensue when a conductor remains unaware of the impact of her or his nonverbal behaviors. He advocates the use of video self-assessment by student conductors in order to monitor and improve their nonverbal communication skills. McClung states that "the conductor must become cognitively, aurally, and visually aware of the potential power of gesture, and set about to master the psychomotor skills that produce desirable musical results" (p. 27).

**Communication of facial emotions in conducting.** Penrose (2012) associates the six facial emotions articulated by Ekman (2003) with choral conducting. He proposes that happiness, sadness, fear, and disgust expressed facially by a conductor elicit different reactions from the singers. He suggests, for instance, that the conscious use of an “angry” face by the conductor can bring intensity to the performance of a composition, while employing a “surprise” face might not be advisable in choral singing contexts because of its quick transition.

**Beliefs about nonverbal conductor communication in choral methods materials.** To date, many choral conducting and choral methods textbooks (e.g., Decker & Kirk, 1995; Demarree & Moses, 1995; Garretson, 1998; Gordan, 1989) view conducting patterns and hand gestures primarily as a means to convey succinctly to ensembles a conductor's musical intentions with respect to dynamics, phrasing, tempo, and style. Green (1997), for instance, states, “Your hand-arms are your technique in conducting. They speak a very skillful language...your clear-speaking gestures are your vocabulary” (p. 2).

Some books allude generally to the potential contributions of other aspects of nonverbal conductor communication. Rudolf (1950), for instance, emphasizes the importance of the face and eyes in conducting. He states that the expressions conveyed by the conductor's eyes and overall facial expressions relate more to the performers about the conductor's intentions than hand gestures.

Jordan (1996) suggests, “choral ensembles, over time, will mirror the posture of their conductor” (p. 12). He further contends that poor conducting posture could have an unfavorable effect on choristers' ability to breathe effectively. Jordan writes that choral sound will also be affected by the conductor's gestures and if those gestures are “rigid, angular, and tense” (p. 13) the choir's sound will be adversely affected.

Brinson and Demorest (2014) observe, “the most obvious form of nonverbal communication is the conducting gesture, but more subtle nonverbal signals can also communicate messages to the choir” (p. 278). They also recognize that through facial expressions and body language "messages are communicated to the choir, whether or not you want them to be; wise conductors pay attention to nonverbal aspects of their rehearsal demeanor” (p. 278).

Comparatively fewer textbooks, however, specifically focus on various conductor nonverbal behaviors in terms of their potential effects on singers' physiological vocal production, singing efficiency, and tone quality. According to Eichenberger (1994), everything a choral conductor nonverbally shows a choir potentially affects the overall choral sound. He further suggests that specific nonverbal conductor behaviors have specific effects on choir intonation and tone quality, stating, for instance, that a choir's sound will “sag in pitch” if the conductor shows a lateral conducting gesture, while a vertically moving upward gestures insures that "something good happens to the tone." Similarly, Durrant (2003) claims that an upward moving, vertical gesture is “immensely beneficial when exploring ways of improving intonation and lightening the vocal timbre” (p. 147).

Such beliefs about the possible effects of nonverbal choral conductor behaviors on choral sound occur as well today among segments of the choral conducting profession. For example, results from surveys of 30 practicing choral conductors (Grady, 2011a) indicate that a majority of the surveyed conductors perceive that a conductor's nonverbal gesture could affect the intonation and timbre of a choir.

These beliefs and perceptions, moreover, may have implications for choral conducting pedagogy. Eichenberger (in McClung, 1996) frames the matter thusly:

A conductor can step in a room and in two seconds win or alienate the whole ensemble; the way he or she looks, where the eyes go, and how the nose tips are messages being sent to the performers. I think that we don't teach conducting adequately if we don't carefully investigate all the possibilities that nonverbal language brings to the communication between conductor and performer (p. 20).

A small, but growing number of empirical investigations to date examined the effects of particular nonverbal conductor behaviors on vocal sound as measured with solo singers. Only two studies thus far (Grady, 2013a; Grady, 2013b) have measured the effects of specific choral conductor gestures on the timbre and intonation of intact choirs in naturalistic settings. No study to date has measured the effects of a range of nonverbal behaviors employed by multiple conductors on the timbre and intonation of multiple choirs.

### **Purpose of the Study and Research Questions**

The purpose of this investigation was first to examine the effects of aggregate nonverbal behaviors exhibited by multiple, videotaped conductors ( $N = 10$ ) on the long term average spectra (LTAS), intonation, and surveyed perceptions of three university choirs ( $N = 61$  choristers) as they sang from memory the same a cappella motet scored for SATB voices, and then to assess relationships between time spent in selected nonverbal conducting behaviors (vertical gestural plane, lateral gestural plane, hand shape, emotional face expression) and the choirs' sung performances.

The following research questions informed this study:

1. Do audio recording analyses (LTAS, pitch analysis) indicate significant differences in the timbre and intonation of each choir's sound according to the aggregate nonverbal behaviors exhibited by each of the multiple conductors?

2. Do the 10 videotaped conductors exhibit significant differences according to time spent in vertical gestural planes, lateral gestural planes, hand shape (bend of fingers, space between fingers, palm direction), identified emotional face expressions, and responses acquired from singer questionnaires?

3. Are there statistically significant relationships between (a) selected conductor behaviors (vertical gestural plane, lateral gestural plane, hand shape, emotional face expressions) and the timbre and intonation of the choirs and (b) between singer questionnaire responses and the timbre and intonation of the choirs?

## CHAPTER TWO

### **Review of Literature**

This chapter examines empirical research literature related both directly and indirectly to the effects of nonverbal conductor behaviors on vocal sound. In so doing, it focuses on the following broad categories of investigations: (a) nonverbal communication in non-music contexts, (b) emotional face expressions, (c) verbal instructions versus nonverbal gestures, (d) ensemble members' interpretations of conducting gestures, (e) the effects of received instruction in conducting on ensemble performance, (f) conductor body type, (g) "good" and "bad" gestures, (h) singer mimicry of nonverbal conductor facial behaviors, (i) expressive conducting, (j) specific conducting gestures in solo singing contexts, and (k) specific conductor gestures in choral singing contexts.

#### **Nonverbal Communication in Non-Music Contexts**

Empirical research in nonverbal communication began to flourish in the 1950s. Since that time, researchers have investigated a multitude of topics relating to nonverbal communication.

Some investigations focused on schooling contexts. This line of investigation included examinations of (a) nonverbal communication in classroom teaching (Arndt & Pesch, 1984; Woolfolk & Douglas, 1983), (b) the teaching of nonverbal communication skills (French, 1977; Schwebel & Schwebel, 2002), and (c) fostering social health in school through nonverbal communication (Haithcox-Dennis, 2011).

Other studies examined nonverbal communication in social interactions (Dijksterhuis & Bargh, 2001; Frauendorfer, Schmid, Nguyen, & Gatica-Perez, 2014; Lakin, Jefferis, Cheng, & Chartrand, 2003) and in situations involving persuasion (Gunnery & Hall, 2014). Studies by



Burgoon (1978), Felipe and Sommer (1966), and Hall (1966) looked at personal space issues in nonverbal communication occurring in social contexts.

Still other researchers investigated the use of the body as a means of communication (Gross, Crane, & Fredrickson, 2010), the expression of bias through body language (Meadors & Murray, 2014), and the reactions of varied populations to physically attractive individuals (Byrne & Reeves, 1968; Farley, 2014; Mills & Aronson, 1965). Many studies used eye contact (e.g., Argyle & Dean, 1965) and gaze (e.g., Palancia & Itier, 2012) as dependent measures of nonverbal communication.

### **Emotional Face Expressions**

**Emotional face expression recognition.** Multiple studies have investigated human ability to recognize emotional face expressions. Jehna et al. (2011) utilized functional magnetic resonance imaging (fMRI) to measure non-emotional and emotional face recognition. The researchers showed 96 pictures (half females and half males) from the Karolinska Directed Emotional Faces (KDEF) photo-set database (Lundqvist, Flyky, & Ohman, 1998) to 30 participants. The photos featured three different emotional expressions (anger, fear, disgust) along with a non-emotional expression (neutral) photo from a frontal perspective. Results indicated that recognition of each of the expressions activated different parts of the participants' brains: (a) neutral faces elicited activation in the fusiform gyri, (b) angry faces produced activity in left middle and superior frontal gyri and the anterior cingulate cortex, and (c) disgust activated the fronto-orbital cortex and in the insula.

Güntekin and Basar (2007a) investigated the modulation of electrical manifestations related to emotional expression in electroencephalography (EEG) recordings of 20 healthy participants through event-related oscillations (EROs). The researchers analyzed the EROs of

neutral, angry, and happy faces. Following the recording session, the participants expressed the degree of their emotional involvement (valence and arousal) using Self-Assessment Manikin ratings. Results indicated that participant's brains responded faster to angry face stimulations than to neutral or happy face stimulations. The researchers concluded that analysis of brain oscillatory responses distributed over the scalp in combination with subjective ratings of emotional impact of stimuli provided a good basis for analyzing the influence of emotional information processing on the brain.

In a follow-up study using the same procedures, Güntekin and Basar (2007b) found that processing of emotional face expressions differed between men and women. Participant women ( $n = 13$ ) evidenced significantly greater occipital beta response than participant men ( $n = 13$ ) during the presentation of face expressions (neutral, angry, happy).

Goren and Wilson (2006) investigated participants' ( $N = 8$ ) ability to discriminate synthetic happy, sad, angry, and fearful faces to determine the amount of geometric change required to recognize these emotions during brief presentations in different conditions (central viewing, peripheral viewing, and inversion). Results indicated that peripheral presentation of faces made recognition more difficult, except for happy faces. Confusion between fear and sad emotions was common. These findings appeared to support the idea that human beings may process emotions in separate parts of the brain.

Kirita and Endo (1995) examined the happy face advantage with respect to the mode of processing. Participants ( $N = 14$ ) completed three experiments. In Experiment 1, participants recognized happy faces faster than sad faces when they were presented in an upright position, but participants recognized sad faces faster than they did happy faces when the photos were inverted. Results of Experiment Two showed happy faces were likely to be recognized holistically, while

sad faces were likely to be recognized by analytic mode. Experiment Three produced similar results when participants recognized happy and sad expressions on real faces.

Dimberg, Thunberg, and Elmehed (2000) used a backward-masking technique (neutral phase followed by the stimulus of happy, neutral, or angry) to show photos of emotional facial expressions to participants ( $N = 120$ ) fitted with EMG electrodes. The researchers divided participants into three facial expression pairing groups: happy-neutral ( $n = 40$ ), neutral-neutral ( $n = 40$ ), and angry-neutral ( $n = 40$ ). The stimulus face was displayed for 30 ms, a duration too short for participants to recognize having seen it. Results after the first 500 ms indicated that participants in the happy-neutral group exhibited more activity in the zygomatic major muscle and participants in the angry-neutral group exhibited more activity in the corrugator supercilii muscle.

Emotional face expressions can be very brief. Yan, Wu, Liang, Chen, and Fu (2013) examined duration of micro-expressions, i.e., the fast facial expressions presumed to indicate leakage of genuine emotions. Participants ( $N = 22$ ) watched 17 emotional video episodes that were rated highly positive or highly negative while trying to maintain a neutral face. Leaked fast expressions (less than 500 ms;  $N = 109$ ) were selected and analyzed. Researchers concluded that micro-expressions could be defined as expressions lasting less than 500 ms, or expressions with onset duration less than 260 ms.

**Emotional face expressions in relation to music.** Jeong-Won et al. (2011) investigated the effect of auditory stimuli (happy and sad instrumental music) and visual stimuli (happy and sad faces) on participant perceptions of facial emotions. Non-musicians and instrumental musicians ( $N = 15$ ) were presented with music alone (happy or sad music), face alone (happy or sad faces), and music combined with faces where the music excerpt was played while presenting

either congruent emotional faces or incongruent emotional faces. Results indicated that participant ratings of emotion in faces were influenced by emotion in music.

Niedenthal, Brauer, Halberstadt, and Innes-Ker (2001) examined participants' ( $N = 160$ ) ability to detect changes in emotional facial expressions while the participants were in manipulated emotional states. An experimental group (two-thirds of the participants) experienced a combination of films and music to manipulate their emotional states (happy or sad); the control group did not view the films. Participants then watched a video of a happy or sad face that morphed into its opposite emotion while the happy or sad priming music played in their earphones. Participants identified when the offset of the initial emotion happened. Results indicated that participants in the happy condition recognized the offset of the happiness earlier than those in the sad condition and those in the sad condition recognized the offset of the sadness sooner than those in the happy condition.

**Directed imitation of nonverbal singer facial behaviors.** Livingston, Thompson, and Russo (2009) used motion capture technology and surface electromyography (sEMG) to measure the facial behaviors of participants directed to imitate the facial expressions exhibited by a singer. In Experiment One, eight musically trained participants wearing facial markers for motion capture analysis viewed videos ( $N = 18$ ) of an individual singing who showed facial emotions (happy, sad) to match the song performed. The researchers asked participants to imitate the singing and the emotion expressed with the singing as shown on the videotapes. Results indicated that the participants' faces imitated the facial expressions displayed on the stimulus videos. In Experiment Two, four participants not involved in Experiment One watched the same 18 videos and, while singing with EMG electrodes affixed to the zygomatic major (smiling) and corrugator supercilli (frowning) muscles, tried to reproduce the facial expressions observed on

the video. Results indicated strong, positive correlations between muscle activation and video stimuli.

### **Conducting Gesture Research**

**Verbal instructions versus nonverbal gestures.** Skadsem (1996, 1997) twice investigated four modes of presenting dynamic level instructions to singers: verbal instructions, written instructions, changes in the size of conducting gestures, and volume changes by a recorded choir. In the first study (Skadsem, 1996), high school choristers ( $N = 37$ ) learned the tune “Michael Row the Boat Ashore” and sang the piece on the syllable “la” 10 times while following a videotaped conductor who utilized a basic, right hand only, four-beat conducting pattern. During their singing, participants wore headphones and listened to a group of three men and three women singing the melody. Participants sang under the following four conditions: (a) conductor larger (loud) or smaller (soft) gesture, (b) headphone ensemble volume increase or decrease of 15 dB to create the loud and soft choral conditions, (c) conductor verbal instruction to sing the second phrase loudly or softly, and (d) written dynamic markings of “f (loud)” or “p (soft)” written in the score. Three judges used a Continuous Response Digital Interface (CRDI) to determine singer response to dynamic changes. Results indicated that verbal instructions were most effective in attaining correct dynamic changes.

In a subsequent study, Skadsem (1997) repeated many of the same procedures with a larger pool of participants ( $N = 144$ ). She utilized the same folk tune and four modes of presenting dynamic instructions. Participants included conductors ( $n = 48$ ), collegiate singers ( $n = 48$ ), and high school singers ( $n = 48$ ). The pre-recorded conductor exhibited the following gestural size sequences: (a) Phase One medium/Phase Two medium, (b) Phase One medium/Phase Two small, and (c) Phase One medium/Phase Two large. The verbal and written

instructions were the same in the previous investigation, but the heard headphone volumes reflected 30 dB differences to create loud and soft conditions. Overall results showed, once again, that verbal directions significantly affected singers' responses to scored dynamics.

**Ensemble members' interpretations of conducting gestures.** Sousa (1988) examined five standard instrumental conducting texts to codify specific nonverbal gestures and to determine how effective these gestures might be at communicating precise musical intentions. Sousa, with the assistance of three other expert conductors identified 55 common conducting gestures that he organized into eight categories (beat patterns, dynamics, styles, preparations, releases, fermata/holds, tempo changes, and phrasing). Band students ( $N = 306$ ) in junior high ( $n = 110$ ), high school ( $n = 102$ ), and college ( $n = 94$ ) viewed videos of a conductor displaying the 55 gestures and completed a pencil-and-paper test to determine how accurately they could interpret the gestures. Results indicated that gesture recognition increased and the standard deviations decreased with increasing age and experience.

**Effects of received instruction in conducting on ensemble performance.** Kelly (1997) investigated conducting instruction with fifth-grade students ( $N = 151$ ) in eight beginning bands. Over a 10-week time frame, each band performed the same warm-up exercise during every rehearsal. Four experimental bands received up to 10 minutes of conducting instruction in each class and four control bands received no conducting instruction. Topics for the conducting instruction included preparatory and cut-off gestures, patterns of three and four, gestures in dynamics, staccato, legato, and phrasing. All individual band members were administered the *Watkins-Farum Performance Scale*, Form A as a pre- and posttest. Results indicated that the bands who received the conducting instruction displayed significantly more improvement than the control group bands in rhythmic performance, rhythm reading, and phrasing abilities.

Cofer (1998) investigated the effects of conducting gesture lessons on seventh-grade wind instrumentalists ( $N = 60$ ). He divided participants evenly into treatment and control groups. Treatment-group instrumentalists received short lessons over five consecutive days to improve their recognition and response to common conducting gestures. A researcher-designed lesson plan included instruction in the gestures, vocal responses to the gestures on a neutral syllable, and practice on the gestures on a constructed four-bar melody. The control group received instruction in music expression concepts, including director modeling and tempo tapping, but did not receive conducting gesture instruction. Participants completed both pencil-and-paper and individual musical performance posttests. Results indicated that instrumentalists in the treatment group were better able than control group participants to relate to and play according to particular nonverbal conducting gestures.

**Conductor body type.** VanWeelden (2002b) investigated whether conductor body type and presentational factors (posture, facial expression, eye contact, perceived confidence in the conductor) influenced participants' ( $N = 163$ ) judgments of conductor and ensemble performances. Six female conductors were videotaped conducting the same piece in different performance halls. Participants watched videos of the conductors and responded to survey items pertaining to the ensemble performance (the same audio recording for each conductor) and the appearance of the conductor. Results indicated that body type was not a factor, and that there was a moderately strong relationship between performance ratings and conductor posture, facial expression, and confidence when undergraduate music majors rated the conducting videos.

**“Good” and “bad” conductor gestures.** Madsen (1991) investigated the effects of “good” and “bad” conductor gestures on evoking choral sound. A non-auditioned chorus prepared Orlando di Lasso's “O Occhi Manza Mia” and recorded the work twice under the

direction of a conductor for whom they had not previously sung. The conductor alternated between gestures and postures intended to promote “good” vocal sound and gestures and postures intended to promote “bad” vocal sound. Participants ( $N = 72$ ), half music majors ( $n = 36$ ) and half non-music majors ( $n = 36$ ), evaluated the audio recordings using a CRDI dial. Results revealed a small, but significant preference for the “good” conductor gestures in the second recording by the non-music majors. Results showed no other significant differences between the conducting conditions.

**Singer mimicry of nonverbal conductor facial behaviors.** Daugherty and Brunkan (2013) examined chorister ( $N = 114$ ) facial movements as they sang a phrase of Mozart’s “Ave Verum Corpus” while watching a videotaped conductor. In the baseline condition video, the conductor displayed a traditional conducting pattern with neutral facial expression. In the experimental condition video, the conductor showed a traditional conducting pattern while modeling an /u/ vowel on the words “verum” and “corpus.” A panel of seven expert judges viewed counterbalanced still photos of participants. Results indicated increased participant lip rounding during the experimental condition of both vowels in more than 90% participants. Acoustical measurements of formant frequency profiles also indicated that more than 90% of participants evidenced lowered formant frequency profiles, an acoustical characteristic of rounded lips. Almost half (49.12%) of singer participants reported differences in conductor mouth behaviors, but only 22.81% specifically and accurately noted conductor lip rounding during the two /u/ vowels.

Manternach (2011a) conducted a similar investigation using motion capture technology. Participants ( $N = 47$ ) wore reflective sensors for motion capture on their faces (above each eyebrow, above and below the lips, on the corners of the mouth, and on a headband). The motion



captures system used infrared cameras to track the sensor locations in X (horizontal), Y (vertical), and Z (depth) locations during the conditions. Manternach used the same melody, Mozart's "Ave Verum Corpus," as Daugherty and Brunkan. Singer participants sang the melody while viewing a conductor showing the following counterbalanced conditions: (a) eyebrow raise first half and modeled /u/ second half, (b) neutral eyebrows first half and modeled /u/ second half, (c) eyebrow raise first half and neutral lips second half, and (d) neutral eyebrows first half and neutral lips second half.

Manternach's results indicated that the sensors on the corners of the mouth were closer together (indicating increased lip rounding) during the conductor lip rounding conditions. Also, more lip rounding occurred during posttest singing compared to pretest singing, perhaps suggesting a training effect. Other analysis revealed significantly more eyebrow raise during the second occurrence of the raised condition compared to the second occurrence of the neutral eyebrow condition. More participants (44.7%) indicated observed changes in the conductor's lips than in observed conductor eyebrow lift (12.5%). The researcher suggested that such results may indicate some level of non-conscious mimicry.

**Expressive conducting.** Several studies examined conductor expressivity. Although definitions of "expressivity" varied among these studies and, in some cases were missing altogether, a commonality seemed to be that the researchers viewed "expressive" conducting as any use of gestures that departed from other than consistent use of traditional conducting patterns.

**Instrumental contexts.** Gallops (2005) examined conductor effectiveness in nonverbally eliciting expressive-interpretive performances from instrumentalists. The researcher video recorded fifteen instrumental conductors conducting the same piece three times (time-beating,

and two versions with expressive conducting). Faces were blurred from stimulus videos and only hands and upper chests were visible. Instrumentalists ( $N = 25$ ) watched and performed individually for the conductor videos. Using the Karpicke's Gestural Response Instrument, panels of experts evaluated conducting gesture effectiveness and musician performance responses. Results indicated that the conductors rated as most expressive utilized more nontraditional conducting including changing the size and placement of the pattern.

Sidoti (1990) investigated high school band students' ( $N = 139$ ) ability to follow musical expression gestures displayed by a conductor (staccato, marcato, legato, crescendo, decrescendo, accelerando, ritardando, and fermata). Participants practiced four melodies on unmarked scores for three days. After the practice days, participants performed the excerpts with expressive markings added and following a video taped conductor. The conductor displayed specific expression gestures for half of the markings and only beat time for the other half of the markings in the participants score. Results indicated a significant difference between expressive and non-expressive conducting on high school instrumentalists' performances of expression markings in a score. Players performed expression markings more accurately when playing for a conductor using expressive conducting.

House (1998) studied the effects of expressive and non-expressive (time-beating) conducting on the performances of advanced instrumental musicians ( $N = 60$ ). Participants played a newly-composed etude while following a videotaped conductor with either the expressive or non-expressive (time-beating) condition. Results indicated that instrumentalists' performances improved while observing expressive conducting. Also, performer perceptions were more favorable toward the conductors using expressive conducting than time-beating conducting.

Morrison, Price, Geiger, and Cornacchio (2009) examined the effect on evaluations of identical ensemble performances with conductor use of high-expressivity or low-expressivity conducting techniques. This study employed four conducting videos (two with expressive conducting, two with non-expressive conducting) with the same sound recording. University wind ensemble members ( $N = 118$ ) rated instrumental ensemble expressivity on a 10-point Likert-type scale. Half of the participants also rated the expressivity of the conductor on an identical scale. Results indicated ensemble expressivity was rated significantly higher for the expressive conducting than the non-expressive conducting. There was also a significant moderate correlation between ratings by participants evaluating both the conductor and the ensemble. Price, Morrison, and Mann (2011) replicated this study with collegiate non-music major participants ( $N = 286$ ) with the same result.

Silvey (2011) examined whether identical conducting performances would be evaluated differently on the basis of excellent or poor ensemble performances. He employed four one-minute videos of highly expressive conductors synchronized with either excellent or poor recordings. Collegiate band, choir, and orchestra students' ( $N = 120$ ) rated conductor expressivity and ensemble performance quality on a 10-point Likert-type scale and provided one comment about each video. Results indicated that ensemble performance quality significantly affected ratings of conductor expressivity. Comments were directed to the conductor in the excellent-performance condition and to the ensemble in the poor-performance condition.

In a series of studies, (Price & Chang, 2001, 2005; Price 2006) examined the associations between conductor expressivity, ensemble performance expressivity, and festival ratings. Price and Chang (2001) investigated the relationship between instrumental conductor expressivity and middle and high school bands' expressivity. Instrumental music education majors ( $N = 27$ ) rated

video and audio recordings of 15 bands performing at a district band festival. Ratings on the visual-only and audio-only recordings were evaluated on a scale of 1 to 100 (least expressive to most expressive). Results indicated no significant relationships between conductor expressivity ratings and ensemble expressivity ratings.

Price and Chang (2005) undertook a second study to investigate conductor and ensemble expressivity at a state-level festival. Video and audio recordings of nine public high school bands, three that received each of the three festival ratings of Superior (I), Excellent (II), and Good (III) were used for the study. Participants ( $N = 89$ ) were university students enrolled in conducting, band repertoire, and instrumental techniques at three different universities. Participants rated 60-second clips of video-only conducting and audio-only excerpts using the same 1 to 100 scoring scale used in the previous study (Price & Chang, 2001). Results revealed no significant correlation between the expressivity ratings of the conductor gestures and the ensemble sound. In addition, the audio ratings of expressivity did not show a positive relationship to the festival ratings. Conductors of the highly rated bands that received I ratings, were actually judged to be significantly less expressive than the conductors of the lower rated bands, receiving II or III ratings.

In the third and final study of the series, Price (2006) expanded the scope of the study to include overall conducting quality and performance quality, not just conductor expressiveness. Price used the same recordings from the previous study (Price & Chang, 2005). Participants ( $N = 51$ ) rated the quality of the videotaped conductors and the quality of audio recordings of the ensembles on a scale of 1 to 100 (poor quality to excellent quality). Participants also offered reasons for their scores using categories for the conductor (nonverbal communication, beat pattern, expressivity, beat clarity, body movement, hand, baton, intensity, gesture, posture,

miscellaneous) and the ensemble (intonation, expressivity, ensemble, tone quality, balance, technical, blend, performance error, miscellaneous). As in the two previous studies, results indicated that there was not a statistically significant relationship between the conductor ratings and the ensemble performance ratings.

***Choral contexts.*** Morrison and Selvey (2011) solicited preferences of middle school and high school choir and band students ( $N = 429$ ) while watching videos of expressive and non-expressive conductors. Students rated the expressivity of four choral excerpts conducted by two conductors who used high expressive and low expressive gestures. A control group rated an audio-only version of the choral performance. The students preferred the performances that evidenced expressive conducting, although the performances heard remained consistent.

Napoles (2013) examined sound produced by a choir while observing both expressive and non-expressive conductors ( $N = 4$ ) in three presentational modes (audio only, conductor viewed from the front, and conductor viewed from the back). A chorus sang a prepared musical excerpt for four different conductors who either displayed an expressive conducting gesture (frequent body movement, expressive gestures, approving and disapproving facial expressions, group eye contact) or strict conducting. High school student musicians ( $N = 131$ ) at a choir camp rated the three modes of presentation for expressivity. In all three modes, students rated the expressive conductors and the audio recordings acquired under expressive conducting conditions significantly more favorably than non-expressive conductors and the audio recordings acquired under non-expressive conducting conditions. Participants' lowest expressivity ratings came from the conductor front view recordings.

***Specific conductor gestures in solo singing contexts.*** In a series of studies, Fuelberth (2003a, 2003b, 2004) tested the effects of various left-hand conducting gestures (no change,

fisted gesture, palm up, palm down, stabbing gesture, and sideways phrase-shaping gesture) on the vocal tension or anticipated tension of individual singers. In a pilot study (Fuelberth, 2003a), participants ( $N = 16$ ) observed a videotaped conductor leading a 10-measure excerpt of the folk song "Turtle Dove." Singers sang on a neutral "loo" syllable. During the first four measures of the excerpt, the conductor maintained a traditional four-beat pattern (baseline). Over the next six measures, the conductor utilized the six experimental left-hand conducting conditions. Following the singing examples, participants viewed another ordering of the six videos and evaluated the level of inappropriate singer tension that each gesture would hypothetically evoke. Singers perceived more vocal tension during the stabbing and fisted left-hand gestures; conversely, the sideways, phrase-shaping gesture had the lowest mean rating for perceived inappropriate singer tension.

Fuelberth's second investigation (2003b) used the same six left-hand gestures and the same folk song with an increased number and variety of participants. Participants ( $N = 103$ ) included conductors ( $n = 34$ ), college singers ( $n = 34$ ), and high school singers ( $n = 35$ ). Participants individually sang the melody while watching the conductor video and being videotaped. Three experienced choral directors analyzed the videotapes and assessed inappropriate singer tension during the first four measures (baseline) and the six experimental measures on a 10-point Likert-type scale (scale anchors were, *minimum inappropriate vocal tension* and *maximum inappropriate vocal tension*). Results indicated increases in inappropriate singer tension during all experimental conditions compared to baseline ratings. The fisted and stabbing gestures generated the largest mean differences. However, age, experience, and sex of participants did not seem to have an affect on scoring.

In her third investigation, Fuelberth (2004) again utilized the same melody and left-hand gestures. This study looked at perceptions only of inappropriate vocal tension. Undergraduate and graduate student participants ( $N = 192$ ) were asked to evaluate the amount of inappropriate vocal tension that could hypothetically be generated by the videotaped conductor's gestures. Participants responded using the same 10-point Likert-type scale from the previous study. Results indicated that participants anticipated that the stabbing and fisted gestures would produce an increase in inappropriate vocal tension compared to the no change condition. Much like perceptions in the first study, the sideways, phrase-shaping gesture was perceived to have the least anticipated inappropriate vocal tension.

Manternach (2011b) tested singer head and shoulder movements in relation to conductor preparatory gesture. Individual vocalists ( $N = 60$ ) sang "America" seven times while observing a videotaped conductor modeling head and shoulder movements with preparatory gestures. Participants wore a choir robe and stood in front of a set of choral risers for the recording session. Two 1 cm grids were behind and beside the singer participant for analysis of singer movement. A mark was placed on the singer's nose and a clip on the shoulder of the choir robe; both were visible against the grids for indirect measurement of participant head and shoulder movements. The videotaped conducting conditions included both upward and downward moving preparatory gestures. The Up gesture began on the conducting plane, lifted to forehead height and returned to the plane for the first beat. The Uphead condition added an upward head movement to the Up gesture and the Shoulder condition added a shoulder shrug. The Down gesture began at roughly sternum height, initially dropped to establish the conducting plane, rebounded up, and then returned to the conducting plane for the first beat. The Downhead condition added a downward head nod to the Down gesture.

Results indicated that singer upper body movements varied significantly according to direction of conductor preparatory gesture. Participants exhibited more vertical head movement during the Uphead condition and more vertical shoulder movement during the Shoulder condition. The researcher posited that these results might indicate the presence of chorister mimicry of certain conductor head or shoulder movements. Also, participants appeared to exhibit more upward head movement during the downward moving gestures compared to the upward moving gestures. The researcher speculated that the downward moving gestures, which took longer to complete than the upward gesture, may have simply allowed for more time for singer upper body movement to take place.

In a subsequent study, Manternach (2012) again examined whether varied nonverbal conductor behaviors during preparatory gesture affected singers' head movement and voicing behaviors. In this study, he sought to examine engagement of extrinsic laryngeal muscles of singers while singing and following video taped conducting. Participants ( $N = 23$ ;  $n = 15$  experienced singers;  $n = 8$  naïve singers) sang the first phrase of Mozart's "Ave Verum Corpus" eight times in five different orderings while watching the videotaped conductor display three fully-crossed preparatory gestures conditions: (a) upward moving or downward moving arm, (b) upward moving head with intentional posterior neck tension or neutral head positioning, and (c) clenched fist with intentional arm tension or open palm. Manternach attached surface EMG electrodes to participants to measure singer microvolt muscle activity in the posterior neck, upper trapezius, suprahyoid, and sternocleidomastoid muscle regions during inhalation. Audio recordings also provided acoustical data in the form of  $F_0$ , amplitude, and formant frequencies and perceptual data in the form of heard inhalation, onset, and overall sound.



Results showed suprahyoid and sternocleidomastoid mean muscle region activity displayed small, but statistically significant increases during upward moving gestures and fist ed gestures relatively. Evaluations of singer recordings exhibited higher sung amplitudes and more occurrences of raised median formant frequencies for the fist ed gesture and less efficient singer inhalation during upward moving gestures. A viewing panel perceived that upward moving, upward head, and fist ed gestures would evoke increased levels of inappropriate singer tension. Lastly, some of the results differed based on the demographic variables of singer sex and experience.

**Specific conductor gestures in choral singing contexts.** Two studies to date have examined the effect of specific nonverbal conductor gestures on conglomerate, group choral sound. In an exploratory investigation, Grady (2013a) examined the effects of three right-hand conducting gestures (traditional pattern, lateral gesture, and vertical gesture) on acoustical and perceptual measures of choral sound. A chorus ( $N = 29$ ) jointly performed the folk song “All Through the Night” while watching a video taped conductor displaying three right-hand gestures: (a) traditional conducting pattern, (b) vertical-only gesture, and (c) lateral-only gesture. Results indicated significant mean LTAS signal differences between conditions. Pitch analyses showed that the sound while the chorus observed the vertical-only gesture was most in tune, and the sound while the chorus observed the lateral-only gesture was least in tune. Expert listeners consistently reflected majority preferences for the vertical-only condition when contrasted with both the lateral-only and traditional pattern conditions. Finally, singer participant responses indicated more positive comments about the vertical conducting gesture than the other two gestures.

Grady (2013b) examined potential acoustical and psychoacoustical effects of nonverbal conducting gestures on the choral sound of an established women's choir ( $N = 18$ ) as it performed a previously learned composition under multiple conductors (the ensemble's regular conductor as the baseline condition and five guest conductors). Each conductor nonverbally led 20 measures of Eleanor Daley's "The Lake Isle of Innisfree." Results indicated that conductor nonverbal gestural behaviors could, in a short time, affect the choir's performance of a previously learned work. LTAS data showed significant mean signal amplitude differences between the baseline condition and each of the guest conductors. All expert listeners reported a heard difference between recordings of the baseline conductor and all guest conductors. Grid overlay analysis of height and size of conducting gestures suggested an association between height of conducting gesture (above shoulder) and larger cents' deviations in the choir's intonation.

## CHAPTER THREE

### METHOD

#### **Purpose of the Study**

The purpose of this investigation was first to examine the effects of aggregate nonverbal behaviors exhibited by multiple, videotaped conductors ( $N = 10$ ) on the long term average spectra (LTAS), intonation, and surveyed perceptions of three university choirs ( $N = 61$  choristers) as they sang from memory the same a cappella motet scored for SATB voices, and then to assess relationships between time spent in selected nonverbal conducting behaviors (vertical gestural plane, lateral gestural plane, hand shape, emotional face expression) and the choirs' sung performances. This chapter outlines the design, procedures, equipment, and dependent measures used in this study.

#### **Singer Participants**

Established mixed choruses from three Midwestern universities constituted the singer participants ( $N = 61$ ) for this study. Chorus A ( $n = 26$ ;  $n = 15$  female,  $n = 11$  male) singers ranged in age from 20 to 25 years ( $M = 22$  years), Chorus B ( $n = 21$ ;  $n = 10$  female,  $n = 11$  male) singers ranged in age from 18 to 36 years ( $M = 24$  years), and Chorus C ( $n = 14$ ;  $n = 7$  female,  $n = 7$  male) ranged in age from 19 to 23 years ( $M = 21$  years).

#### **Conductor Participants**

Conductor participants ( $N = 10$ ) were university professors ( $n = 7$ ) and doctoral students ( $n = 3$ ) in music education and choral conducting. Conductors ranged in age from 34 to 54 ( $M = 40.9$  years), seven were female (70%) and three were male (30%). The conductors averaged 15.6 years of choral conducting experience (range: 13 - 20 years).

### **Sung Musical Excerpt**

This study utilized the Palestrina motet, “O bone Jesu” (see Figure 1), as the sung musical excerpt. The 10 conductors received this composition two weeks in advance of the recording session to afford them sufficient time to prepare. The three choirs learned the motet with their regular conductors during regularly scheduled rehearsals prior to the recording sessions. By the time of recording sessions, each choir could sing the piece from memory.

The researcher selected this composition because of its (a) small ranges and tessituras, (b) Latin text for vowel matching, (c) short length, and because (d) it contained the same vowel on first and last chords, and many interior cadences, a factor that would assist precision of intonation analyses.

## O bone Jesu

G. P. da Palestrina  
(1526-94)

5

Soprano  
O bo - ne Je - su! mi - se - re - re no -

Alto  
O bo - ne Je - su! mi - se - re - re no -

Tenor  
O bo - ne Je - su! mi - se - re - re no -

Bass  
O bo - ne Je - su! mi - se - re - re no -

10 15

S  
bis, qui - a tu cre - a - sti nos, tu re - de -

A  
bis, qui - a tu cre - a - sti nos, tu re - de -

T  
bis, qui - a tu cre - a - sti nos, tu re - de -

B  
bis, qui - a tu cre - a - sti nos, tu re - de -

20

S  
mi - sti nos san - gui - ne tu - o pre - ti - o - sis - si - mo.

A  
mi - sti nos san - gui - ne tu - o pre - ti - o - sis - si - mo.

T  
mi - sti nos san - gui - ne tu - o pre - ti - o - sis - si - mo.

B  
mi - sti nos san - gui - ne tu - o pre - ti - o - sis - si - mo.

Figure 1. The sung musical excerpt, "O bone Jesu" by Palestrina.

### **Conductor Video Recording Sessions**

Each conductor prepared his or her own conducting prior to a video recording session. The only stipulations imposed by the researcher were (a) that each conductor employ the same tempo (quarter note = 84) as a control for variations in timing that might confound subsequent video and audio analyses, and (b) that conductors not use batons, which would prevent detailed analyses of hand shapes. For each conductor recording session, conductors wore all black clothing, including long sleeves to mask possibly confounding variables due to any visible skin blemishes on the arms or differences in the color of the clothing worn.

The researcher placed an orange sticker on the midpoints of both shoulders of each conductor for gestural height and width analyses. I determined the midpoint of the shoulder by placing a cloth measuring tape on the participant's shoulder and finding the midpoint between the neck and the far edge of the shoulder.

Conductors stood with toes touching a line taped on the floor 28 in. (0.71 m) from a vertical white screen. A music stand with the score was placed directly in front of the conductor and lowered to a height that would not impede a hand view from the video camera.

A ZOOM Q3 Handy Video Recorder captured the conducting performances. The camera recorded a frontal view of each conductor from a distance of 10 ft 8 in. (3.25 m). The camera recorded a mid-thigh to above the head view of each conductor to ensure that all gestures were within the screen. I positioned the camera on a tripod at a height of 5 ft 6 in. (1.68 m). The conductors viewed life-size pictures of the faces of four singers (two female, two male), attached at 24 in. (0.61 m) intervals to a pole that extended 4 ft to the right and 4 ft to the left of the camera at the same height of 5 ft 6 in. (1.68 m) to simulate the height of choral singers in the front row. The order of the four pictures from the left to the right simulated the soprano, bass,

tenor, and alto sectional choir formation used in this study, and provided a reference point for any desired conductor cueing.

A second video recorder was placed 5 ft (1.52 m) to the left of the conductor at a height of 48 in. (1.22 m) to capture a side view of conductor gestures. I used the second camera recording for hand shape analysis if hand shapes were unidentifiable from the front view camera due to camera angle.

During the conductor video recording sessions, the researcher played an audible metronome at 84 mm. to ensure that all conductor performances were at the same tempo. I asked the conductors to start and end their conducting sessions with hands at their sides for uniformity between conductors on the stimulus video for the three choirs. Conductors could re-record their performances until they were satisfied with the resulting videotape. Conductors signed a consent form and filled out a demographic questionnaire. (Appendix A)

### **Choral Recording Sessions**

The recording session for each of the three choirs took place in that choir's rehearsal space. Each choir stood on risers in a three row, SBTA sectional formation. In all cases, voice sections within each choir contained at least three singers, the minimum number required for a chorusing effect to occur (Ternstrom & Karna, 2002).

A Roland R-05 digital sound recorder captured each performance at a sampling rate of 44.1 kHz (16 bits) in .wav format. The recorder was placed 12 ft (3.66 m) from the front row of the choir, in a mixed to diffuse sound field, at a height of 5 ft 4 in. (1.63 m) or approximate conductor ear height. Volume and gain controls, set manually at the beginning of each recording session, remained the same throughout all recordings. Prior to each sung trial, singers heard the starting pitch sounded by a Master-Key pitch pipe (C - C range).

During the choir recording sessions, singers viewed a life-sized projection of the videotaped conductors, as determined by the researcher standing next to the projection screen prior to each choral recording session. The projection screen stood 15 ft (4.57 m) from the front row of the choir. The 15 foot distance ensured that the screen did not block the digital sound recorder in the “conductor position” and that the distance between the recorder and the freestanding projection screen minimized reflections of sound off the screen.

The researcher created three stimulus videos so that each choir viewed the 10 conductors in a different order. A 15 s “please respond to the survey” screen followed each conducting episode to allow time for choristers to complete the singer survey. Each conductor video was 1 min 9 s in length. With the 15 s survey intervals, each recording session lasted 15 minutes.

### **Survey Instrument**

**Singer survey.** Singer participants completed two questionnaires during the choir recording sessions. Prior to the recording session, choristers signed consent forms and completed a demographic questionnaire. During the recording sessions, the singers responded by means of a visual analogue scale (VAS) to two questions immediately following each conductor’s video: (a) “I could follow the conductor’s gestures,” anchored by *none of the time* and *all of the time*; and (b) “While following this conductor, my singing felt,” anchored by *non-efficient* and *efficient*.

See Appendix B.

### **Post-Recording Session Video Recording Analyses**

**Vertical gestural plane.** Vertical gestural plane analysis determined the height of conductor gestures. I digitally transferred video recordings of the 10 conductors to a MacBook Pro computer for viewing with QuickTime software.

I utilized Dr. Levin’s Phi Dental Grid software (Levin & Meisner, 2010) for video



analysis of height of vertical gestural plane above the shoulders. The software allowed me to create a square with a horizontal line that I could superimpose over each conductor's video to measure the amount of time that each conductor's gestures were above and below his or her shoulders. To calculate height of the conducting gesture, I positioned the grid over each video and aligned the horizontal grid line to the two stickers on the conductor's shoulders (see Figure 2).

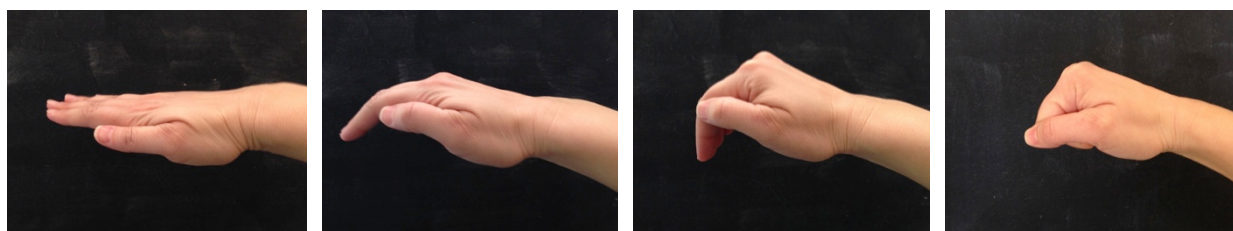
I placed the grid's horizontal line across each conductor's shoulders at the beginning of his or her video and used the frame button on the QuickTime software to forward one frame at a time. QuickTime software has 29.97 frames per second. Each frame constituted approximately 0.033 of a second or 33 milliseconds. I considered anytime that any part of the hand was above the horizontal line to be an above shoulder gesture. I timed each conductor's hands separately (right, left) for the entire video to find the aggregate amount of time in milliseconds and the percentage of time overall that each conductor had his or her hands above and below shoulder height. The software allowed me to move the line as needed over the video to keep the line between and touching the two stickers on the conductor's shoulders.

**Lateral gestural plane.** Lateral gestural plane analysis determined the width of conductor gestures. I used the same software and procedures for lateral gestural plane as used for the vertical gestural plane analyses. As indicated by Figure 2, the difference was that the lateral gestural grid overlay featured two vertical lines that I placed on each conductor's shoulder stickers. I measured the aggregate amount of time in milliseconds and the percentage of time overall that each conductor had his or her hands within and outside of the lateral gesture vertical lines.



*Figure 2.* Screenshots of the horizontal line grid overlay and vertical lines grid overlay for conductor gestural plane analysis.

**Hand shape analysis.** To determine overall hand shapes of each of the 10 conductors I analyzed conductor videos with three hand-shape identifiers and QuickTime video player software. The three hand shape identifiers described (a) bend of fingers (b) space between fingers, and (c) palm direction. Four levels described the degree of bend in conductors' fingers: 1 = no bend, 2 = slight curve, 3 = lots of bend/large curve, 4 = fully curled fingers/fist (see Figure 3).



*Figure 3.* Pictures showing amount of finger bend.

Note. 1 = no bend, 2 = slight curve, 3 = lots of bend/large curve, 4 = fully curled fingers/fist.

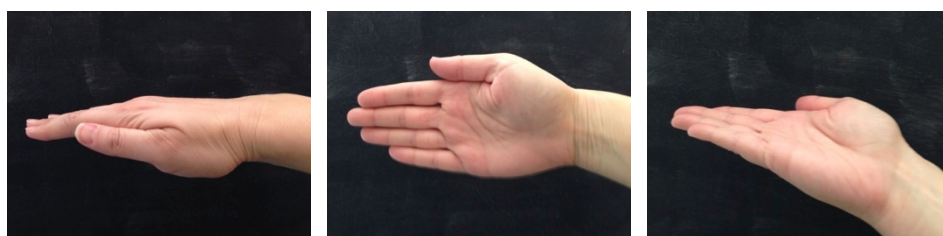
Figure 4 depicts the guidelines used to determine the amount of space between fingers in of conductor gestures. Three levels described theses distances between fingers: 1 = fingers touching, 2 = close finger spacing, and 3 = splayed fingers.



*Figure 4.* Pictures showing space between fingers.

Note. 1 = fingers touching, 2 = close finger space, and 3 = splayed fingers.

The third hand shape identifier was palm direction. The three levels of palm direction were: 1 = palm down, 2 = palm to side (thumb on top), and 3 = palm up (see Figure 5). Because often the palm was not precisely vertical or horizontal, I labeled the palm direction according to the direction it most nearly approached.



*Figure 5.* Pictures showing palm direction.

Note. 1 = palm down, 2 = palm to side (thumb on top), and 3 = palm up.

Using the forward frame button on the QuickTime software, I timed to the millisecond the amount of time both the right and left hands of each conductor evidenced each of the three hand shapes. In this manner I calculated hand shape times and percentages for each conductor's entire video.

An outside observer independently repeated the same procedures for a randomly selected 50% of all five gesture analyses. I counted as agreement any differences within  $\pm 20$  milliseconds, but not any differences of more than 20 milliseconds. Obtained reliability (agreements divided by agreements plus disagreements) was .96.

**Conductor emotional face expressions analysis.** Undergraduate music therapy and music education students ( $N = 30$ ) in beginning and intermediate choral conducting courses watched (in groups of four) videos of all 10 conductors. Using pictures from the Karolinska Directed Emotional Faces (KDEF) database (Lundqvist, Flykt, & Öhman, 1998), these students determined conductor emotional facial expressions by means of a Continuous Response Digital Interface (CRDI) dial. As shown in Figure 6, both male and female faces that depicted the emotional facial expressions of angry, neutral, and happy were selected from the KDEF database.



*Figure 6.* Pictures (female and male) of the three emotional facial expressions: angry, neutral, and happy.

In groups of four, the CRDI participants viewed one of three versions of the 10 videotaped conductor performances. Each version presented the conductors in a different order. Participants watched the conductor videos while moving the CRDI dial to indicate the emotional face expression (happy, neutral, angry) they perceived best described the overall emotional facial

expression of the conductor in each video. Participants were encouraged to move the dial as often as needed to describe the changing emotional face expressions of each conductor. For each group of viewers, two of the CRDI dials featured female facial expressions and two featured male facial expressions.

### **Post Choir Recording Session Audio Analyses**

**Long term average spectra measurements.** I obtained long term average spectra (LTAS) data through KayPentax Computerized Speech Lab (CSL) software using a window size of 512 points with no pre-emphasis or smoothing, a bandwidth of 86.13 Hz, and a Hamming window. I used data from one channel of the Roland recordings, because differences between the two channels were negligible. I transferred the obtained data to an Excel spreadsheet for subsequent statistical analyses.

**Pitch analysis measurements.** For overall pitch analysis, I extracted from each of the 30 choral performances a one-second excerpt from each sung voice part (SATB) at the midpoint of the opening [ɔ] vowel and the midpoint of the [ɔ] vowel on the final chord.

Because choral sound constitutes a complex acoustic phenomenon, it is problematic to use computerized extractions of fundamental frequency ( $F_0$ ). Following procedures used by Howard (2004), I evaluated perceptual “pitch” with the assistance of Pitch Analyzer 2.1 software and a MacBook Pro laptop computer.

The Pitch Analyzer 2.1 software (See Figure 7) produced a reference tone set initially to the score notated pitch for each pitch in the extracted sustained vowel. The Pitch Analyzer 2.1 enabled simultaneous playing of the extracted one-second sung excerpt (on a constant loop) and the reference tone. I adjusted the frequency of the reference tone, presented in Hertz, until it matched the perceived pitch of the sung excerpt. The software program displayed the difference

in cents between the notated pitch and the perceived pitch. The score-notated fundamental frequency and the perceived pitch, each in Hertz, and the deviation in cents were then recorded on an Excel spreadsheet for analyses.

I repeated the same procedures for all 10 conductor recordings a day later. I counted as agreement any differences within  $\pm 1$  Hertz, but not any differences of more than 1 Hz. Obtained reliability (agreements divided by agreements plus disagreements) was .92.

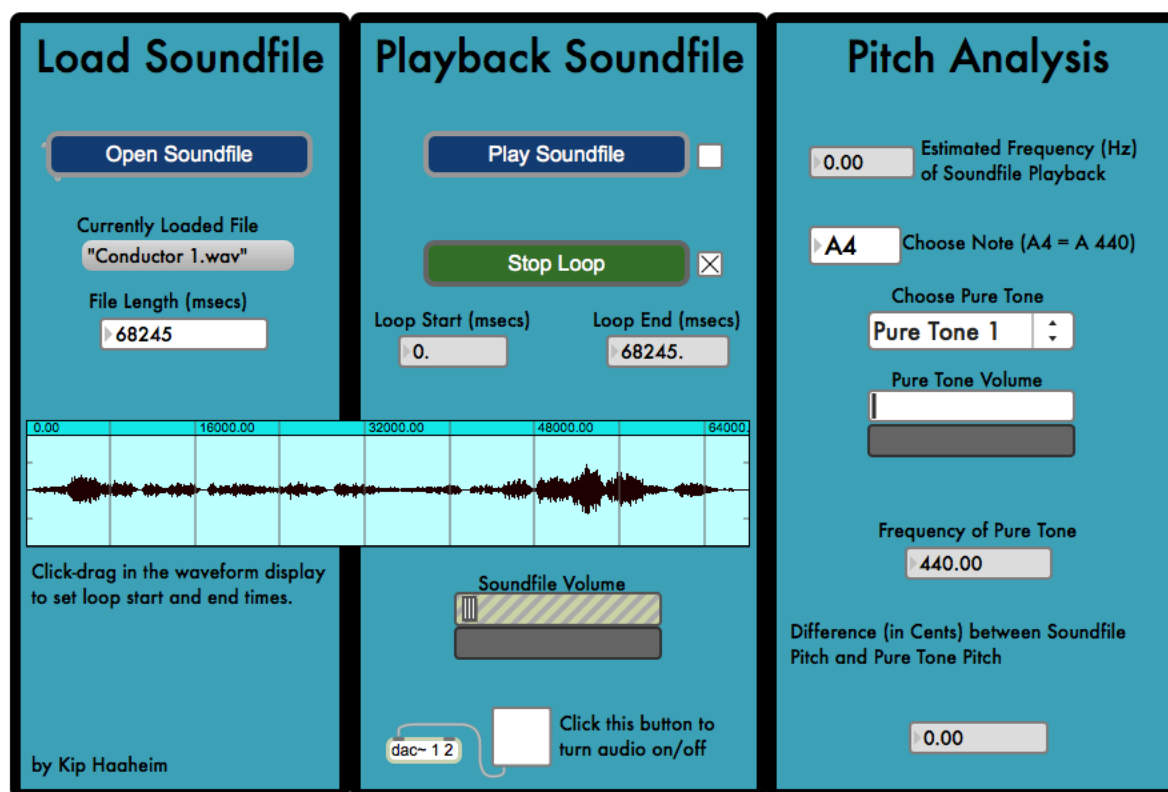


Figure 7. Pitch Analyzer 2.1.

## CHAPTER FOUR

### RESULTS

The purpose of this investigation was first to examine the effects of aggregate nonverbal behaviors exhibited by multiple, videotaped conductors ( $N = 10$ ) on the long term average spectra (LTAS), intonation, and surveyed perceptions of three university choirs ( $N = 61$  choristers) as they sang from memory the same a cappella motet scored for SATB voices, and then to assess relationships between time spent in selected nonverbal conducting behaviors (vertical gestural plane, lateral gestural plane, hand shape, emotional face expression) and the choirs' sung performances. This chapter presents the results according to the research questions posed for this investigation. A predetermined alpha level of .05 served to indicate significance in statistical tests.

#### **Research Question One: Choral Analyses**

The first research question inquired if (a) long term average spectra (LTAS) data and (b) pitch analysis data would indicate differences between each choir's performances under the direction of the 10 conductors, whom each choir viewed in different orders. These results are presented by choir, first with reference to the entire spectrum examined (0 - 10 kHz), then for the 2.0 – 4.0 kHz spectrum, a region that includes frequencies to which human hearing is most sensitive (Fletcher & Munson, 1933).

**Long-term average spectra.** Human vocal sound is a grouping of simultaneous frequencies that constitutes a complex sound. Each complex sound includes the sung pitch (fundamental frequency) as well as many other simultaneous frequencies. Each frequency exhibits power or energy. Depending on context, some frequencies are dampened (exhibit less energy) and some are amplified (exhibit more energy). LTAS procedures average this complex

vocal sound over time. Thus, LTAS data are useful for detecting persisting timbral events across a specified period of time.

Howard & Angus (2006) state that a 1 dB difference in the signal energy of complex sound may comprise a just noticeable difference, depending upon the nature of the sound and the hearing acuity of listeners. Thus, obtained differences of 1 dB or greater may be useful for interpreting the following results.

**Choir A.** Figure 8 presents obtained LTAS contours across the 0 - 10 kHz spectrum according to 10 conductor recordings for Choir A.

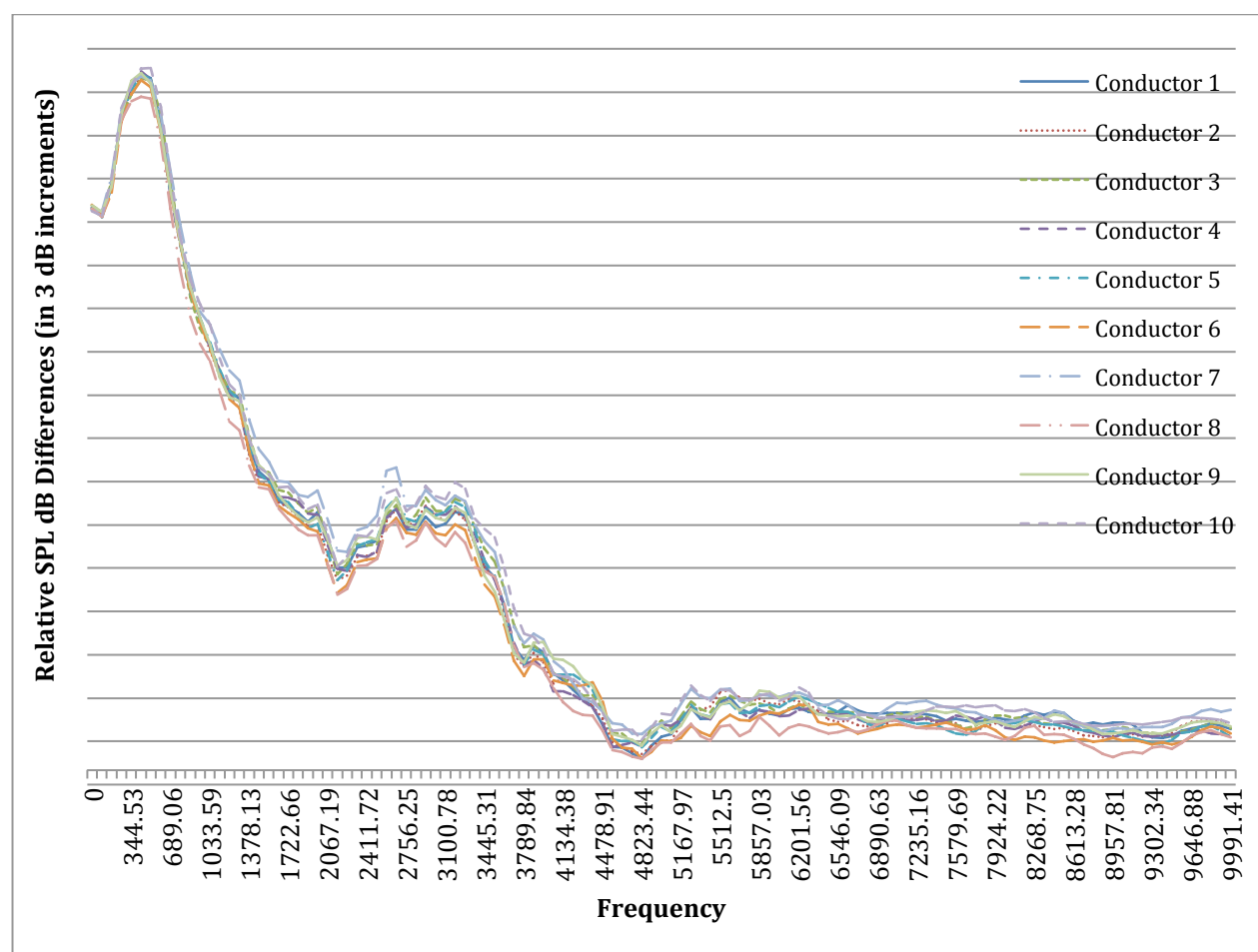


Figure 8. LTAS of the 10 conductor recordings across the entire 0 - 10 kHz spectrum for Choir A.



Comparisons of differences among the 10 sung conditions indicated that Choir A's singing under the direction of Conductors 7, 9, and 10 elicited the most mean signal energy in this choir's 10 recordings. Mean amplitude differences among performances led by these three conductors were less than 1 dB. On the other hand, singing under the direction of Conductors 5, 6, and 8 elicited the least mean signal energy among the 10 recordings from Choir A. The grand mean difference in 0 - 10 kHz spectrum energy between the Conductor 7 recording (most spectral energy of the 10 conditions) vs. the Conductor 8 recording (least spectral energy of the 10 conditions) was:  $M = 1.92$  dB, range = 0.11 to 3.94 dB.

Figure 9 compares the 10 conductor recordings of Choir A within the 2.0 – 4.0 kHz frequency region. This spectrum includes frequencies to which the human ear is most responsive.

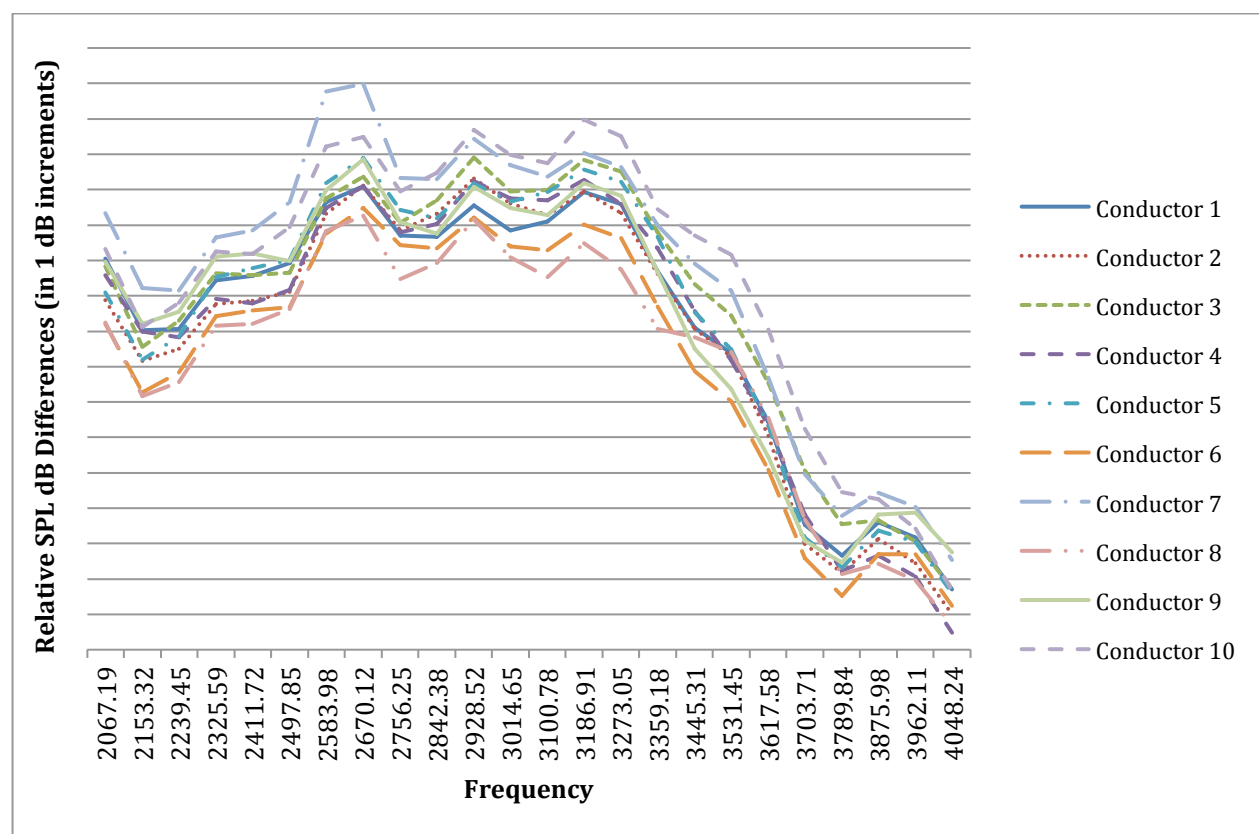


Figure 9. The 2.0 - 4.0 kHz region LTAS of the 10 performed conditions for Choir A.

Similar to what occurred in the 0 – 10 kHz region, assessments of mean spectral energy differences among Choir A performances in the 2 – 4 kHz region indicated that the same conductors (Conductors 7, 9, and 10) elicited the most mean signal energy. Conductors 2, 6, and 8 elicited a decrease of mean signal energy from Choir A in the 2 - 4 kHz region. As was also the case in the 0 – 10 kHz region, the Conductor 7 recording exhibited the greatest mean spectral energy of the 10 recordings in the 2 - 4 kHz regions, and the performance under Conductor 8 evidenced the least mean spectral energy of the 10 performances. The grand mean difference in 2 - 4 kHz spectrum energy between the Conductor 7 recording (most spectral energy of the 10 conditions) vs. the Conductor 8 recording (least spectral energy of the 10 conditions) was:  $M = 2.49$  dB, range = 1.14 to 3.94 dB.

**Choir B.** Figure 10 shows each of the entire spectrum (0 – 10 kHz) LTAS for the 10 performances by Choir B.

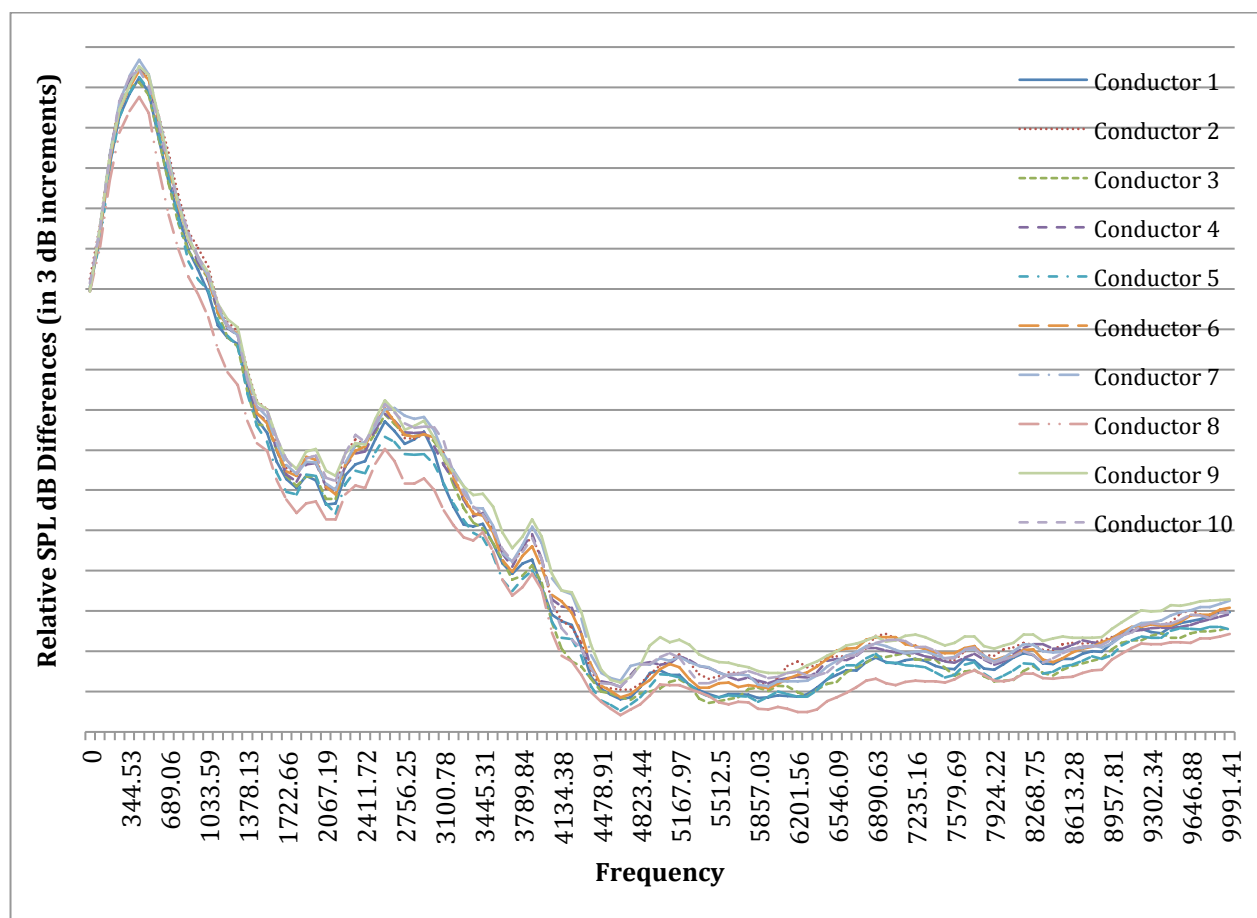


Figure 10. LTAS of the 10 recordings across the entire 0 - 10 kHz spectrum for Choir B.

Comparisons of differences among the 10 sung conditions indicated that Choir B's singing under the direction of Conductors 2, 7, and 9 elicited the most mean signal energy of the 10 recordings. Mean amplitude differences among performances led by these three conductors were less than 1 dB. On the other hand, singing under the direction of Conductors 3, 5, and 8 elicited the least mean signal energy of the 10 recordings for Choir B. The grand mean difference in 0 - 10 kHz spectrum energy between the Conductor 9 recording (most spectral energy of the 10 conditions) vs. the Conductor 8 recording (least spectral energy of the 10 conditions) was:  $M = 2.60$  dB, range = 0.02 to 5.16 dB.

Figure 11 compares the 10 recordings of Choir B within the 2.0 – 4.0 kHz frequency region.

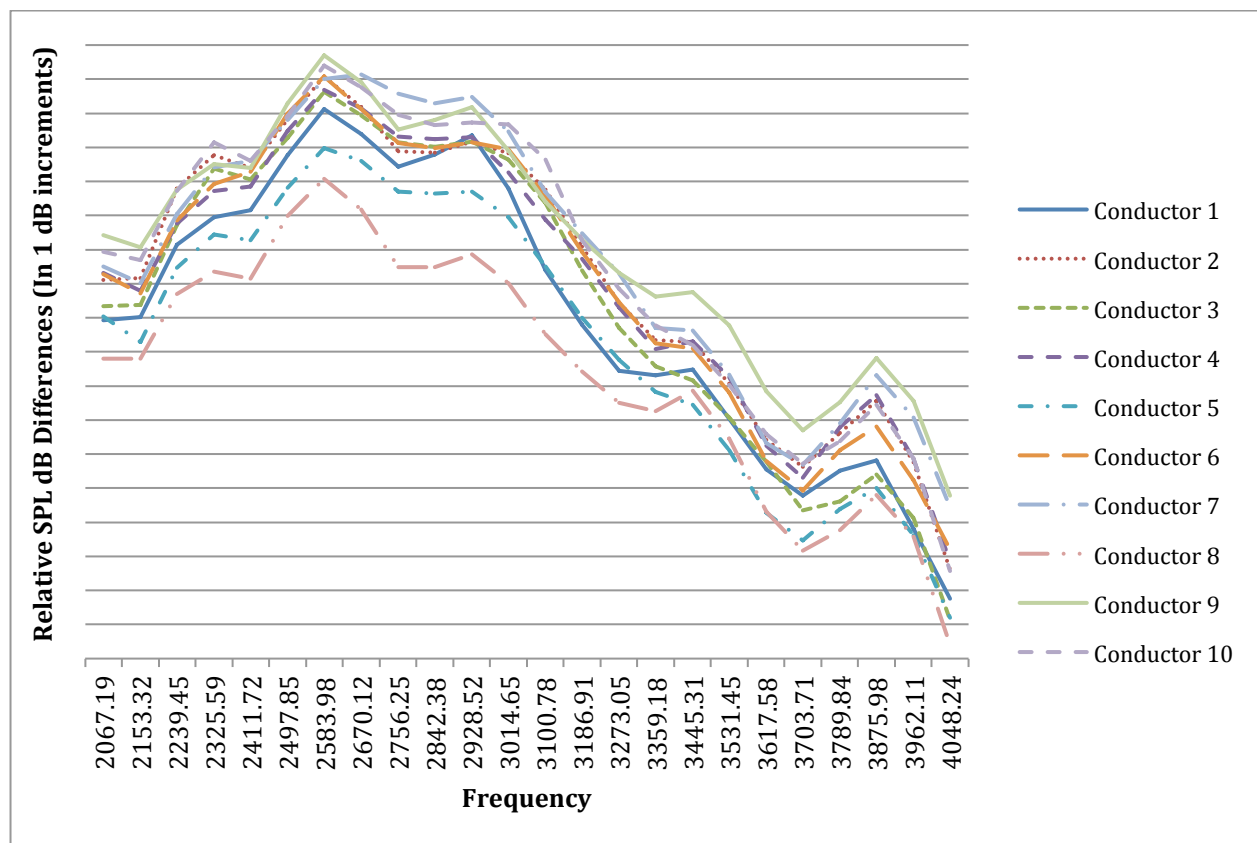


Figure 11. The 2.0 - 4.0 kHz region LTAS of the 10 performed conditions for Choir B.

Similar to what occurred in the 0 – 10 kHz region, assessments of differences between the 10 conductor recordings for Choir B in the 2 – 4 kHz region indicated the same conductors as eliciting the most mean signal energy and the least mean signal energy with one exception (Conductor 1 instead of 3). Conductors 7, 9, and 10 again elicited an increase in mean signal energy in of higher frequency partials, while Conductors 1, 5, and 8 elicited singing with a decrease in mean signal energy of higher frequency partials. As was also the case in the 0 – 10 kHz region, the Conductor 9 recording exhibited the greatest mean spectral energy of the 10 recordings in the 2 - 4 kHz regions, and the performance under Conductor 8 evidenced the least mean spectral energy of the 10 performances. The grand mean difference in 2 - 4 kHz spectrum energy between the Conductor 9 recording (most spectral energy of the 10 conditions) vs. the

Conductor 8 recording (least spectral energy of the 10 conditions) was:  $M = 3.66$  dB, range = 2.88 to 4.38 dB.

**Choir C.** Figure 12 presents the Choir C obtained LTAS contours across the 0 - 10 kHz spectrum from each of the 10 Choir C recordings.

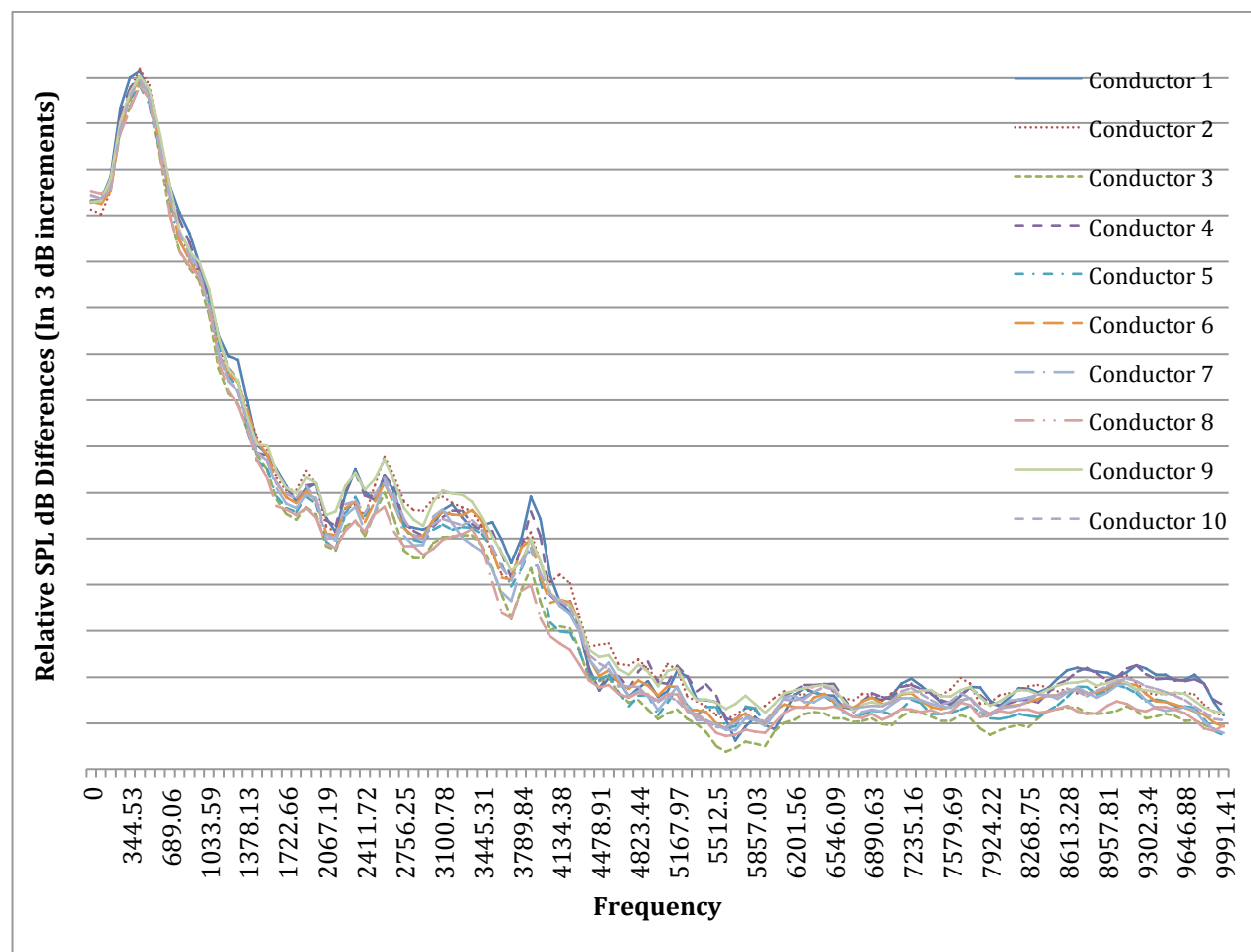


Figure 12. LTAS of the 10 recordings across the entire 0 - 10 kHz spectrum for Choir C.

Comparisons of differences among the 10 sung conditions indicated that Choir C's singing under the direction of Conductors 1, 2, and 9 yielded the most mean signal energy of the 10 recordings. Mean amplitude differences among performances led by these three conductors were less than 1 dB. On the other hand, singing under the direction of Conductors 3, 5, and 8 yielded the least mean signal energy of the 10 recordings for Choir C. The grand mean difference

in 0 - 10 kHz spectrum energy between the Conductor 9 recording (most spectral energy of the 10 conditions) vs. the Conductor 8 recording (least spectral energy of the 10 conditions) was:  $M = 1.61$  dB, range = 0.42 to 3.88 dB.

Figure 13 compares the 10 conductor recordings of Choir C within the 2.0 – 4.0 kHz frequency region.

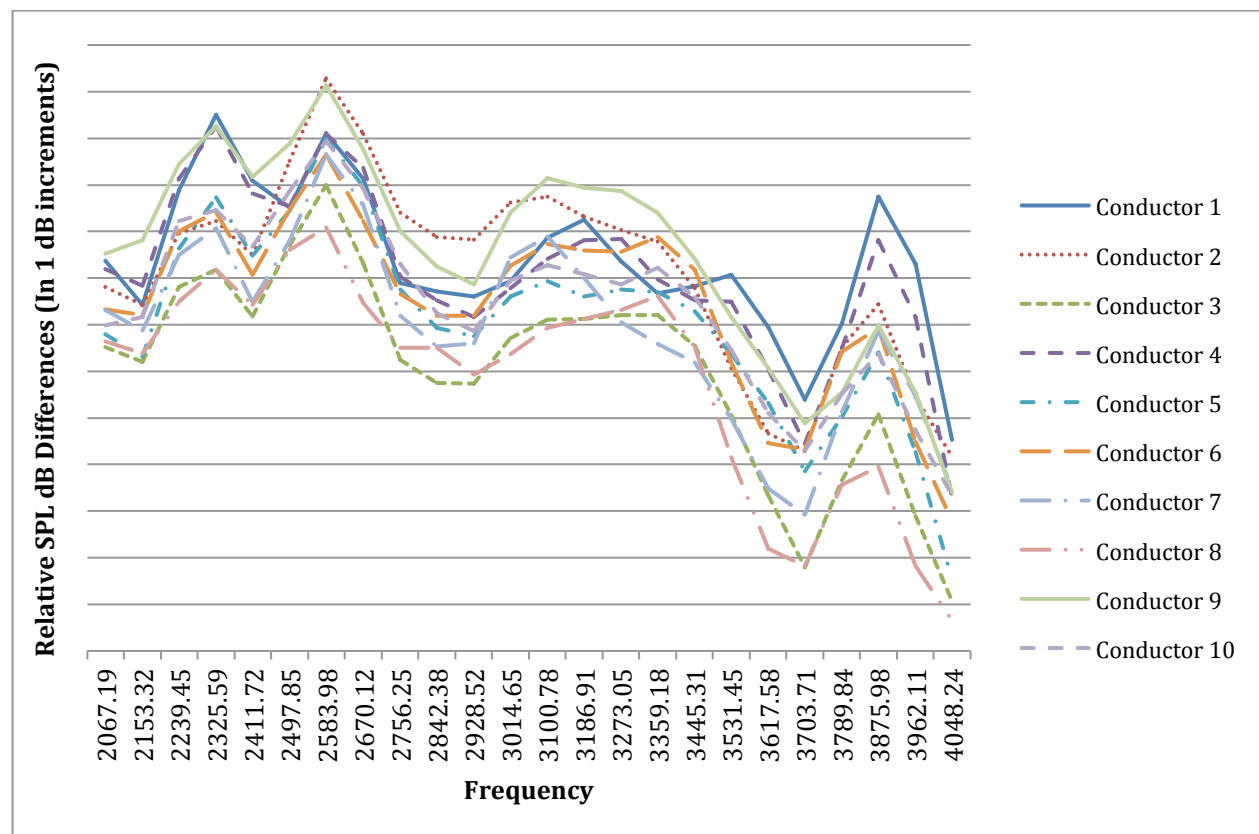


Figure 13. The 2.0 - 4.0 kHz region LTAS of the 10 performed conditions for Choir C.

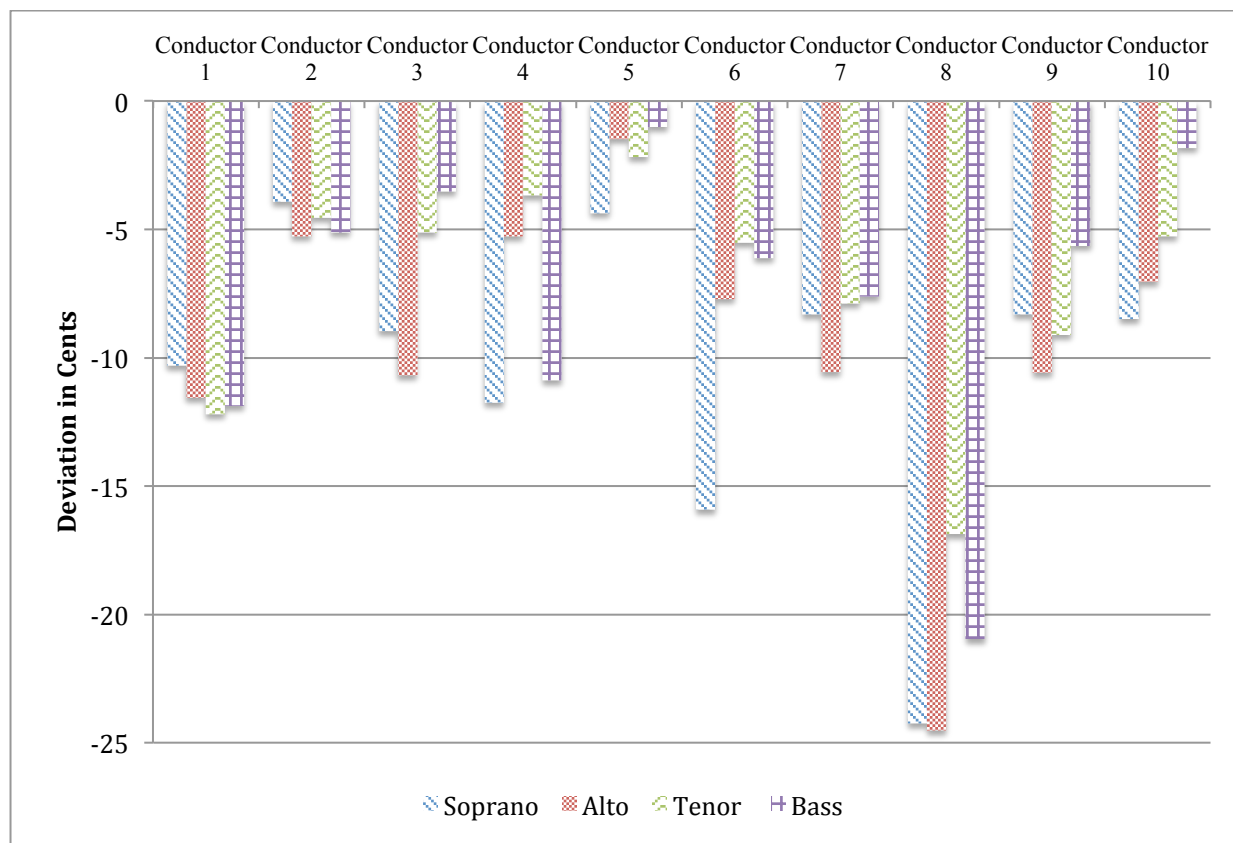
Similar to what occurred in the 0 – 10 kHz region, assessments of differences among the 10 conductor recordings for Choir C in the 2 – 4 kHz region indicated the same conductors as eliciting the most mean signal energy and the least mean signal energy with one exception (Conductor 7 instead of 5). Conductors 1, 2, and 9 again elicited an increase in mean signal energy in higher frequency partials, while Conductors 3, 5, and 8 elicited singing with a decrease in the mean signal energy of higher frequency partials. As was also the case in the 0 – 10 kHz

region, the Conductor 9 recording exhibited the greatest mean spectral energy of the 10 recordings in the 2 - 4 kHz regions, and the performance under Conductor 8 evidenced the least mean spectral energy of the 10 performances. The grand mean difference in 0 - 10 kHz spectrum energy between the Conductor 9 recording (most spectral energy of the 10 conditions) vs. the Conductor 8 recording (least spectral energy of the 10 conditions) was:  $M = 2.69$  dB SPL, range = 1.74 to 3.88 dB.

**LTAS summary.** A 10 (the 10 conducted performances) x 3 (the three choirs) repeated measures ANOVA yielded a significant interaction effect,  $F(9,108) = 157.546, p < .001$ . Thirty follow-up paired  $t$ -tests (two-tailed) measured specific differences between choirs for each conductor with a Bonferroni adjustment of alpha levels to provide conservative tests of significance ( $p = .05/30 = .002$ ).  $T$ -test results indicated significant statistical differences ( $p < .002$ ) between all but one (3.33%) of the pairings: Conductor 7 Choir B vs. Conductor 7 Choir C ( $p = .009$ ).

**Pitch analysis.** For each sung performance by the three choirs, I calculated in cents the pitch deviations between scored pitches and sung pitches for each voice part in each choir according to conductor. For overall pitch deviations in cents, I then compared the sung final four-part chord of each recording with the sung first chord of the recording. For the purpose of interpreting results, a difference of  $\pm 7$  cents was considered a just noticeable difference in intonation and therefore out of tune (Lindgren & Sundberg, 1972). Results are presented according to choir.

**Choir A.** Figure 14 presents overall pitch deviations (from first pitch to final pitch) for each voice part (SATB) for Choir A singers across all 10 conductors.

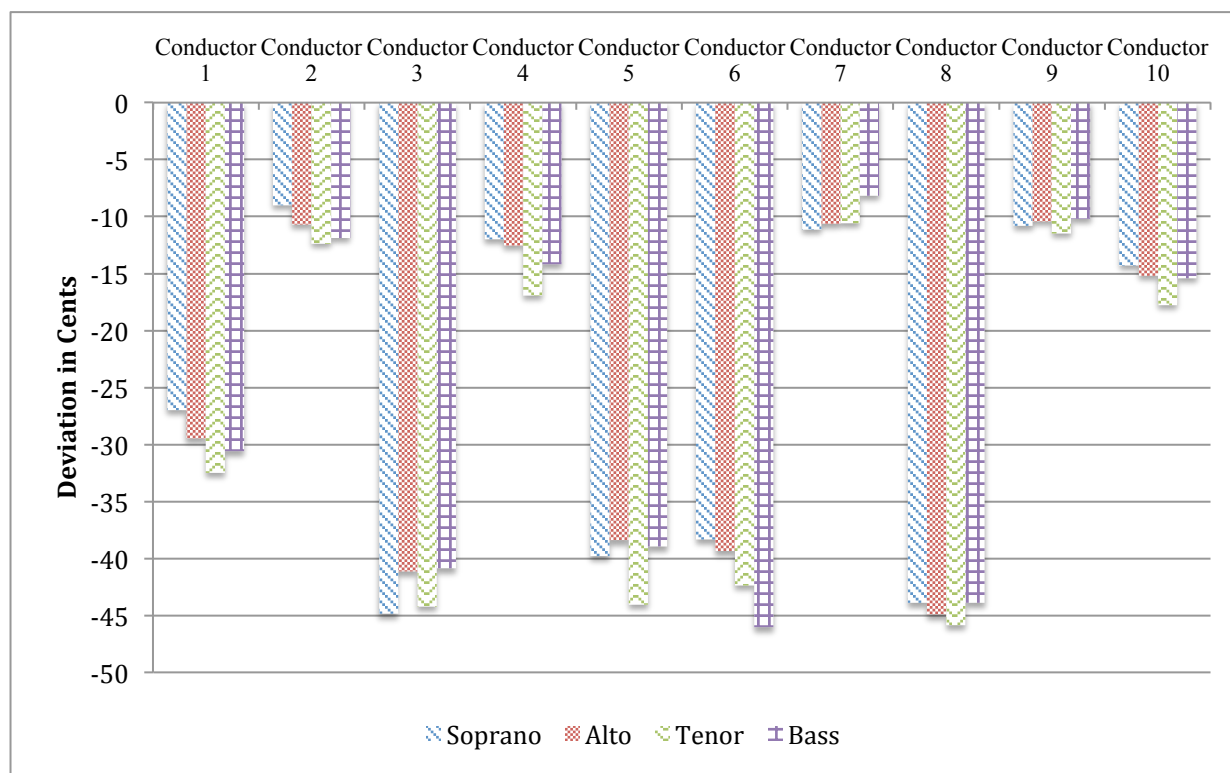


*Figure 14.* Choir A overall pitch deviations in cents from first pitch to last pitch in the musical excerpt.

Choir A sang the most “in tune” (within  $\pm 7$  cents) of the three choirs. Means (in cents) of the differences in the four pitches (SATB) from the first pitch to the last pitch for each conductor were as follows: Conductor 1, -11.49; Conductor 2, -4.72; Conductor 3, -7.08; Conductor 4, -7.90; Conductor 5, -2.27; Conductor 6, -8.82; Conductor 7, -8.60; Conductor 8, -21.65; Conductor 9, -8.42; and Conductor 10, -5.67. Choir A sang in tune for the whole musical example under the direction of Conductors 2, 5, and 10. Choir A sang the most out of tune, 21.65 cents flat overall for Conductor 8.



**Choir B.** Figure 15 illustrates Choir B tuning under each of the 10 conductors.



*Figure 15.* Choir B overall pitch deviations in cents from first pitch to last pitch in the musical excerpt.

Choir B sang the most “out of tune” (exceeding  $\pm 7$  cents) of the three choirs. Means of the differences in the four pitches (SATB) from the first pitch to the last pitch for each conductor were as follows: Conductor 1, -29.89; Conductor 2, -10.99; Conductor 3, -42.77; Conductor 4, -13.93; Conductor 5, -40.31; Conductor 6, -41.51; Conductor 7, -10.15; Conductor 8, -44.64; Conductor 9, -10.74; and Conductor 10, -15.66. Choir B sang with the smallest pitch deviations for Conductors 2, 7, and 9 and with the largest pitch deviations for Conductors 3, 5, 6, and 8.

**Choir C.** Figure 16 presents overall pitch deviations, from first pitch to final pitch, for each choir voice part for Choir C across all 10 conductors.

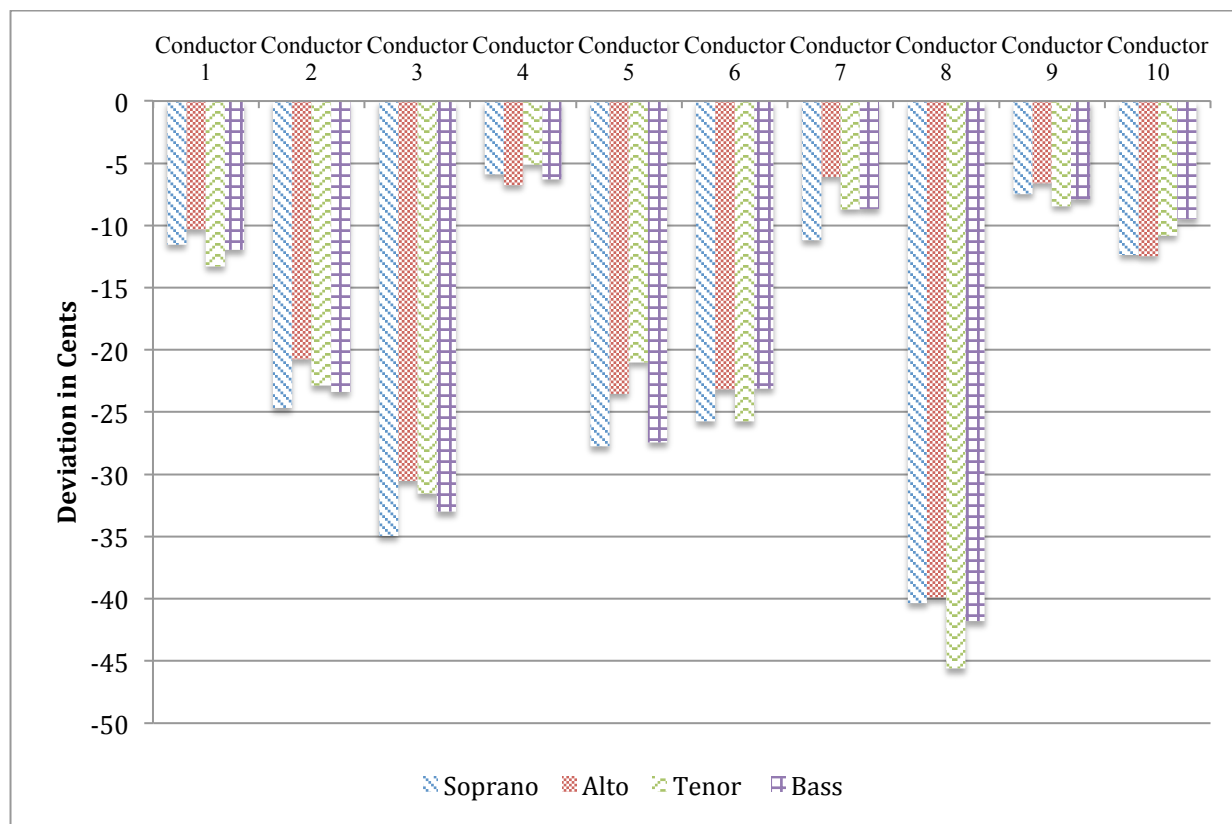


Figure 16. Choir C overall pitch deviations in cents from first pitch to last pitch in the musical excerpt.

Means of the differences in the four pitches (SATB) from the first pitch to the last pitch for each conductor were as follows: Conductor 1, -11.80; Conductor 2, -22.93; Conductor 3, -32.51; Conductor 4, -6.02; Conductor 5, -24.93; Conductor 6, -24.46; Conductor 7, -8.67; Conductor 8, -41.91; Conductor 9, -7.61; and Conductor 10, -11.29. Choir C sang in tune (within  $\pm 7$  cents of scored frequencies) for Conductor 4. Choir C sang with the smallest pitch deviations for Conductors 4, 7, and 9 and with the largest pitch deviations for Conductors 3, 5, 6, and 8.

**Pitch deviation summary.** Figure 17 depicts the means of the means for each conductor (means of the deviations of the four pitches [SATB] from beginning to end of motet, and the means of the three choirs).

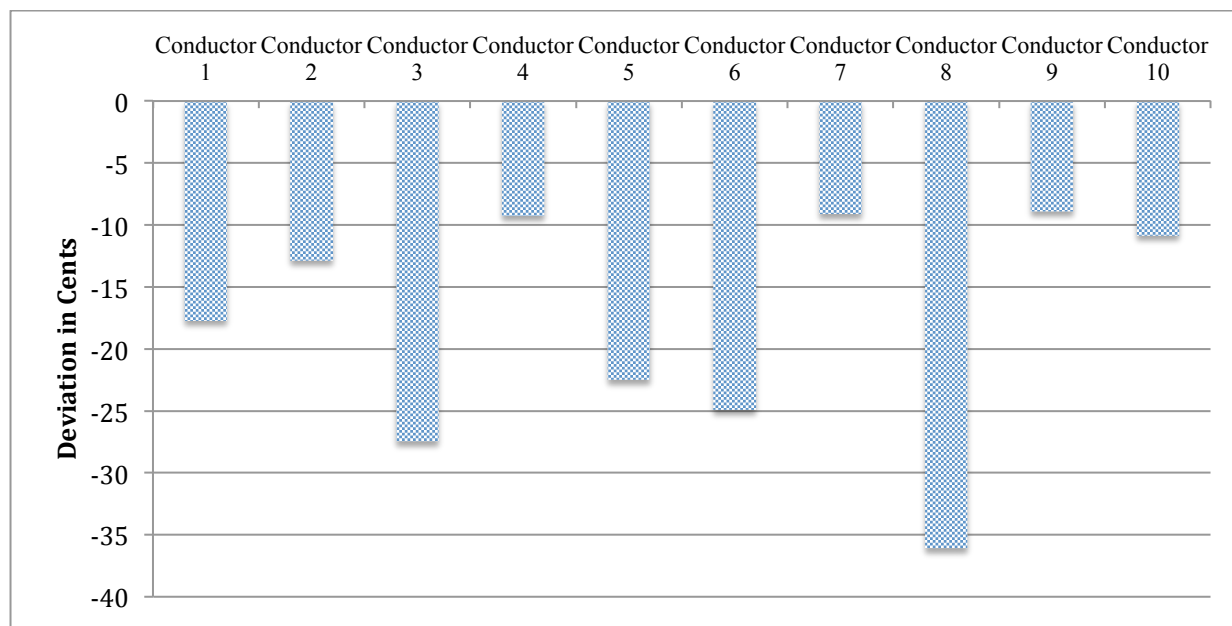


Figure 17. Grand means of all pitch deviations from first chord to last chord for each conductor across all voice parts and the three choirs.

Grand means of pitch deviations across all four voice parts and all three choirs showed that Conductors 4, 7, and 9 elicited the most nearly in tune singing from the three choirs ( $M = -9.28$ ,  $M = -9.14$ ,  $M = -8.92$ , respectively). Performances under Conductors 3, 5, 6, and 8 evidenced the largest pitch deviations ( $M = -27.46$ ,  $M = -22.50$ ,  $M = -24.93$ ,  $M = -36.06$ , respectively).

A 10 x 3 repeated measures ANOVA found a significant interaction effect,  $F(1,7) = 7.689$ ,  $p < .001$ . Thirty follow-up paired  $t$ -tests (two-tailed) measured specific differences between choirs for each conductor with a Bonferroni adjustment of alpha levels to provide conservative tests of significance ( $p = .05/30 = .002$ ).  $T$ -test results indicated significant statistical differences ( $p < .002$ ) between all but 10 (30.00%) of the choir pairings: Conductor 4 comparison of Choir A and Choir B ( $p = .009$ ), Conductor 4 comparison of Choir A and Choir C ( $p = .005$ ), Conductor 5 comparison of Choir A and Choir B ( $p = .048$ ), Conductor 5 comparison of Choir A and Choir C ( $p = .065$ ), Conductor 6 comparison of Choir A and Choir B ( $p = .004$ ),

Conductor 7 comparison of Choir A and Choir B ( $p = .003$ ), Conductor 7 comparison of Choir A and Choir C ( $p = .007$ ), Conductor 9 comparison of Choir A and Choir C ( $p = .012$ ), Conductor 10 comparison of Choir A and Choir B ( $p = .007$ ), and Conductor 10 comparison of Choir A and Choir C ( $p = .003$ ). These results indicated that for the most part 30% of the pairings tested showed consistency among the tunings while 70% of the pairings tested showed statistically significant differences in intonation.

### **Research Question Two: Conductor Nonverbal Behavior Analyses**

The second research question inquired whether the 10 videotaped conductors exhibited significant differences according to vertical gestural plane, lateral gestural plane, hand shape (bend of fingers, space between fingers, palm direction), emotional face expressions, and responses acquired from singer questionnaires. Measurements of six nonverbal conductor behaviors (two gestural planes, three hand shapes, and emotional face expressions of each of the 10 conductors) and results from the singer questionnaire provided the data for analyses.

**Vertical gestural plane.** I investigated the height (above and below shoulder height) of conductor gestures with vertical plane analysis. See Figure 2. For each conducting video, I counted total time in milliseconds and then calculated for right hand and left hand, separately, the percentage of time the conductor's vertical gestural plane exhibited movement above shoulder height and below shoulder height. Table 1 shows right-hand and left-hand percentage of time in below and above shoulder gestures for each conductor.

Table 1

*Percentage of Time for Each Conductor for Vertical Gestural Plane (Below or Above Shoulder), Reported According to Right and Left Hand*

	Right Hand		Left Hand	
	Below Shoulder	Above Shoulder	Below Shoulder	Above Shoulder
<b>Conductor 1</b>	92.52%	7.48%	98.88%	1.12%
<b>Conductor 2</b>	85.44%	14.56%	95.00%	5.00%
<b>Conductor 3</b>	88.98%	11.02%	96.41%	3.59%
<b>Conductor 4</b>	92.04%	7.96%	85.29%	14.71%
<b>Conductor 5</b>	72.72%	27.28%	80.83%	19.17%
<b>Conductor 6</b>	77.77%	22.23%	95.63%	4.37%
<b>Conductor 7</b>	87.86%	12.14%	86.36%	13.64%
<b>Conductor 8</b>	69.17%	30.83%	73.20%	26.80%
<b>Conductor 9</b>	91.80%	8.20%	86.94%	13.06%
<b>Conductor 10</b>	89.85%	10.15%	88.01%	11.99%

The majority of conductors ( $N = 7$ ) spent 80-100% of the recorded conducting in below-shoulder gestures. Conductor 1 spent the most time of the 10 conductors in the below-shoulder gestural plane with the right hand below shoulder height 92.52% of the time and the left hand below shoulder height 98.88% of the time. Three conductors had an average of 20-30% of their gestural time in the above shoulder plane. Conductor 8 exhibited the highest gestures with 30.83% of right hand gestures and 26.80% of left hand gestures above shoulder height.

**Lateral gestural plane.** The lateral gestural plane analysis examined the width of each conductor's right-hand and left-hand gestures (See Table 2). Inside conductor gestures constituted gestures within the vertical lines from the shoulder stickers, that is, mostly inside the trunk of the conductor's body. Outside conductor gestures were wider gestures beyond the

vertical lines and outside the trunk of the body. Table 2 shows the percentage of total time each conductor's right and left hands moved inside or outside of the vertical measuring lines.

Table 2

*Percentage of Time for Each Conductor for Lateral Gestural Plane (Inside or Outside of the Trunk of the Body), Reported According to Right and Left Hand*

	Right Hand		Left Hand	
	Outside	Inside	Outside	Inside
<b>Conductor 1</b>	76.50%	23.50%	24.71%	75.29%
<b>Conductor 2</b>	73.59%	26.41%	81.31%	18.69%
<b>Conductor 3</b>	65.49%	34.51%	84.76%	15.24%
<b>Conductor 4</b>	82.91%	17.09%	69.66%	30.34%
<b>Conductor 5</b>	84.42%	15.58%	83.30%	16.70%
<b>Conductor 6</b>	51.89%	48.11%	65.53%	34.47%
<b>Conductor 7</b>	47.23%	52.77%	19.37%	80.63%
<b>Conductor 8</b>	91.12%	8.88%	84.71%	15.29%
<b>Conductor 9</b>	71.21%	28.79%	36.70%	63.30%
<b>Conductor 10</b>	73.50%	26.50%	94.71%	5.29%







Nine of the ten conductors (90%) used outside right hand gestures for more than half of their conducting time. Seven of the ten conductors (70%) used outside gestures with their left hand more than half of the time. Conductor 8 spent the most time in an outside plane (91.12% right hand, 84.71% left hand). Conductor 7 exhibited across both hands the most time in the inside gestural plane (52.77% right hand, 80.63% left hand).

**Hand shape analysis.** I used three separate analyses for conductor hand shapes (finger bend, finger spacing, palm direction). For each hand shape analysis, I counted the amount of time in milliseconds and then calculated percentages of time each conductor's right and left hands exhibited one of the hand shapes.

**Finger bend.** Finger bend analysis calculated gradations of conductor finger bend from no bend to lots of bend (levels 1, 2, 3). Table 3 presents percentage of time for each amount of finger bend for all 10 conductors by right and left hand.

Table 3

*Percentage of Time in Each Amount of Finger Bend for Each of the 10 Conductors by Right and Left Hand*

	Right Hand			Left Hand		
	1 	2 	3 	1 	2 	3 
<b>Conductor 1</b>		26.65%	73.35%	4.27%	48.45%	47.28%
<b>Conductor 2</b>		66.30%	33.70%		100.00%	
<b>Conductor 3</b>	2.48%	97.52%			64.95%	35.05%
<b>Conductor 4</b>	30.24%	43.88%	25.87%	13.30%	60.83%	25.87%
<b>Conductor 5</b>		12.82%	87.18%		53.64%	44.76%
<b>Conductor 6</b>		60.63%	39.37%	2.23%	97.77%	
<b>Conductor 7</b>		67.77%	32.23%		57.72%	42.28%
<b>Conductor 8</b>	16.26%	77.86%	5.87%		71.60%	28.40%
<b>Conductor 9</b>	73.45%	26.55%		62.52%	37.48%	
<b>Conductor 10</b>	16.41%	80.29%	3.30%		8.93%	91.07%







All conductors used level 2 finger bend (a slight bend) during their recorded conducting with both the right and left hands. Conductor 9 used the most flat fingered position (no bend, level 1) with 73.45% of right hand gestures and 62.52% of left hand gestures. Conductor 5 averaged across both hands the most level 3 (lots of finger bend) position, while Conductor 10 exhibited the greatest percentage (91.07%) of single-hand level 3 position.

**Finger spacing.** I calculated finger spacing for each hand according to three levels: (a) touching fingers, (b) little space between fingers, and (c) spread fingers. Table 4 presents the

percentages of time spent by each conductor in each of these levels, disaggregated by hand.

Table 4

*Percentages of Time in Each Level of Finger Spacing for Each of the 10 Conductors by Right and Left Hand*

	Right Hand			Left Hand		
	1 	2 	3 	1 	2 	3 
<b>Conductor 1</b>	30.00%	70.00%		20.44%	76.36%	3.20%
<b>Conductor 2</b>	84.85%	15.15%		34.56%	65.44%	
<b>Conductor 3</b>	65.24%	34.76%		43.83%	56.17%	
<b>Conductor 4</b>	19.32%	75.78%	4.90%		84.85%	15.15%
<b>Conductor 5</b>	40.87%	57.52%	1.60%	16.46%	50.44%	33.10%
<b>Conductor 6</b>	46.75%	52.18%	1.07%	2.52%	36.07%	61.41%
<b>Conductor 7</b>	4.95%	79.81%	15.24%		37.62%	62.38%
<b>Conductor 8</b>		100.00%			81.21%	18.79%
<b>Conductor 9</b>	66.07%	33.93%		71.80%	28.20%	
<b>Conductor 10</b>	2.18%	67.67%	30.15%	43.88%	56.12%	







All conductors ( $N = 10$ ) at some point in their conducting videos utilized level 2 spacing (little space between fingers). Conductor 9 exhibited the most level 1 finger touching behaviors (66.07% right hand, 71.80% left hand). Among all conductors, Conductor 7 evidenced the most level 3 spread finger behaviors across both the right (15.24%) and left (62.38%) hands.

***Palm direction.*** I calculated for three levels of palm direction for each hand: (a) palm down, (b) palm to the side (thumb up), and (c) palm facing up. Table 5 presents these results.



Table 5

*Percentage of Time in Each Palm Direction for Each of the 10 Conductors by Right and Left Hand*

	Right Hand			Left Hand		
	1 	2 	3 	1 	2 	3 
<b>Conductor 1</b>	34.17%	64.76%	1.07%		11.12%	88.88%
<b>Conductor 2</b>	98.01%	1.99%		24.51%	73.64%	1.84%
<b>Conductor 3</b>	67.04%	32.96%		35.83%	59.90%	4.27%
<b>Conductor 4</b>	88.25%	11.75%		13.06%	71.31%	15.63%
<b>Conductor 5</b>		100.00%		10.72%	80.78%	8.50%
<b>Conductor 6</b>	25.87%	74.13%		48.59%	51.41%	
<b>Conductor 7</b>	85.24%	14.76%		19.47%	52.91%	27.62%
<b>Conductor 8</b>	92.33%	7.67%		31.46%	30.58%	37.96%
<b>Conductor 9</b>	31.84%	68.16%		9.71%	83.40%	6.89%
<b>Conductor 10</b>	66.46%	33.54%		11.26%	88.74%	

All 10 conductors (100%) used palm-to-the-side hand shapes during their conducting. Most conductors ( $N = 9$ , 90%) used palm-down gestures with either their right or left hands. Conductors 2 and 8 conducted with a right-hand, palm-down hand shape more than 90% of the time (98.01%, 92.33% respectively). Only Conductor 1 employed a right-hand, palm up hand shape, while eight conductors (80%) used the palm-up position in their left hands. Conductor 1 used the most overall palm-up gestures compared to the other conductors (88.88% left hand, 1.07% right hand).

I conducted a one-way repeated measures multivariate analysis of variance (MANOVA) with measures of vertical gestural plane, lateral gestural plane, and the three hand shape identifiers as the five dependent variables and the 10 videotaped conductors as the independent

variables. The multivariate result yielded a significant main effect, Pillai's Trace = .964,  $F(45, 4950) = 26.265, p < .001$ , partial  $\eta^2 = .193$ , indicating significant differences ( $p < .001$ ) among the 10 conductors according to time spent in each of the overall gestural planes and hand shapes analyzed. (The univariate  $F$  tests showed there was a significant difference between conductors for all five dependent variables: (a) vertical plane,  $F(9, 991) = 4.952, p < .001$ , (b) lateral plane,  $F(9, 991) = 19.976, p < .001$ , (c) finger bend,  $F(9, 991) = 56.591, p < .001$ , (d) finger spacing,  $F(9, 991) = 44.996, p < .001$ , and (e) palm direction,  $F(9, 991) = 23.674, p < .001$ .)

**Emotional face expressions.** Overall mean emotional face expressions for each conductor were determined through use of Continuous Response Digital Interface (CRDI) software and hardware. CRDI participants ( $N = 30$ ) turned a continuous dial between three emotionally representative faces (angry, neutral, happy) while watching the 10 conductors' videos. The dial reported scores on a scale of 0 (angry face) to 254 (happy face). A score of 127 indicated a neutral face. Figure 18 shows mean CRDI facial expression scores for each of the 10 conductors.

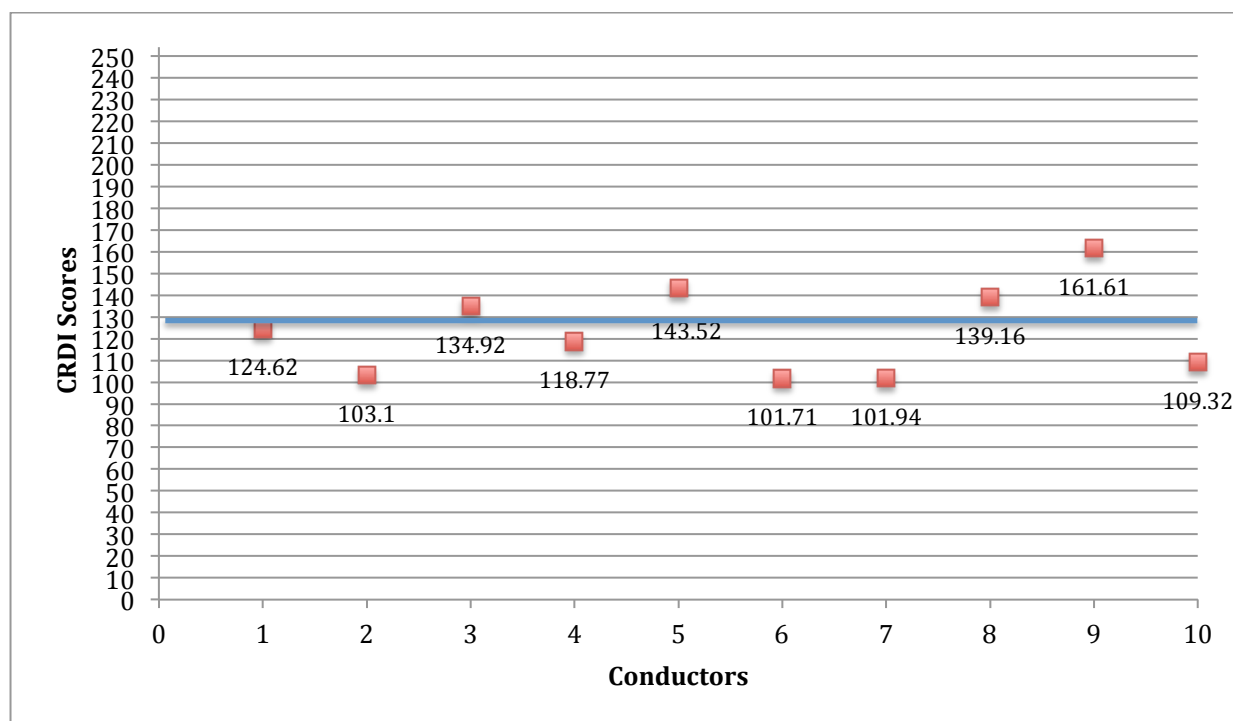
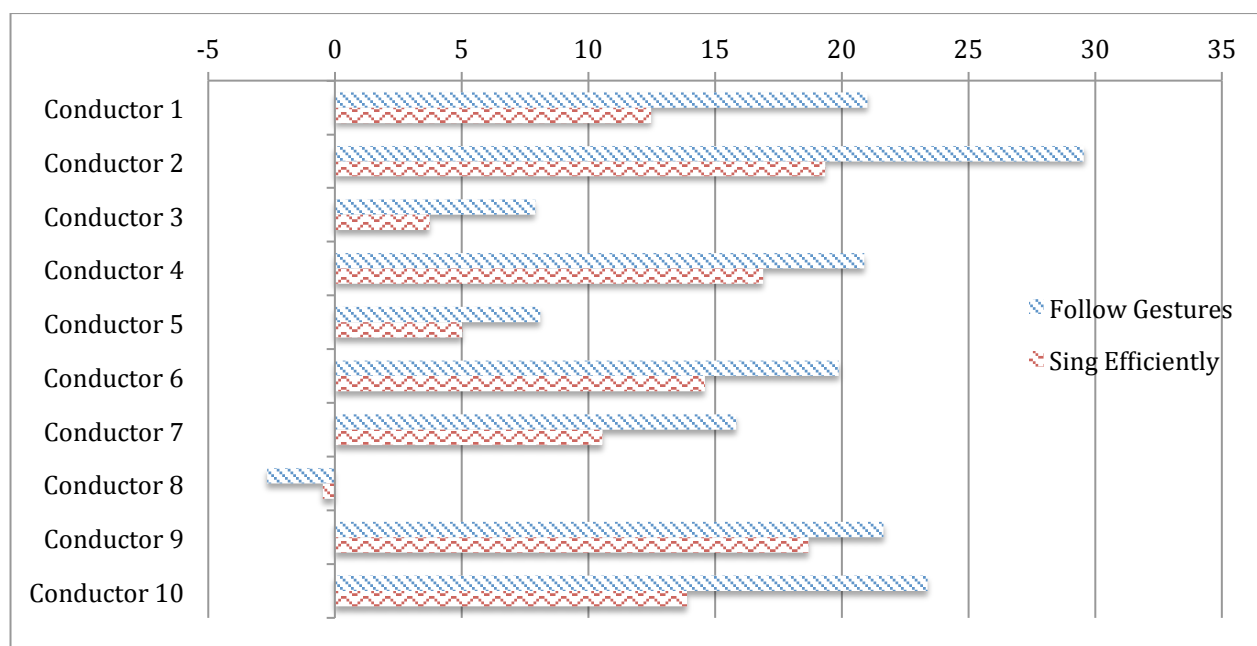


Figure 18. Mean scores for the 10 conductors according to emotional face expressions.

Note. Blue line represents the neutral face line (score of 127). Above the blue line is a score toward the happy face and below the line is a score toward the angry face.

Overall, CRDI participants rated all 10 conductors close to the neutral face line (within 35 points). Six conductors (60%) scored between neutral and angry face, while four conductors (40%) scored between neutral and happy face. CRDI participants thought Conductor 9 exhibited overall the happiest face of the conductor participants with a score of 161.61. Among the 10 conductors, CRDI participants rated Conductors 6 and 7 as closest to an angry facial expression, with scores of 101.71 and 101.94, respectively. A one-way repeated measures Analysis of Variance (ANOVA) yielded a significant main effect in participants' mean ratings of the conductors' emotional face expressions ( $F [9,64] = 395.582, p < .001$ ), indicating that the 10 conductors used significantly different emotional face expressions during their conductor recordings.

**Singer survey responses.** Immediately after each sung performance while following a videotaped conductor, singer participants from each of the three choirs responded by means of a visual analogue scale (VAS) to two questions: (a) “I could follow the conductor’s gestures,” anchored by *none of the time* and *all of the time*; and (b) “While following this conductor, my singing felt,” anchored by *non-efficient* and *efficient*. Figure 19 depicts the mean responses to the two questions for each of the 10 conductors.



*Figure 19.* Mean singer responses (in millimeters) to the two survey questions for each of the 10 conductors.

Of the 10 conductors, Conductor 2 garnered the highest mean ratings on both questionnaire items. Conductors 1, 4, 6, 9, and 10 averaged similarly high ratings from participants for both items. Singers thought they were least able to follow the gestures of Conductors 3, 5, and 8, and they thought they sang less efficiently with Conductors 3, 5, and 8 compared with the other conductors. Conductor 8 was the only conductor to average negative ratings on both items.

To test for statistical significance, I employed two one-way repeated measures analyses of variance, one for each survey question. The first ANOVA found a significant main effect in participants' responses to the first question about singer ability to follow the conductor's gesture ( $F [1,60] = 17.183, p < .001$ ). The second ANOVA found a significant main effect in participants' responses to the second question about singer perceptions of efficiency in singing ( $F [1,60] = 8.770, p < .001$ ).

### **Research Question Three: Relationships**

The final research question inquired if there were statistically significant relationships between the conductor behaviors (vertical gestural plane, lateral gestural plane, hand shape, emotional face expressions) and the timbre and intonation of the choirs. To answer this question, I computed Pearson Correlations to see if there were statistically significant correlations between the seven selected conductor behaviors (vertical gestural plane; lateral gestural plane; hand shape including, bend of fingers, space between fingers, and palm direction; emotional face expressions; singer questionnaire responses) and the intonation and timbre of the choirs' performances. Table 6 shows correlation results between LTAS analysis and the seven conductor behaviors.

Table 6

*Correlations Between LTAS Data and Singer Survey Results; Emotional Face Expressions; Vertical Gestural Plane, Lateral Gestural Plane; and the Three Hand Shapes (Finger Bend, Finger Spacing, Palm Direction)*

	LTAS			
	Correlation	$N =$	$r^2$	Significance
Pitch	.96	10	.85	*.001
Singer Survey, Follow Gestures	.88	10	.77	*.001
Singer Survey, Efficiency of Singing	.89	10	.79	*.001
Vertical Gestural Plane, Below	.68	10	.46	*.032
Vertical Gestural Plane, Above	-.68	10	.46	*.032
Lateral Gestural Plane, Inside	.51	10	.26	.135
Lateral Gestural Plane, Outside	-.51	10	.26	.135
Emotional Face Expressions	-.27	10	.07	.444
Finger Bend 1	.41	10	.17	.241
Finger Bend 2	-.37	10	.14	.296
Finger Bend 3	-.05	10	.003	.894
Finger Spacing 1	.34	10	.12	.339
Finger Spacing 2	-.48	10	.23	.166
Finger Spacing 3	.06	10	.004	.863
Palm Direction 1	-.17	10	.03	.632
Palm Direction 2	.27	10	.07	.456
Palm Direction 3	-.17	10	.03	.639

*Note.* \* =  $p < .05$ .

As indicated in Table 6, there were strong positive correlations between LTAS and Singer Perceptions of “Follow the Conductor's Gestures,”  $r = .88$ ,  $n = 10$ ,  $p = .001$ , and LTAS and Singer Perceptions of “Singing Efficiently,”  $r = .89$ ,  $n = 10$ ,  $p = .001$ , both of which were

significant. LTAS and Above-Shoulder Conducting Plane resulted in a moderate negative correlation,  $r = -.68$ ,  $n = 10$ ,  $p = .032$ , while LTAS and Below-Shoulder Conducting Plane resulted in a moderate positive correlation,  $r = .68$ ,  $n = 10$ ,  $p = .032$ , both of which were significant. Although not statistically significant, there was a moderate negative correlation for LTAS and Laterally Outside the Trunk of the Body,  $r = -.51$ ,  $n = 10$ ,  $p = .135$ , and LTAS and Laterally Inside the Trunk of the Body showed a moderate positive correlation,  $r = .51$ ,  $n = 10$ ,  $p = .135$ . Emotional face expressions and the three hand shapes did not show significant correlations to LTAS data.

Table 7 shows obtained correlations between Pitch Analysis and the seven conductor behaviors including singer surveys, emotional face expressions, gestural plane, and hand shapes.

Table 7

*Correlations Between Pitch Analysis Data and Singer Survey Results; Emotional Face Expressions; Vertical Gestural Plane; Lateral Gestural Plane; and the Three Hand Shapes (Finger Bend, Finger Spacing, Palm Direction)*

	Pitch Analysis			
	Correlation	$N =$	$r^2$	Significance
LTAS	.96	10	.92	*.001
Singer Survey, Follow Gestures	.80	10	.64	*.006
Singer Survey, Efficiency of Singing	.81	10	.67	*.005
Vertical Gestural Plane, Below	.56	10	.31	.091
Vertical Gestural Plane, Above	-.56	10	.31	.091
Lateral Gestural Plane, Inside	.42	10	.18	.228
Lateral Gestural Plane, Outside	-.42	10	.18	.228
Emotional Face Expressions	-.24	10	.06	.501
Finger Bend 1	.39	10	.15	.266
Finger Bend 2	-.44	10	.19	.202
Finger Bend 3	.04	10	.002	.909
Finger Spacing 1	.19	10	.04	.598
Finger Spacing 2	-.29	10	.08	.422
Finger Spacing 3	.06	10	.004	.864
Palm Direction 1	-.13	10	.02	.731
Palm Direction 2	.19	10	.04	.594
Palm Direction 3	-.12	10	.01	.734

*Note.* \* =  $p < .05$ .

There were strong positive correlations between intonation and singer perceptions of “Follow the Conductor's Gestures,”  $r = .80$ ,  $n = 10$ ,  $p = .006$ , and intonation and singer perceptions of “Singing Efficiently,”  $r = .81$ ,  $n = 10$ ,  $p = .005$ , both of which were significant.



There was a strong positive correlation between LTAS and pitch,  $r = .96, n = 10, p = .000$ , which was significant.

Although not statistically significant, there was a moderately strong negative correlation,  $r = -.56, n = 10, p = .091$ , between Pitch analysis and above-shoulder conducting plane and a moderately strong positive correlation,  $r = .56, n = 10, p = .091$ , between intonation and below-shoulder conducting plane. Lateral gestural plane, emotional face expressions and the three hand shapes did not show significant correlations with pitch analysis data. There was a strong positive correlation between LTAS and pitch,  $r = .96, n = 10, p = .000$ .

## CHAPTER FIVE

### DISCUSSION

This investigation builds on a small group of studies to date (Grady, 2013a, 2013b; Morrison & Selvey, 2011; Napoles, 2013) that examine potential effects of selected nonverbal conductor gestures on choral, as opposed to solo, vocal sound. In so doing, it offers replicable protocols and a variety of data that may inform the direction of future research in a relatively under-investigated area of interest to choral music practitioners and researchers.

Among primary findings: (a) singer questionnaires yielded significantly different aggregate ratings of the ten conductors with respect to perceived clarity of gestures and perceived singing efficiency in performances led by the different conductors; (b) LTAS analyses of recorded motet performances found significant differences in the spectral energy of higher frequency partials (timbre) exhibited by the three choirs when singing under the nonverbal leadership of the ten conductors; (c) pitch analyses indicated that the choirs sang significantly more in tune while following some conductors and significantly less in tune while singing for other conductors; (d) the timbre and pitch results appeared to be largely conductor specific, that is, each of the three choirs overall responded similarly to each of the ten, counter-balanced conductor videos presented; (e) LTAS (timbre) and pitch (intonation) results exhibited significantly strong, positive correlations, suggesting that those conductors whose nonverbal gestures evoked more spectral energy in the choirs' sound tended also to elicit more in tune singing and that the efforts of those conductors whose nonverbal behaviors resulted in less in tune singing also tended to be accompanied by less energetic singing; (f) the ten conductor participants, who were asked to conduct the motet with few priori strictures, exhibited significantly different amounts of aggregate time spent in the gestural planes and hand shapes

analyzed; (g) conductor vertical gestures above shoulder level were associated significantly with less timbral energy, while conductor vertical gestures below shoulder level were related significantly to increased timbral energy in the choirs' sound; (h) there were significantly strong, positive correlations between the two-item singer questionnaire responses and pitch, and between singer questionnaire items and LTAS data, suggesting that performances led by the conductors rated highest by the singers, i.e., those conductors whose gestures they could follow and sing efficiently with, tended to exhibit the least pitch deviations and the most spectral energy, while performances led by the conductors rated lowest by the singers tended to exhibit the most deviations in pitch and less spectral energy in the choir sound; (i) there were moderately strong, though not significant, associations between lateral gestures whose width remained largely within the torso area and both pitch (more in tune) and timbre (more spectral energy), and between lateral gestures whose width extended beyond the torso area and both pitch (less in tune) and timbre (more less spectral energy); and (j) there were weak, non-significant correlations between aggregate time spent in various hand postures and the choirs' timbre and intonation, and between identified emotional face expressions and analyses of the choir's sound.

These results are confined to the ten conductors, the three choirs, and the methodologies and procedures of this particular investigation. Nonetheless, they appear to merit reflection by researchers who may continue to refine this area of investigation and consideration by choral conducting and choral methods instructors interested in the possible relationships between particular nonverbal conducting behaviors and choral sound. To that end, the following discussion proceeds according to matters related to the three research questions posed for this study.

I envisioned this investigation as (a) flowing from the few studies to date that examine nonverbal conductor behaviors and choir sound, and (b) as a foundation for a new series of continuing studies. One way to situate this investigation in that broad context is to look at the logic of its research questions and the methods employed to answer those questions, and thereby consider suggestions for future research, weaknesses and limitations of the present study, and implications for choral music education.

### **Research Question One**

The first research question addresses a sometimes implicit, but nevertheless pervasive, assumption in some professional and anecdotal literature, namely that some nonverbal conductor behaviors and nonverbal conducting strategies likely have universal application to all choral ensembles (e.g., Eichenberger, 1994; Jordan, 1996).

I use a quasi-experimental methodology to evaluate that assumption. Given the ubiquity of director-led choral ensembles in human cultures and thus the impracticality of assembling a truly random sample of choirs or choral conductors, this study employs a purposive, convenience sample of ten choral conductors and three mixed choirs, each of which has in common a university context, either in terms of conductor preparation and experience or choir function. Three studies to date (Grady, 2013b; Morrison & Selvey, 2011; Napoles, 2013) examine effects of nonverbal gestures by multiple conductors (Grady, 2013b,  $N = 6$  conductors; Morrison & Selvey, 2011,  $N = 2$  conductors; Napoles, 2013,  $N = 4$  conductors) on perceptual (Grady, 2013b; Morrison & Selvey, 2011; Napoles, 2013) and acoustic (Grady, 2013b) measures of the choral sound produced by a single choir. Results from these investigations suggest that varying nonverbal conductor behaviors may yield significant differences in both perceived and acoustical evaluations, but no study has yet explored this possibility across multiple choirs.

Aside, then, from an obvious need to acquire more data about possible interactions between nonverbal conductor behaviors and choir sound, the first research question posed by the present investigation has a decided and focused agenda: Will multiple choirs react similarly to each set of nonverbal gestural vocabularies and behaviors exhibited by an array of conductors?

According to the results obtained in the particular context of this study, the basic answer appears to be yes. In other words, both the LTAS analyses of choir timbre and the pitch analyses of choir intonation indicate that, in the main, the nonverbal behaviors exhibited by each of the multiple conductors had very similar, significant effects on choral timbre and intonation across the three choirs.

This finding, of course, must be confirmed or refuted by subsequent studies using different arrays of conductors and different groups of choirs. Still, the here demonstrated possibility that at least three choirs react to each conductor similarly in terms of their sung timbre and intonation may bode well for the course of future research and for ongoing professional discussions about the scope and content of choral conducting pedagogy.

That said, it is important to note what the results of this simple experiment do and do not indicate. Although various controls (e.g., the same sung motet, the same instructions to conductors, the same distances from choir to microphone, videotaped conducting, counterbalancing of the order in which each choir viewed the conductors, the consistency of tempo afforded by the conductors hearing a metronome, choirs performing in the same sectional formation, each choir performing without scores in order to focus visual attention primarily on the conductor, none of the choirs having previously known or sung for these particular conductors) contribute to the credibility of these results, two factors were not controlled: (a) the

nonverbal behaviors exhibited by each conductor, and (b) the acoustics of the rooms in which the choirs performed.

With respect to the former, each conductor basically led the motet according to his or her best judgment. The sole stipulations were that conductors could not speak, should wear black clothing, should not use a baton, and would hear a metronome in the background during filming. Thus, the findings relative to the first research question posed indicate that the choirs responded similarly to the particular, aggregate arrays of nonverbal behaviors displayed by each conductor. They do not indicate anything per se about which particular nonverbal behaviors may have contributed most or least to the choirs' timbre and intonation.

Future studies may wish to consider obtaining measures of choral timbre and intonation by having each choir perform in the same room. The choirs participating in the current study came from different universities in different states; thus, it was more practical for me to travel to the choirs than to ask the choirs to come to a central location. There may be some advantages to acquiring recordings in the field, among them: (a) each choir is used to singing in its particular rehearsal venue, (b) each choir was able to learn and rehearse the motet in the same familiar surroundings used for the recording session, and (c) the dimensions of each venue permitted consistent distances from the front row of the choir to placement of the microphone in each room's mixed to diffuse sound field with ample distance between the microphone and the rear walls of each venue. Even so, as indicated in studies by Ternström (1989) and Hom (2013), differing room acoustics can play a role in choir sound, and it would be interesting to replicate this experiment with the choirs performing in the same venue.

It is not strictly necessary to calibrate within the recording venue a sole microphone used to acquire LTAS data. Nor would the absence of such calibration necessarily affect the relative

dB SPL means used for the statistical procedures of this study, given that the manually set volume and recording levels of the factory calibrated microphone remained consistent for all recordings, as did the choir to microphone distances. Nonetheless, future investigations might be interested in obtaining absolute dB SPL readings that could be compared across studies.

In some previous studies utilizing LTAS as a measure of choral timbre (Daugherty, Manternach, & Brunkan, 2012; Daugherty, Grady, & Coffeen, 2013; Grady, 2013a), the comparison of LTAS data is across several conditions within a single choir with one conductor. In these situations the dampening of the higher frequency partials were perceived or interpreted as a more blended sound (cf. Ford, 2003). In the current study, as in Grady (2013b), choristers singing for different conductors appear to sing with more or less spectral energy depending on their comfort and understanding of each individual conductor's gestures, as measured by the singer questionnaire responses. In short, the choristers participating in this study exhibited more spectral energy in performances led by conductors they perceive as easy to follow and with less spectral energy in performances led by conductors perceive as more difficult to follow.

The pitch analysis procedures for this investigation are confined to comparisons of sung first chord tuning and final chord tuning with the pitches notated in the motet score. While sufficient for gaining understanding of cents deviations at the beginning and at the end of the piece, subsequent investigations that perhaps employ fewer conductors or fewer choirs might check tuning at junctures throughout the sung performance. I confine pitch analyses to the first and final chords simply because of the number of conductors and the number of choirs in this particular study (30 performances with 8 pitches per performance = 240 separate pitches to analyze).

Of potential interest to those who bear responsibility for choral conducting curricula and to the authors of choral conducting textbooks is the finding --again, a finding thus far limited to this one study-- that the different choirs similarly modified their timbre and intonation for the various conductors absent any verbal instructions to do so. If borne out by subsequent studies, this factor could suggest that attention to conductor nonverbal behaviors might be a time-efficient way to do business in choral rehearsal settings.

Choirs participating in this study are university-based choirs. Subsequent investigations might well employ choirs of various ages and ability levels, ranging from children's choirs to senior citizen ensembles. The choirs in this study perform a four-part, SATB motet. Future studies could also consider use of a wide range of choral literature, from unison to eight-part divisi compositions.

Of particular interest to choral conducting pedagogy would be a study, or series of studies across multiple choirs, in which the ability and experience levels of the conductors varied widely. Conductor participants in this study had graduate degrees and many years' experience. Comparing the nonverbal behaviors of novice and expert conductors in terms of choir sound could be informational and perhaps assist choral conducting teachers by identifying specific nonverbal behaviors in which novice conductors should be instructed.

Videotaped conducting ensures consistency among what the three choirs saw. With videotaped conducting as a control, there is reasonable assurance that each choir responded to precisely the same visual stimuli. However, even though the ten conductors participating in this study are very experienced, professional conductors who might be expected to imagine how a university choir would respond to gestural vocabularies employed for conducting a specific



motet, pre-recorded conducting in the absence of a choir does not afford conductors an opportunity to react to and adjust nonverbal behaviors according to what they hear from a choir.

Future studies might devise ways to record conductors in the presence of an actual choir, such that a metronome could still be used and the choir's singing later removed from the video recording. An interesting line of future research, moreover, could examine conductors' prepared or planned conducting gestures before working with a choir compared to the gestures they use while “in the moment” and conducting actual singers.

### **Research Question Two**

The second research question inquires about time spent by each conductor in selected nonverbal behaviors. Its intent is to begin to identify particular nonverbal behaviors that may advance the focus of research in this area beyond the rather vague arena of defining nonverbal conductor behavior as inclusive of any and all non-spoken behaviors under such amorphous, umbrella terms as “expressive conducting” or “musical conducting.” The overall logic informing this question, in other words is reductionist. It has to do with pinpointing specific, measurable nonverbal conductor behaviors that eventually can be tested as independent variables in subsequent investigations.

In the more immediate context of the present study, I simply seek to find out if the ten participating conductors spent significantly similar or dissimilar amounts of time displaying any of an array of selected nonverbal behaviors: vertical gestural planes (below and above shoulder level), lateral gestural planes, hand shape (bend of fingers, space between fingers, palm direction), and identified emotional face expressions. These particular, selected behaviors are among the various factors mentioned in the professional and anecdotal literature as possible

contributors to modifying choir sound nonverbally. This phase of the investigation employed a basically descriptive methodology.

Obviously, the ten conductors evidenced many other nonverbal behaviors, but one has to start somewhere. Moreover, given the huge amount of time required for millisecond by millisecond analyses of the ten conductor videos and the sheer volume of data points, I opted in this investigation to describe the aggregate amount and percentages of time each conductor spent in each selected behavior across the whole motet.

There are advantages and disadvantages to this sort of macro description. On the one hand, it can identify and isolate “big picture” variables of potential interest for this and subsequent investigations. Findings from the second research question, for instance, indicate that particular conductors spent significantly different percentages of time in certain nonverbal behaviors than other conductors.

On the other hand, however, a macro approach ignores the possibility that micro analysis of particular, smaller moments in the motet might yield promising data. For example, the percentage of time a conductor displays a particular hand shape across an entire motet might not be as informative as knowing at a particular moment, such as a sustained cadence chord, the percentage of time spent displaying that hand shape.

Another consideration, of course, is the nature of the dependent measures currently available for measuring conglomerate, choral sound. While not an immediate consideration for the second research question of this investigation, which simply describes "what is" relative to the selected nonverbal behaviors displayed by these conductors, it does relate to the first and third research questions where LTAS and pitch analyses are used as dependent variables.

Although it is possible to do pitch analyses of a single chord, for instance, the duration of that chord may not be sufficient for credible LTAS analyses.

Nonetheless, future investigations may wish to include or even focus on micro analyses of particular nonverbal conductor behaviors. Micro analysis, however, is not a focus of the current study.

Rather than describe what particular conductors already do nonverbally when asked to conduct a particular piece of choral literature, future studies could prescribe and insure that the conductors spend like amounts of time in displaying particular, contrasting nonverbal behaviors. For instance, a like amount of time in above the shoulder vertical plane and below the shoulder vertical plane gestures could set up a more experimental, rather than descriptive, context. As it happened, the ten conductors in this study mostly gestured vertically in a mid- to low-plane, perhaps heeding the testimony of some choral conducting texts (e.g., Garretson, 1998; Green, 2007) that conductors use a waist to shoulder space for gestures.

Most of the conductors in the present study chose to employ a traditional four pattern in conducting the motet, though many of them deviated from or melded that pattern at particular junctures. Due to the shape of the traditional four pattern, most all of the conductors show a beat two considered “inside” and a beat three considered “outside” of the measurement lines. Thus, the majority of measurement depends heavily on where each conductor places the crux of his or her pattern. Some were within (e.g., Conductor 7) and some outside (e.g., Conductor 8) the torso area. Thus, the conducting pattern chosen likely played a role in measurements of time spent in the two lateral gestural planes analyzed.

The width of the conductor gestures displayed by the left hand may be of more interest than gestural width displayed by the right hand. Seven of the 10 conductors’ gestures with their

left hands remained outside the torso area for the majority of the time (more than 65%). Left hand gestures for these conductors tend to be either a mirroring of the beat pattern of the right hand or, more often, a held out gesture or a slowly moving hand to imply phrasing or a dynamic change. Future research could investigate differences in choral sound when the same conductor is showing a mirrored pattern as compared to an “expressive” gesture. One could investigate whether the second hand mirroring the same pattern elicits more efficiency in rhythmic accuracy, or on the other hand, if the extra pattern distracts from the conductor’s actual intentions.

The second research question also includes responses from singer questionnaires. Findings indicate that the choristers as a whole perceived significant extent differences among the ten conductors with respect to ease of following displayed nonverbal conducting and with respect to perceived singing efficiency while observing and following the conductors. These singer responses appear to provide a point of triangulation with data from the first research question. Just as the singers' timbre and intonation differ when viewing the ten conductors, so do their ratings of the conductors following each sung performance. These individual conductor ratings, moreover, were similar across the three choirs.

Given time constraints and considerations of possible participant fatigue, questionnaires in studies of this type should necessarily be short. In future studies, however, singer questionnaires might provide opportunity for open-ended responses in addition to directed ratings.

Likewise, it may be more informative for subsequent investigations to involve the singers in ratings of conductor facial expressions. There may be differences in how persons actually singing while observing the conductor perceive his or her face expressions in distinction from having persons not singing rate those expressions. This study incorporates pictures from the

Karolinska Directed Emotional Faces (KDEF) database (Lundqvist, Flykt, & Öhman, 1998). Although used in numerous social science studies, these pictures may not sufficiently represent potential nuances in the emotional content conveyed by choral conductors in a musical ensemble context.

Moreover, upon reflection, one might not expect persons conducting a sacred motet to exhibit a wide range of distinctive emotional facial expressions, a factor borne out in this investigation by the results of continuous observer ratings. Although the ratings reflect statistically significant differences among the various conductors, in actuality these differences are minor; that is, observers perceived nearly all of the conductors as exhibiting slightly more or slightly less neutral faces. Perhaps future researchers might consider a less global construct than emotional face expression and focus, for example, upon more specific behaviors such as amount of direct eye contact, eyebrow lifting, and buccal or forehead muscle movements.

### **Research Question Three**

By inquiring about possible significant associations between the described, selected nonverbal conductor behaviors, singer questionnaire responses, and the dependent measures of choir timbre and choir intonation, the third research question for this investigation seeks to consider jointly and move forward the findings from research questions one and two. Here, the data input for correlations between exhibited conductor behaviors and the dependent measures of timbre and pitch were computed on the macro level, i.e., across the entire sung performances, according to the amount of time spent exhibiting particular behaviors. Future studies that consider micro analyses might obtain differing associations when examining particular, shorter moments in the conducted performances.

Of major interest is the finding of significant positive relationships between LTAS and intonation, LTAS and singer responses, intonation and singer responses, and LTAS and vertical gestural plane. The strong positive correlation between pitch (intonation) and LTAS (timbre) indicates that as these choirs sing more in tune they are also singing with more spectral energy. Conversely, as a choir sings with less spectral energy they sing more out of tune.

The singer survey responses in this exploration correlate strongly and positively to the timbre and intonation of each of the choirs. Performances led by conductors rated highest by the choristers also have least pitch deviations and most spectral energy (Conductors 1, 2, 9, 10), while the lowest rated conductors have the largest pitch deviations and least spectral energy (Conductors 3, 5, 8).

Few choral conducting texts at present appear to address the potential role of nonverbal conductor behaviors and gestures as a means of modifying choir sound, as opposed to simply communicating musical, score-based intentions. Results of the present investigation, which employs 10 conductors and three choirs, suggest that choral ensembles may respond similarly to particular, exhibited nonverbal conductor behaviors, and in that response alter the timbre and intonation of their singing. Much more research is needed.

However, the possibility that particular nonverbal conductor behaviors, particularly use of the vertical gestural plane, may be associated positively and significantly with singing behaviors across multiple choirs provides food for thought to researchers and music educators alike. Perhaps the primary take away from this investigation is that aggregate nonverbal conducting behaviors appear to matter in terms of choir timbre, pitch, and perceived singing efficiency. Moreover, the nonverbal behaviors exhibited by the conductors in this study appear to elicit differences in choir sound in a very brief amount of time. If borne out by subsequent

studies, these factors potentially suggest numerous implications for choral conducting pedagogy and for the ways in which conductors perceive their roles and their abilities to evoke nuances in choir sound. As Eichenberger (in McClung, 1996) remarks, " I think that we don't teach conducting adequately if we don't carefully investigate all the possibilities that nonverbal language brings to the communication between conductor and performer" (p. 20).

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## Appendix A

### **Informed Consent Statement HSCL # 00001139**

The Department of Music at the University of Kansas supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You may refuse to sign this form and not participate in this study. You should be aware that even if you agree to participate, you are free to withdraw at any time. If you do withdraw from this study, it will not affect your relationship with this unit, the services it may provide to you, or the University of Kansas.

#### PURPOSE OF THE STUDY

*To study the effects of multiple conductor non-verbal gestures on choral sound.*

#### PROCEDURES

You will be asked to conduct a previously learned song for a video recording. The conducting segment will take approximately one minute.

The proceedings of this study will be video taped and will be used solely by the researcher. The video recording will be utilized for two further steps in this study. The video recording will be shown to three choirs and to music students. It is a requirement of this study that you be video taped. The tapes will be locked in a cabinet accessible only to the researcher and will be destroyed after a time period of one year.

#### RISKS

*There are no risks or discomforts associated with this study.*

#### BENEFITS

*The subject will have the opportunity to sing with a variety of directors.*

#### PAYMENT TO PARTICIPANTS

*There will be no payment made to study participants.*

#### PARTICIPANT CONFIDENTIALITY

Your name will not be associated in any publication or presentation with the information collected about you or with the research findings from this study. Instead, the researcher(s) will use a study number or a pseudonym rather than your name. Your identifiable information will not be shared unless (a) it is required by law or university policy, or (b) you give written permission.

Permission granted on this date to use and disclose your information remains in effect indefinitely. By signing this form you give permission for the use and disclosure of your information for purposes of this study at any time in the future.

#### REFUSAL TO SIGN CONSENT AND AUTHORIZATION

You are not required to sign this Consent and Authorization form and you may refuse to do so without affecting your right to any services you are receiving or may receive from the University of Kansas or to

participate in any programs or events of the University of Kansas. However, if you refuse to sign, you cannot participate in this study.

#### CANCELLING THIS CONSENT AND AUTHORIZATION

You may withdraw your consent to participate in this study at any time. You also have the right to cancel your permission to use and disclose further information collected about you, in writing, at any time, by sending your written request to: *Melissa Grady*, 1530 Naismith Dr. Lawrence, KS. 66045.

If you cancel permission to use your information, the researchers will stop collecting additional information about you. However, the research team may use and disclose information that was gathered before they received your cancellation, as described above.

#### QUESTIONS ABOUT PARTICIPATION

Questions about procedures should be directed to the researcher(s) listed at the end of this consent form.

#### PARTICIPANT CERTIFICATION:

I have read this Consent and Authorization form. I have had the opportunity to ask, and I have received answers to, any questions I had regarding the study. I understand that if I have any additional questions about my rights as a research participant, I may call (785) 864-7429 or (785) 864-7385, write the Human Subjects Committee Lawrence Campus (HSCL), University of Kansas, 2385 Irving Hill Road, Lawrence, Kansas 66045-7568, or email [irb@ku.edu](mailto:irb@ku.edu).

I agree to take part in this study as a research participant. By my signature I affirm that I am at least 18 years old and that I have received a copy of this Consent and Authorization form.

Type/Print Participant's Name	Date
Participant's Signature	

#### Researcher Contact Information

Melissa Grady, Principal Investigator  
1530 Naismith Dr.  
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1530 Naismith Dr.  
Lawrence, KS. 66045  
[jdaugher@ku.edu](mailto:jdaugher@ku.edu)

**Conductor Survey**

Conductor Number: \_\_\_\_\_

Age: \_\_\_\_\_ Sex: M F

*Education: Please circle all that apply and list your emphasis in each.*

Bachelor of Music \_\_\_\_\_

Masters of Music \_\_\_\_\_

PhD/DMA in progress \_\_\_\_\_

PhD \_\_\_\_\_

DMA \_\_\_\_\_

*Work Experience: Please list the number of years you have taught at each level.*

Elementary School \_\_\_\_\_

Junior High \_\_\_\_\_

High School \_\_\_\_\_

College \_\_\_\_\_

Solo Voice \_\_\_\_\_

Number of years as a choral conductor: \_\_\_\_\_

**Thank you for participating in this study!**

## Appendix B

### Informed Consent Statement HSCL # 00001139

The Department of Music at the University of Kansas supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You may refuse to sign this form and not participate in this study. You should be aware that even if you agree to participate, you are free to withdraw at any time. If you do withdraw from this study, it will not affect your relationship with this unit, the services it may provide to you, or the University of Kansas.

#### PURPOSE OF THE STUDY

*To study the effects of multiple conductor non-verbal gestures on choral sound.*

#### PROCEDURES

You will be asked to sing a previously learned song with the choir while watching video taped conductors. This will take approximately 15 minutes.

The proceedings of this study will be audio recorded and will be used solely by the researcher.

All proceedings will be transcribed by the researcher only. The tapes will be locked in a cabinet accessible only to the researcher and will be destroyed after a time period of one year.

#### RISKS

*There are no risks or discomforts associated with this study.*

#### BENEFITS

*The subject will have the opportunity to sing with a variety of directors.*

#### PAYMENT TO PARTICIPANTS

*There will be no payment made to study participants.*

#### PARTICIPANT CONFIDENTIALITY

Your name will not be associated in any publication or presentation with the information collected about you or with the research findings from this study. Instead, the researcher(s) will use a study number or a pseudonym rather than your name. Your identifiable information will not be shared unless (a) it is required by law or university policy, or (b) you give written permission.

Permission granted on this date to use and disclose your information remains in effect indefinitely. By signing this form you give permission for the use and disclosure of your information for purposes of this study at any time in the future.

#### REFUSAL TO SIGN CONSENT AND AUTHORIZATION

You are not required to sign this Consent and Authorization form and you may refuse to do so without affecting your right to any services you are receiving or may receive from the University of Kansas or to participate in any programs or events of the University of Kansas. However, if you refuse to sign, you cannot participate in this study.

#### CANCELLING THIS CONSENT AND AUTHORIZATION

You may withdraw your consent to participate in this study at any time. You also have the right to cancel your permission to use and disclose further information collected about you, in writing, at any time, by sending your written request to: *Melissa Grady*, 1530 Naismith Dr. Lawrence, KS. 66045.

If you cancel permission to use your information, the researcher will stop collecting additional information about you. However, the research team may use and disclose information that was gathered before they received your cancellation, as described above.

#### QUESTIONS ABOUT PARTICIPATION

Questions about procedures should be directed to the researcher(s) listed at the end of this consent form.

#### PARTICIPANT CERTIFICATION:

I have read this Consent and Authorization form. I have had the opportunity to ask, and I have received answers to, any questions I had regarding the study. I understand that if I have any additional questions about my rights as a research participant, I may call (785) 864-7429 or (785) 864-7385, write the Human Subjects Committee Lawrence Campus (HSCL), University of Kansas, 2385 Irving Hill Road, Lawrence, Kansas 66045-7568, or email [irb@ku.edu](mailto:irb@ku.edu).

I agree to take part in this study as a research participant. By my signature I affirm that I am at least 18 years old and that I have received a copy of this Consent and Authorization form.

Type/Print Participant's Name	Date
Participant's Signature	

#### Researcher Contact Information

Melissa Grady, Principal Investigator  
1530 Naismith Dr.  
Lawrence, KS. 66045  
[mgrady@ku.edu](mailto:mgrady@ku.edu)

Dr. James Daugherty, Faculty Supervisor  
1530 Naismith Dr.  
Lawrence, KS. 66045  
[jdaugher@ku.edu](mailto:jdaugher@ku.edu)

## SINGER PARTICIPANT QUESTIONNAIRE

Your age: \_\_\_\_\_

Circle one: Male    Female

Please indicate previous years of regular, ongoing choir membership in any kind of choir (including school, church/synagogue, and/or community choirs) at the following levels (If none, write zero.):

ELEMENTARY SCHOOL AGE Choir Participation: \_\_\_\_\_ years

MIDDLE OR JR HIGH SCHOOL AGE Choir Participation: \_\_\_\_\_ years

HIGH SCHOOL AGE Choir Participation: \_\_\_\_\_ years

COLLEGE AGE Choir Participation: \_\_\_\_\_ years

POST COLLEGE AGE Choir Participation: \_\_\_\_\_ years

Please indicate number of years of any regular, ongoing VOICE LESSONS with a private teacher (If none, write zero.):

\_\_\_\_\_ years

Please indicate number of years of any regular, ongoing CHORAL CONDUCTING experience (If none, write zero.):

\_\_\_\_\_ years

Please indicate number of years of any regular, ongoing INSTRUMENTAL CONDUCTING experience (If none, write zero.):


\_\_\_\_\_ years

Thank you for participating!




**Conductor 1:** After singing for this conductor, please respond to the following two items by placing a single vertical mark on the line below the statement.

I could follow the conductor's gestures:


None of the Time \_\_\_\_\_ | \_\_\_\_\_ All of the Time  


While following this conductor, my singing felt:


Non-efficient \_\_\_\_\_ | \_\_\_\_\_ Efficient  


**Conductor 2:** After singing for this conductor, please respond to the following two items by placing a single vertical mark on the line below the statement.

I could follow the conductor's gestures:


None of the Time \_\_\_\_\_ | \_\_\_\_\_ All of the Time  


While following this conductor, my singing felt:


Non-efficient \_\_\_\_\_ | \_\_\_\_\_ Efficient  


**Conductor 3:** After singing for this conductor, please respond to the following two items by placing a single vertical mark on the line below the statement.

I could follow the conductor's gestures:


None of the Time \_\_\_\_\_ | \_\_\_\_\_ All of the Time  


While following this conductor, my singing felt:


Non-efficient \_\_\_\_\_ | \_\_\_\_\_ Efficient  


**Conductor 4:** After singing for this conductor, please respond to the following two items by placing a single vertical mark on the line below the statement.

I could follow the conductor's gestures:


None of the Time \_\_\_\_\_ | \_\_\_\_\_ All of the Time  


While following this conductor, my singing felt:


Non-efficient \_\_\_\_\_ | \_\_\_\_\_ Efficient  


**Conductor 5:** After singing for this conductor, please respond to the following two items by placing a single vertical mark on the line below the statement.

I could follow the conductor's gestures:


None of the Time \_\_\_\_\_ | \_\_\_\_\_ All of the Time  


While following this conductor, my singing felt:


Non-efficient \_\_\_\_\_ | \_\_\_\_\_ Efficient  


**Conductor 6:** After singing for this conductor, please respond to the following two items by placing a single vertical mark on the line below the statement.

I could follow the conductor's gestures:


None of the Time \_\_\_\_\_ | \_\_\_\_\_ All of the Time  


While following this conductor, my singing felt:


Non-efficient \_\_\_\_\_ | \_\_\_\_\_ Efficient  


**Conductor 7:** After singing for this conductor, please respond to the following two items by placing a single vertical mark on the line below the statement.

I could follow the conductor's gestures:


None of the Time \_\_\_\_\_ | \_\_\_\_\_ All of the Time  


While following this conductor, my singing felt:


Non-efficient \_\_\_\_\_ | \_\_\_\_\_ Efficient  


**Conductor 8:** After singing for this conductor, please respond to the following two items by placing a single vertical mark on the line below the statement.

I could follow the conductor's gestures:


None of the Time \_\_\_\_\_ | \_\_\_\_\_ All of the Time  


While following this conductor, my singing felt:


Non-efficient \_\_\_\_\_ | \_\_\_\_\_ Efficient  


**Conductor 9:** After singing for this conductor, please respond to the following two items by placing a single vertical mark on the line below the statement.

I could follow the conductor's gestures:

None of the Time \_\_\_\_\_ | \_\_\_\_\_ All of the Time  


While following this conductor, my singing felt:

Non-efficient \_\_\_\_\_ | \_\_\_\_\_ Efficient  




## Appendix C

### **Informed Consent Statement HSCL # 00001139**

The Department of Music at the University of Kansas supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You may refuse to sign this form and not participate in this study. You should be aware that even if you agree to participate, you are free to withdraw at any time. If you do withdraw from this study, it will not affect your relationship with this unit, the services it may provide to you, or the University of Kansas.

#### PURPOSE OF THE STUDY

*To study the effects of multiple conductor non-verbal gestures on choral sound.*

#### PROCEDURES

You will be asked watch video recordings of multiple conductors and adjust the dial on the Continuous Response Digital Interface (CRDI) to your perceptions of the conductor's facial emotional behavior. This will take approximately 15 minutes.

#### RISKS

*There are no risks or discomforts associated with this study.*

#### BENEFITS

*The subject will have the opportunity to observe the gestures of a variety of directors.*

#### PAYMENT TO PARTICIPANTS

*There will be no payment made to study participants.*

#### PARTICIPANT CONFIDENTIALITY

Your name will not be associated in any publication or presentation with the information collected about you or with the research findings from this study. Instead, the researcher(s) will use a study number or a pseudonym rather than your name. Your identifiable information will not be shared unless (a) it is required by law or university policy, or (b) you give written permission.

Permission granted on this date to use and disclose your information remains in effect indefinitely. By signing this form you give permission for the use and disclosure of your information for purposes of this study at any time in the future.

#### REFUSAL TO SIGN CONSENT AND AUTHORIZATION

You are not required to sign this Consent and Authorization form and you may refuse to do so without affecting your right to any services you are receiving or may receive from the University of Kansas or to participate in any programs or events of the University of Kansas. However, if you refuse to sign, you cannot participate in this study.

#### CANCELLING THIS CONSENT AND AUTHORIZATION

You may withdraw your consent to participate in this study at any time. You also have the right to cancel your permission to use and disclose further information collected about you, in writing, at any time, by sending your written request to: *Melissa Grady*, 1530 Naismith Dr. Lawrence, KS. 66045.

If you cancel permission to use your information, the researcher will stop collecting additional information about you. However, the research team may use and disclose information that was gathered before they received your cancellation, as described above.

#### QUESTIONS ABOUT PARTICIPATION

Questions about procedures should be directed to the researcher(s) listed at the end of this consent form.

#### PARTICIPANT CERTIFICATION:

I have read this Consent and Authorization form. I have had the opportunity to ask, and I have received answers to, any questions I had regarding the study. I understand that if I have any additional questions about my rights as a research participant, I may call (785) 864-7429 or (785) 864-7385, write the Human Subjects Committee Lawrence Campus (HSCL), University of Kansas, 2385 Irving Hill Road, Lawrence, Kansas 66045-7568, or email [irb@ku.edu](mailto:irb@ku.edu).

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