

## **Effects of Traditional Pattern, Lateral-Only, and Vertical-Only Conducting Gestures on Acoustic and Perceptual Measures of Choir Sound: An Exploratory Study**

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### **Abstract**

The purpose of this exploratory investigation was to determine whether three contrasting conducting gestures affected acoustical and perceptual measures of choir sound. Participating choristers ( $N = 29$ ) jointly performed "All Through the Night" in unison while watching a videotaped conductor who displayed three alternating right-hand gestures: (a) a traditional conducting pattern, (b) a vertical-only gesture, and (c) a lateral-only gesture. Among primary results: (a) Long Term Average Spectra (LTAS) data showed significant mean signal amplitude differences between conducting conditions across the 0 – 10 kHz, 2.9 – 3.9 kHz, and 4.6 – 5.7 kHz spectral regions; (b) pitch analyses indicated that the choir sang most in tune when observing the vertical-only gesture, and least in tune when observing the lateral-only gesture; (c) expert listener panel ( $N = 8$ ) ratings of counter-balanced pairs of recorded choir performances consistently reflected majority preferences (88%, 75%) for the vertical-only condition when contrasted with the lateral-only condition, and for the vertical-only condition (75%, 75%) when contrasted with the traditional pattern; (d) most singers perceived differences in their own vocal sound (83%) and differences in the sound of the choir (76%) while singing under the three gestural conditions; and (e) choristers offered more positive comments about the vertical conducting gesture than the other gestures observed. These converging acoustical and perceptual data were discussed in terms of nonverbal conducting behaviors, limitations of the study, and suggestions for future research.

### **Keywords**

choir, gesture, conductor, singing, perceptions

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Choral conducting textbooks (Decker & Kirk, 1995; Demare & Moses, 1995; Garretson, 1998; Green, 1997) traditionally address the use of nonverbal conducting gestures to convey a conductor's musical intentions (e.g., tempo, style, dynamics, phrasing) to a choir. However, very few choral conducting resources to date address nonverbal arm and hand gestures in relation to the physiological and acoustical efficiency of singers' vocal production. *What They See is What You Get* (Eichenberger & Dunn, 1994), the title of an instructional videotape by Rodney Eichenberger, serves as a shorthand summary of this latter perspective.

Eichenberger claims that everything the conductor shows a choir nonverbally potentially affects the overall sound of the choir. He further suggests that specific nonverbal gestures will modify the tone quality and intonation of a choir's sound, whether for good or ill. In his video, for example, Eichenberger states that a choir will "sag in pitch" on sustained sounds if the conductor employs a lateral conducting gesture. By contrast, he contends, "as long as you are in an upward movement something good happens to the tone." Similarly, Durrant (2003) claims that an upward right-hand gesture is "immensely beneficial when exploring ways of improving intonation and lightening the vocal timbre" (p. 147).

Empirical studies to date have investigated various aspects of conducting gestures. Cofer (1998) found that seventh-grade wind instrumentalists ( $N = 60$ ) could relate to and play according to particular nonverbal conducting gestures after they had experienced short conducting gesture lessons.

Several studies have examined conductor expressivity. Definitions of "expressivity" varied among these studies; some studies lacked definitions altogether. Nonetheless, a common factor in the use of expressivity as an independent variable in these investigations was some abandonment of traditional conducting patterns. Gallops (2005) studied the

effectiveness of instrumental conductors ( $N = 15$ ) in eliciting expressive-interpretive performances from players. Results indicated that conductors rated as most expressive used more nontraditional conducting including changing the size and placement of the pattern. Sidoti (1990) found a significant difference between expressive and non-expressive conducting conditions with respect to high school instrumentalists' ( $N = 139$ ) performances of scored expression markings. Players performed expression markings more accurately when observing conductors who used expressive conducting.

Results from a study by House (1998) indicated that performances of advanced instrumental musicians ( $N = 60$ ) improved while observing expressive conducting, and that expressive conducting elicited more favorable performer attitudes toward the conductor than non-expressive (time-beating) conducting. On the other hand a series of studies, (Price & Chang, 2001, 2005; Price, 2006) found no significant relationships between assessments of conductor expressivity and perceptions of ensemble expressivity among ensembles performing at state music festivals.

Morrison, Price, Geiger, and Cornacchio (2009) employed four conducting videos (two with expressive conducting, two with non-expressive conducting) synchronized with the same sound recording. University wind ensemble members ( $N = 118$ ) rated instrumental ensemble expressivity significantly higher for the expressive conducting condition than the non-expressive conducting condition. In a similar study, Morrison and Selvey (2011) solicited preferences of middle school and high school music students (choir and band) while watching videos of expressive and non-expressive conductors. Although the performances heard remained consistent, these students preferred the performances that evidenced expressive conducting. Price, Morrison, and Mann (2011) replicated this study

with collegiate non-music majors with the same result.

In a study that included evaluation of expressive conducting in relation to actual choral sound produced by a choir while observing both expressive and non-expressive conductors, Napoles (2013) used both expressive and non-expressive conducting ( $N = 4$  conductors) to test the effects of three presentational modes (audio only, conductor viewed from the front, and conductor viewed from the back) on ratings by students ( $N = 131$ ) at a high school choir camp. 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.

To date, few studies have examined effects of specific conducting gestures on the vocal behaviors of singers. In a series of studies, Fuelberth (2003a, 2003b, 2004) tested effects of various left-hand choral conducting gestures (fisted, palm up, palm down, stabbing, and sideways phrasing gestures) on the vocal tension or anticipated tension of individual singers. Results indicated more anticipated tension with the left-hand fisted, palm down, and stabbing gestures than with the other left-hand gestural conditions. Manternach (2009, 2011) found that singer head and shoulder movements varied significantly according to direction of conductor preparatory gestures. Each of these studies, however, measured effects of specific conductor gestures with solo singers.

The purpose of the present investigation was to compare, in a non-laboratory choral singing context, the potential effects of three right-hand conductor gesture conditions (traditional pattern, lateral-only gesture, vertical-only gesture) exhibited by a videotaped conductor on the aggregate sound of a mixed choir of male and female voices ( $N = 29$ ) singing a folk song ("All Through the Night") in unison.

To that end, the following research questions guided this study:

1. Do long-term average spectra (LTAS) data indicate significant differences in the timbre of choral sound between performances of the choir as it sang the entire melody of "All Through the Night" while observing (a) a traditional conducting pattern, (b) a traditional pattern alternating with a lateral-only gesture, and (c) a traditional pattern alternating with a vertical-only gesture?
2. Do perceptual measures (Max/MSP pitch analyses and expert listeners' [ $N = 8$ ] ratings) indicate differences between performances of the choir as it sang selected vowels and phrases of the folk song while observing (a) a traditional conducting pattern, (b) a lateral-only gesture, and (c) a vertical-only gesture?
3. What do singer participant comments suggest about their perceptions of the three gestural conditions?

## Definitions

### *Vertical-Only Conducting Gesture*

The vertical-only conducting gesture used for this study is a right-hand gesture that lifts 18 in. upward from just below waist height to just below shoulder height, and descends on the same plane. The arm starts with the elbow making a 90-degree angle approximately three in. from the conductor's side. The hand is slightly cupped with palm down and in front of the conductor's body. The top of the hand leads the lifting of the forearm and the elbow moves slightly forward. The wrist does not bend or flap. Figure 1 illustrates the starting and finishing points of this vertical-only conducting gesture.



Figure 1. Vertical-only gesture.

### *Lateral-Only Conducting Gesture*

The lateral-only conducting gesture used in this study is a right-hand movement that travels sideways from its starting point to the right. The arm starts with the elbow making a 90-degree angle approximately three inches from the conductor's side, the hand is slightly cupped in front of the conductor. For ease of motion, I followed Brody and Hall (1999) and Hoppenfeld (1976) by using a forearm in the middle position (mid-point of supination and pronation), as it is the most common forearm position. The wrist, although relaxed, does not bend or move in any direction, the forearm follows the hand, and the elbow moves slightly. The finishing point of the gesture is to the right side of the conductor, 18 in. from its starting point. Figure 2 illustrates the starting and finishing points of this lateral-only conducting gesture.



Figure 2. Lateral-only gesture.

Both the vertical-only and lateral-only gestures begin at the same point, and both travel 18 inches. The palm of the hand is visible at the extension of each movement.

## **Method and Procedures**

### *Singer Participants*

Participants ( $N = 29$ ) constituted an established choir at a Midwestern university. There were 8 males (38.09%) and 21 females (72.41%), ranging in age from 18 to 32 years ( $M = 21.24$  years).

Participants completed a short demographic survey that outlined their previous musical experiences (Appendix A). All participants reported choral experience previous to membership in this ensemble, with an average of 2.93 years of collegiate choir membership. Less than half of the participants ( $N = 12$ , 41.38%) reported instrumental conducting experience, and about a third of the participants ( $N = 10$ , 34.48%) reported choral conducting experience.

### *Expert Listeners*

An expert listening panel ( $N = 8$ ) of experienced choral music educators ( $M = 15.3$  years of choral conducting experience) participated in a portion of this study. Each listener also had experience in adjudicating choral performances. Panelists ranged in age from 27 to 54 ( $M = 37.8$  years). Six panelists were male and two were female. No listener reported any known hearing problems.

### *Sung Melody*

The melody of the Welsh folk song, "All Through the Night," served as the sung musical excerpt for this study (see Figure 3). This melody had an octave range, simple phrasing, and a moderate tempo.

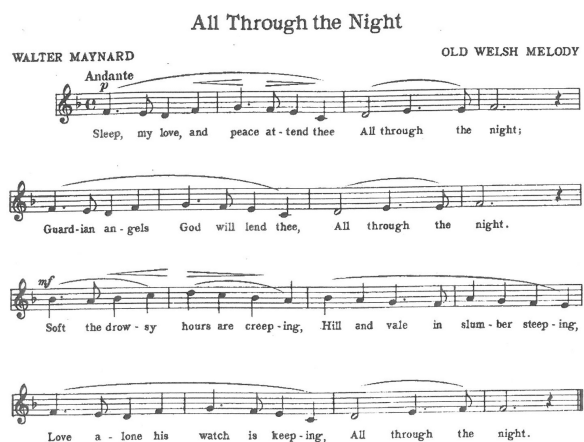


Figure 3. The sung melody.

### Rehearsal Procedures

Choir singers participated in three ten-minute rehearsals on three separate days prior to a recording session. Rehearsals occurred in the same hall used for the recording session.

Singers stood in randomly assigned positions on a three-step choral riser (Wenger Corporation Tourmaster). These standing positions remained consistent throughout the rehearsals and recording session. Inter-singer spacing (18 in.) likewise remained consistent.

The researcher served as the conductor. During rehearsals of the musical excerpt, I conducted the first measure with a traditional conducting pattern (in four). Thereafter, I used no arm gestures in rehearsing the song. I cued successive entrances by modeling the breath. Singer participants demonstrated they could perform the melody from memory by the end of the third rehearsal.

### Stimulus Conductor Videos

For the recording session, I employed videotaped conducting to insure tempo consistency and consistency of non-gestural conducting behaviors (e.g., eye contact, facial affect, body stance) among the sung trials. In preparing these stimulus videos, I used a

metronome (MM = 88), a mirror, and a ZOOM Q3 Handy Video Recorder while practicing each of the three conducting conditions. I then viewed video-recorded results for any inconsistencies, other than conductor right arm gestures. I repeated this cycle until each conducting condition exhibited the consistencies sought.

A panel of three experienced choral conductors viewed the resultant stimulus video to compare and analyze each of its three conducting conditions. Panel members could view portions of the video as many times as desired, and they could pause the video to make frame by frame comparisons. I directed each panelist to compare specifically the three conducting conditions for any differences in conductor facial expression and posture, and to analyze each conducting condition for any differences in hand shape and the size of the particular gestural strategy employed. I also asked the panelists to focus on one of these specific aspects during each viewing. Panelists viewed the video a minimum of six times, each viewing focused on one specific aspect of the conductor or gesture. All panel members confirmed that between each condition conductor facial expression and posture remained consistent, and within each condition gesture size and hand shape remained consistent. Panelists confirmed that the only differences they noted between conditions were changes in right arm gestural direction behaviors.

The stimulus video contained three conducted renditions of the entire melody, presented in this order: (a) traditional pattern only (in four), (b) traditional pattern contrasted with vertical-only gesture, and (c) traditional pattern contrasted with lateral-only gesture. In the two renditions that included vertical-only and lateral-only gestures, I conducted a traditional four pattern in measures 1-2, 5-6, and 13-14. I used vertical-only and lateral-only gestures for the phrase, "all through the night"

at measures 3-4, 7-8, and 15-16, and for the entire third line ("soft the drowsy hours are creeping, hill and vale in slumber steeping"), measures 9-12. One vertical-only or lateral-only gesture lasted for one measure. Thus, in measures 9-12, the vertical-only or lateral-only gesture occurred four times.

I justified this procedure for the stimulus video on the following grounds: (a) LTAS analyses require at a minimum recordings of about 50 - 60 seconds for the most credible results; (b) Each rendition of "All Through the Night" lasted 60 seconds, but it would be highly unlikely, for instance, that a conductor would employ a lateral-only gesture for the entire performance of this melody; (c) Therefore, to satisfy LTAS requirements (in order to have an acoustical dependent measure for this study) and to maintain naturalistic conductor stimuli, I decided to employ the vertical-only and lateral-only gestures only in the selected measures and phrases specified above.

This research decision resulted in two conditions during which I employed a traditional pattern for 22 seconds and either a lateral-only or vertical-only gesture for 38 seconds, yielding a context in which the lateral-only and vertical-only conditions lasted for 63% of each recording. Because LTAS measures may identify persisting spectral events across a period of time, I thought this percentage of time would be sufficient to reveal whether or not the lateral-only or vertical-only stimuli could affect the mean timbral energy of the sung conditions in which they were employed.

### *Recording Session Procedures and Equipment*

During the recording session, singers viewed a life-sized projection of the videotaped conducting, as determined by my standing next to the projection prior to the recording session. Risers were positioned 15 ft. from the projected videos, a distance commonly assumed by conductors during choir rehearsals in this room.

An Edirol R-109 digital sound recorder captured each performance at a sampling rate of 44.1 kHz (16 bits) in .wav format. The recorder was placed 3.8 m (10 ft. 1 in.) from the front row of the choir, in a mixed to diffuse sound field, at a height of 1.65 m (5 ft. 4 in.), or approximate conductor ear height. Volume and gain controls were set manually at the beginning of the recording session, and 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).

Each sung trial was one minute in duration, with ten seconds between trials. Choir members spent a total of 3.5 min in the recording session.

### *Singer Survey*

Immediately after the recording session, singer participants completed a brief three-item questionnaire: (a) What differences if any, did you notice in the conductor's gestures between the three performances? (If you noticed any differences, please describe briefly); (b) Did you perceive your own vocal sound varied between the three conducted performances? (If you noticed any differences, please describe briefly); (c) Did you perceive the overall sound of the choir varied between the three conducted performances? (If you noticed any differences, please describe briefly).

### *Long-term Average Spectra Measurements*

I obtained long-term average spectra (LTAS) data from the choir recordings 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 Blackman window. I used data from one channel of the Edirol R-109 recordings, because differences between the two channels were negligible. I then transferred obtained data to an Excel spreadsheet for subsequent statistical analyses.

For pitch analysis, I extracted from the recordings each of the sustained /a/ vowels ( $N=3$ ) in the repeated word “night,” the /a/ vowel of “hours,” and /ʌ/ vowel of “slumber” in the bridge phrase that begins with the text, “soft the drowsy.” I then used a one second excerpt from the midpoint of each of these vowels to compare intonation among the sung trials.

The Max/MSP configuration (See Figure 4) produced a sinusoidal reference tone set initially to the score notated pitch for each extracted sustained vowel. Intensity of the sine wave output was constant for all conditions.

I repeated the same procedures for all excerpts 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 .89.

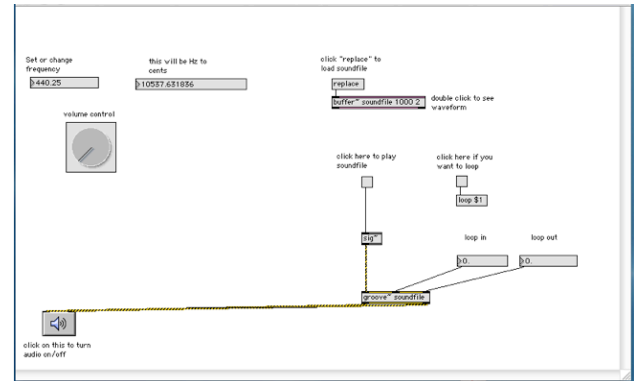


Figure 4. Max/MSP Configuration.

Members ( $N = 8$ ) of the expert panel listened to recordings in a quiet room through AKG 240 headphones. Trimmed .wav recordings were transferred to a compact disc, which was then played on a Sony Compact Disc Player (CDP-497) connected to a PreSonus HP4 distribution amplifier. Volume controls remained consistent. At no time was there compression of the electronic signal.

After hearing each pair of performances, listeners responded to two questions (see Appendix B). They first indicated if they heard a difference between the paired performances by means of five-item scale (*No difference, Little difference, Not sure, Much difference, Very much difference*). Listeners then used a modified Visual Analog Scale (VAS) to rate the overall tone quality (*Less pleasing to More pleasing*) of the second performance compared to the first performance in each pair.

## Results

Results are presented according to the research questions posed for this investigation. A pre-determined alpha level of .05 served to indicate significance for all statistical procedures.

### *Research Question One: Long-Term Average Spectra (LTAS)*

The first research question inquired if long-term average spectra (LTAS) data would indicate acoustical differences between the choir's performances under the three conducting conditions. These results are presented first with

reference to the entire spectrum examined (0 - 10 kHz), then for the 2.9 - 3.9 kHz spectrum, a region that includes frequencies to which human hearing is most sensitive (Fletcher & Munson, 1933), and thirdly, with reference to the 4.6 to 5.7 kHz spectrum, a region in which variations in the voice signal may contribute to human hearers' discriminations between the qualities of voiced sounds.

**0 - 10 kHz spectrum.** Figure 5 presents obtained LTAS contours across the 0 - 10 kHz spectrum according to three gestural conditions (traditional pattern, traditional pattern alternating with a vertical-only gesture, and traditional pattern alternating with a lateral-only gesture).

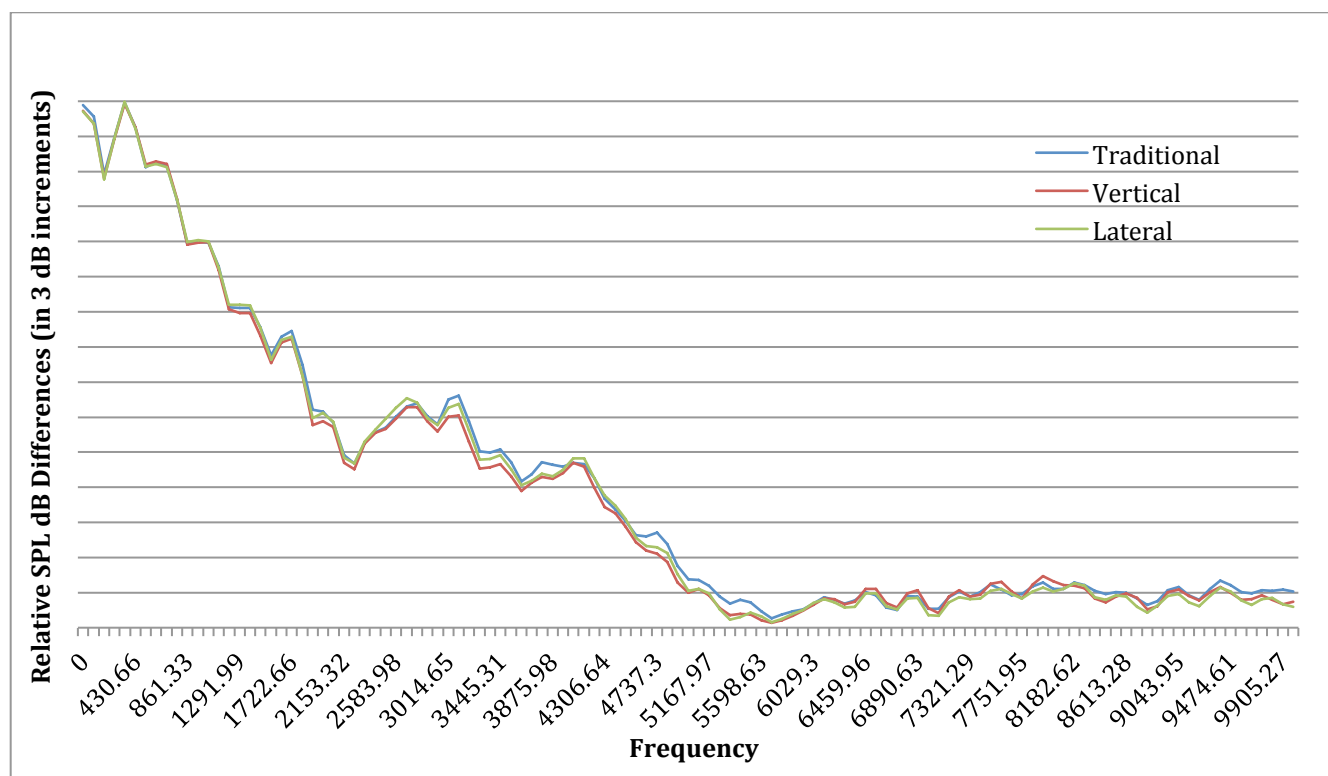


Figure 5. LTAS of the three singing trials across the entire 0 - 10 kHz spectrum.

Comparisons of differences among the three sung conditions indicated a slight decrease in the mean signal energy of higher frequency partials in the hybrid conditions (traditional

pattern with vertical-only, traditional pattern with lateral-only) in relation to the traditional pattern-only condition.

Entire (0 - 10 kHz) spectrum grand mean

differences and ranges were: (a) traditional pattern-only vs. traditional pattern with lateral-only gesture ( $M = 0.44$  dB, range: 0.01 to 1.48); (b) traditional pattern-only vs. traditional pattern with vertical-only gesture ( $M = 0.53$  dB, range: 0.01 to 1.78 dB); and (c) traditional pattern with lateral-only gesture vs. traditional pattern with vertical-only gesture ( $M = 0.38$  dB, range: 0.01 to 1.03 dB).

Results of a one way repeated measures ANOVA indicated a significant effect ( $F [2,115] = 52.070, p < .001$ ). Three follow-up paired  $t$ -tests (two-tailed) measured specific differences in the model with a Bonferroni adjustment of alpha levels to provide

conservative tests of significance ( $p = .05/3 = .017$ ).  $T$ -test results indicated significant statistical differences ( $p < .001$ ) between the traditional vs. traditional with vertical-only conditions and the traditional vs. traditional with lateral-only conditions. The  $t$ -test comparing the traditional with vertical-only and the traditional with lateral-only conditions did not yield statistical significance with the Bonferroni adjustment ( $p = .023$ ).

**2.9 – 3.9 kHz region.** Figure 6 compares the trials within the 2.9 – 3.9 kHz frequency region. This spectrum includes frequencies to which the human ear is most responsive.

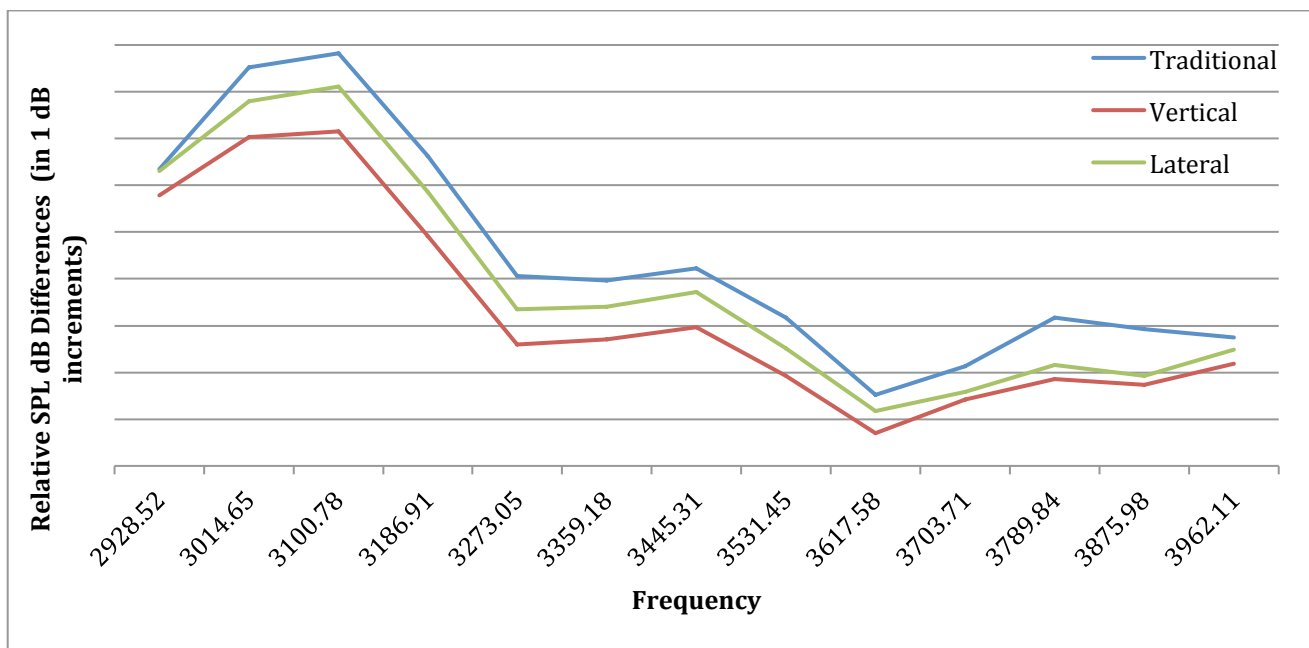


Figure 6. The 2.9 – 3.9 kHz region LTAS of the three performed conditions.

As occurred with the entire spectrum (0 - 10 kHz) data, comparisons of differences among the three sung conditions in the 2.9 – 3.9 kHz region indicated a decrease in the mean signal energy of higher frequency partials in the hybrid conditions (traditional pattern with vertical-only, traditional pattern with lateral-only) in relation to the traditional pattern-only condition.

However, these contrasts were more robust in the 2.9 – 3.9 kHz region.

The 2.9 – 3.9 kHz range grand mean differences and ranges were: (a) traditional pattern-only vs. traditional pattern with lateral-only gesture ( $M = 0.60$  dB, range: 0.05 to 1.01 dB); (b) traditional pattern-only vs. traditional pattern with vertical-only gesture ( $M = 1.17$  dB,

range: 0.56 to 1.72 dB); and (c) traditional pattern with lateral-only gesture vs. traditional pattern with vertical-only gesture ( $M = 0.57$  dB, range: 0.16 to 0.96 dB).

A one way repeated measures ANOVA found a significant effect ( $F [1,12] = 548.532, p < .001$ ). Three follow-up paired  $t$ -tests (two-tailed) measured specific differences using Bonferroni adjustments ( $p = .05/3 = .017$ ).  $T$ -

test results revealed significant differences ( $p < .001$ ) in mean signal amplitude in the 2.9 – 3.9 kHz region among all conditions compared.

**4.6 to 5.7 kHz region.** The conditions with vertical-only and lateral-only gestures, moreover, contributed to mean signal amplitude decreases in the 4.6 to 5.7 kHz frequency region. See Figure 7.

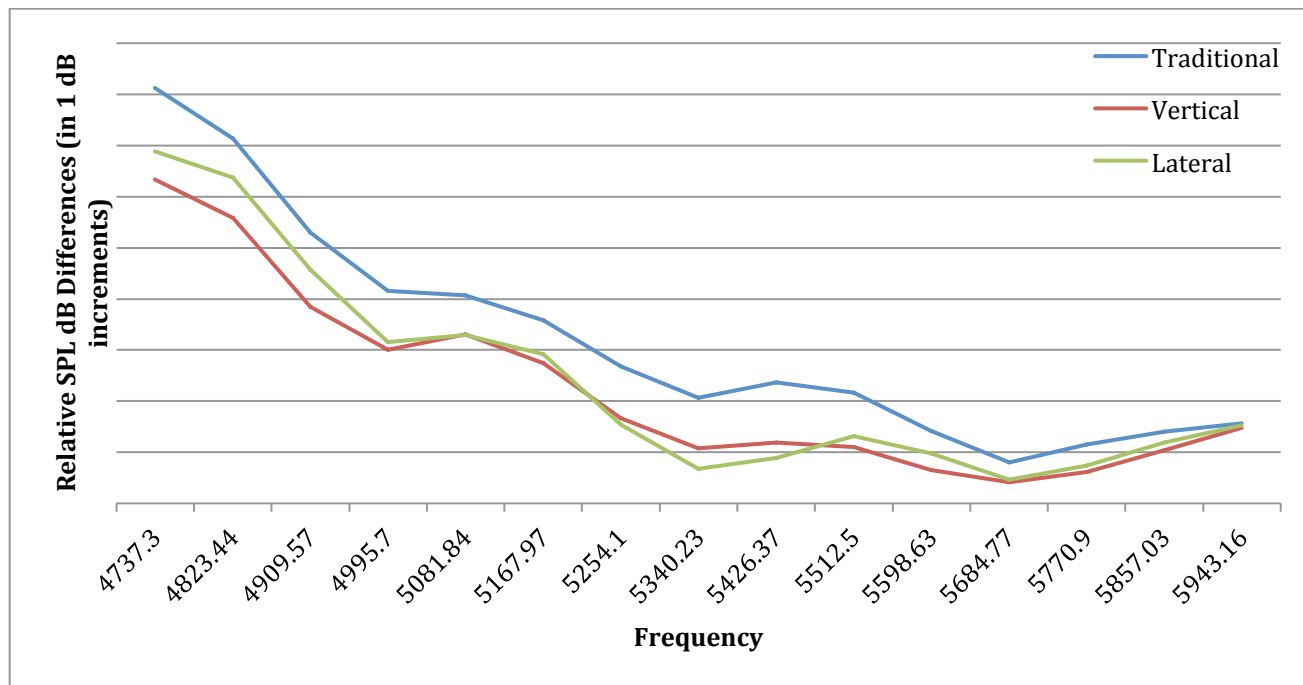


Figure 7. The 4.6 – 5.7 kHz region LTAS of the three performed conditions.

Studies by Ternström (2008), Titze, and Jin (2003), and Monson, Lotto, and Ternström (2011) have suggested that variations in the voice signal above 4 - 5 kHz could contribute data useful to human hearers as they discriminate between the qualities of voiced sounds. Comparison between traditional-only and traditional with lateral-only conditions in the 4.6 to 5.7 kHz frequency region indicated a mean amplitude decrease of 0.86 dB (range: 0.34 - 1.48 dB) in 4.6 to 5.7 kHz partials, while comparison between traditional-only and traditional with vertical-only conditions yielded a mean decrease of 1.05 dB (range: 0.39 to 1.78

dB).

A 1 dB variance in signal amplitude constitutes a just noticeable difference for complex musical sounds depending on the nature of the sound and the hearing acuity of the listener (Howard & Angus, 2006). Thus, listeners could possibly detect the 1 dB+ differences exhibited by the mean signal energy of higher frequency partials as the choir performed under the three gestural conditions, particularly in those frequencies to which human hearing is most sensitive.

A one way repeated measures ANOVA found a significant effect ( $F [1,14] = 25.208, p$

< .001). Three follow-up paired *t*-tests (two-tailed) measured specific differences in the model with Bonferroni adjustments ( $p = .05/3 = .017$ ). *T*-test results revealed significant differences ( $p < .001$ ) in mean signal amplitude in both pairings with the traditional pattern. The vertical-only and lateral-only pairing was not statistically significant ( $p = .075$ ).

### Research Question Two: Perceptual Measurements

The second research question asked if there would be significant differences among the three performances according to perceptual measures of intonation and tone quality. Intonation results are presented first, followed

by results from the panel of expert listeners.

**Pitch analysis.** Using Max/MSP pitch analysis procedures, I compared six sung pitch measurement points (starting pitch, midpoints of the /a/ vowel of each “night” ( $N = 3$ ), midpoint of the /a/ vowel of “hours,” and /Λ/ vowel of “slumber”) in each of the three conducting conditions with the scored pitches of the “All Through the Night” melody. For purposes of this study, in tune or out of tune singing was qualified by the measurement of  $\pm 7$  cents (Sundberg, 1982).

As illustrated in Figure 8, the choir sang slightly under the notated pitch at most all measurement points, but the vertical gesture elicited the most in tune singing.

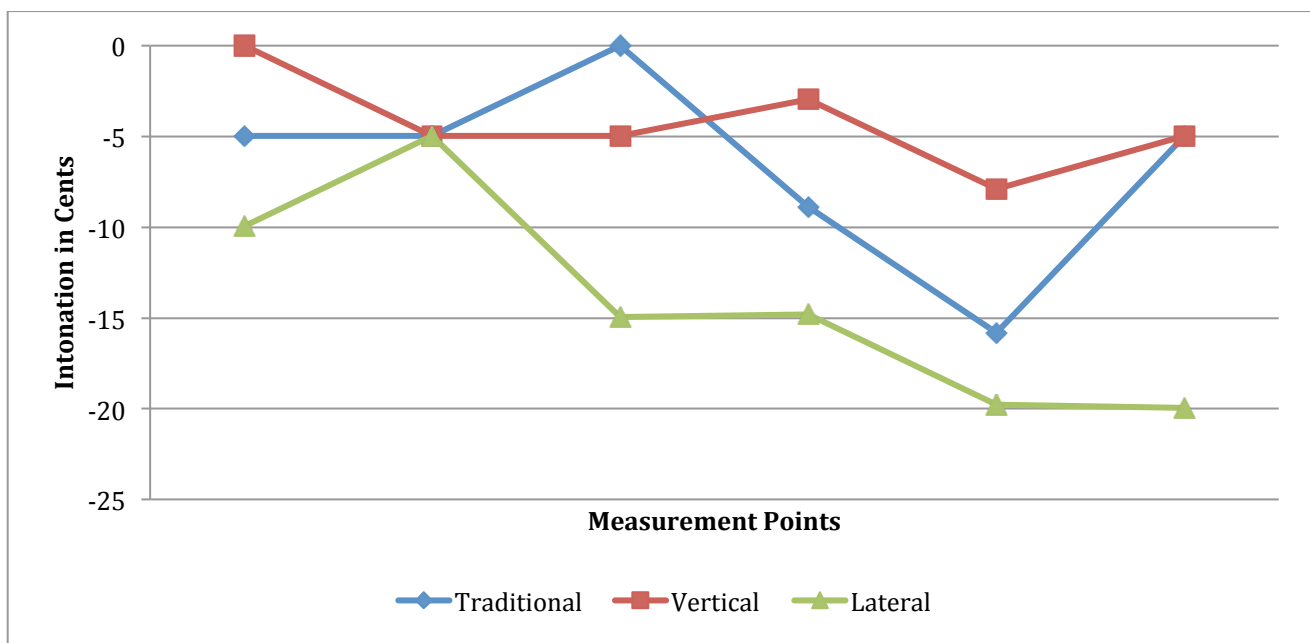


Figure 8. Max/MSP pitch analyses per three conducting conditions.

Note. Measurement Points: Starting Pitch, First /a/ Vowel, Second /a/ Vowel, /a/ Vowel of “hours,” /Λ/ Vowel of “slumber,” Third /a/ Vowel-Final Pitch.

Overall mean pitch deviations were as follows: (a) 4.29 cents for the vertical-only conducting condition, (b) 6.59 cents for the traditional pattern condition, and (c) 14.07 cents for the lateral-only conducting condition.

**Expert listening panel.** Table 1 presents results from expert listeners ( $N = 8$ ) who listened to six counterbalanced and randomly ordered pairs of performances of measures 9 -12 (“soft the drowsy hours are creeping, hill and

vale in slumber steeping”). Each performance was sung under one of three gestural stimuli (traditional pattern, vertical-only gesture, lateral-only gesture). Listeners first reported on a Likert-type scale whether or not they heard a difference in overall choral sound between the

two performances in each pair. They then marked a visual analog scale to indicate whether they perceived the tone quality of the second performance in each pair to be more pleasing or less pleasing than the first performance.

Table 1. *Expert Panel Responses of Heard Difference, Mean VAS Score (in Millimeters), and Mean Preference*

Pairing	Heard a difference	Preference	Mean VAS in millimeters
Lateral vs. Vertical	$N = 8$ (100%) yes	Vertical, $n = 7$ (88%) Lateral, $n = 1$ (12%)	$M = +2.75$
Vertical vs. Lateral	$N = 8$ (100%)yes	Vertical, $n = 6$ (75%) Lateral, $n = 2$ (25%)	$M = -7.00$
Traditional vs. Vertical	$N = 8$ (100%) yes	Vertical, $n = 6$ (75%) Traditional, $n = 2$ (25%)	$M = +3.63$
Vertical vs. Traditional	$N = 7$ (88%) yes $N = 1$ (12%) no	Vertical, $n = 6$ (75%) Traditional, $n = 1$ (12%) No difference, $n = 1$ (12%)	$M = -1.00$
Traditional vs. Lateral	$N = 7$ (88%) yes $N = 1$ (12%) no	Traditional, $n = 5$ (63%) Lateral, $n = 2$ (25%) No difference, $n = 1$ (12%)	$M = -1.75$
Lateral vs. Traditional	$N = 6$ (75%) yes $N = 2$ (25%) no	Traditional, $n = 4$ (50%) Lateral, $n = 2$ (25%) No difference, $n = 2$ (25%)	$M = +2.00$

*Note.* Table pairings are sorted according to gestural pairs and do not necessarily reflect the chronological order in which listeners heard each pair. For the VAS score: + = more pleasing tone quality in second performance; - = less pleasing tone quality in second performance. VAS means reflect listeners' evaluations of the second performance in each pair.

As indicated by Table 1, listener evaluations consistently reflected majority preferences for particular performances both times they heard them, regardless of whether these performances occurred first or second in a performance pair. In each pair that contrasted the vertical-only gesture with either the traditional pattern or the lateral-only gesture, the majority of listeners preferred the choral sound elicited by the vertical-only gesture. Few listeners preferred the lateral-only gesture recording in any pairing, and always with a response of “little” heard difference.

### *Research Question Three: Singer Perceptions*

Upon completion of the recording session, choral singers ( $N = 29$ ) responded to a three-item questionnaire: (a) What differences if any, did you notice in the conductor's gestures between the three performances? (If you noticed any differences, please describe briefly); (b) Did you perceive your own vocal sound varied between the three conducted performances? (If you noticed any differences, please describe briefly); (c) Did you perceive the overall sound

of the choir varied between the three conducted performances? (If you noticed any differences, please describe briefly). I employed quantitative content analysis procedures (Krippendorff, 2004) to analyze participant comments.

For the first item, I sorted participant responses into the mutually exclusive and exhaustive categories of “Yes” and “No.” All participants ( $N = 29$ , 100%) reported noticing that the conductor employed different gestures. The majority of participants ( $N = 25$ , 86.21%) correctly and specifically identified the gestures used.

Most participants ( $N = 24$ , 82.76%) reported that they perceived differences in their own vocal sound (Item Two) as they sang while observing the three gestural conditions. Participants wrote 41 comments for this item. I sorted these participant comments into three mutually exclusive and exhaustive categories, i.e., according to the three conducting gestures employed. Thereafter, I sorted comments further according to whether they were positive, negative, or neutral comments in each category.

There were three discrete comments regarding the traditional conducting pattern. All three comments (100%) were negative: (a) “more clompy,” (b) “disconnected,” and (c) “controlled sound.”

With respect to the vertical conducting gesture employed in the second trial, participants wrote twenty-five discrete comments. Twenty-four were positive comments (96%), ranging from better phrasing and shaping of the line ( $n = 13$  comments), to dynamic contrast ( $n = 4$  comments), to better intonation ( $n = 3$  comments), and to perceptions of a “fuller” or more “rounded” sound ( $n = 4$  comments). One comment (4%) was negative: “I felt we were less unified in terms of rhythm.”

Singers responded with thirteen discrete comments about the lateral conducting condition. Nine of these comments (69.23%) were positive. Of the positive comments, seven participants mentioned phrasing and shaping of

the line, one taller vowels, and one simply stated, “Number three was the best.” There were three negative comments (23.08%): (a) “awkward,” (b) “unsure,” and (c) “plain/narrow vowels.” One comment (7.69%) was neutral, “I did not feel much difference.”

When asked if they perceived the overall sound of the choir varied between the three conducted performances (Item Three), 85% ( $n = 22$ ) of the participants responded “yes” and 24.14% ( $n = 7$ ) reported “no” to perceived differences. Participants wrote 31 comments for this item. I again sorted the accompanying participant comments into three mutually exclusive and exhaustive categories, i.e., according to the three conducting gestures employed. Thereafter, I sorted comments further according to whether they were positive, negative, or neutral comments in each category.

There were three comments about the traditional pattern: One positive comment (33%), “the choir was more together;” and two negative comments (67%), “straight” and “disconnected.”

Singers responded with twenty discrete comments about the perceived effect of the vertical-only conducting gesture on the choir’s sound. All twenty comments (100%) were positive. Nine of these positive comments (45%) mentioned phrasing or a “connected” and “smooth” line, four comments (20%) referred to a “fuller” sound, three comments (15%) mentioned dynamic contrast, two comments (10%) concerned unified vowels, and two comments (10%) referred to improved intonation.

Participants wrote eight discrete comments about the lateral-only conducting gesture. Six of these comments (75%) were positive: improved phrasing ( $n = 3$ ), better intonation ( $n = 1$ ), “fuller” ( $n = 1$ ), and “third was the best” ( $n = 1$ ). The other two comments (25%) were negative: “choir’s worst sound and organization” and “more flat.”

## Discussion

The primary findings of this exploratory investigation are that the conducting gestures tested (traditional pattern, vertical-only, lateral-only) appear to yield gesture-specific (a) small, but statistically significant acoustical differences in the choir's timbre (LTAS); (b) perceptual differences in this choir's intonation and tone quality (pitch analyses and expert listener ratings); and (c) perceptions by most singers of differences in their own vocal sound (83%) and differences in the sound of the choir (76%). These converging acoustical and perceptual data may lend credence to the claims by some choral pedagogues (e.g., Durrant, 2003; Eichenberger, 1994) that the direction (vertical, lateral) of particular conducting gestures could affect choral singing tone quality and intonation in nuanced ways. Such findings, however, are confined to the procedures and participants of this one study. More research is needed before these claims can be definitively confirmed or denied.

One function of an exploratory study in an under-investigated area is to identify some matters of procedure and analysis that future studies may wish to consider. The following discussion raises several such considerations.

The present study employs unison singing of a folk song by an intact university choir of mixed voices. Use of an intact choir accords logically with the stated purpose of the study, i.e., to begin testing various claims in the pedagogical literature that the direction and character of a conductor's gesture affects *choral* sound. However, various logistical and measurement issues follow from this decision.

Logistically, for example, regular university ensembles typically have tight rehearsal schedules to meet their ongoing obligation to prepare for concert performances. Using a conductor other than the ensemble's regular conductor (in order to control for potential novelty effects ensuing from that conductor

employing gestures that might be perceived by singers as out of character for that person, and in order to undertake the time-consuming preparation of the stimulus video) necessitates compromise with respect to the amount of time available for a study such as this one. These factors, coupled with a decision not to use literature from the choir's current repertoire (in order to avoid the possibility of already habituated vocal behaviors), informed the choice of a folk song sung in unison. Future studies, however, might consider use of a simple, homophonic chorale if the appropriate preparation time can be negotiated.

Use of an intact choir, moreover, considerably reduces the number of dependent acoustical measures available to assess the choir's conglomerate tone under the various conducting conditions. Had I tested singers individually, for instance, I might have employed an array of measures ranging from  $F_0$  and amplitude analyses to formant profiles and perturbation assessments. Because of the complexities of conglomerate, choral sound, however, the feasible choices remaining for acoustical (as opposed to perceptual) measurement are LTAS and one-third octave band analyses, both of which assess averaged energy of higher frequency partials across time. It might be possible to place microphones on individuals within a choir, but subsequently separating the acquired individual-only sound from the inevitably acquired sound from others nearby is an enormously intricate task, particularly for an initial exploratory investigation.

Because choral conductors typically would not employ a lateral-only or vertical-only gesture across an entire minute of performance, I decided to employ those gestures only at particular junctures, the sum of which potentially could impact overall LTAS data. As it turned out, these averaged spectral data do suggest small, gesture-specific influences on choral timbre because nothing else changed

between the recorded conditions. Still, in future studies the use of a multi-versed homophonic chorale, particularly one with fermatas at ends of phrases (preferably phrases that end with the same vowel), might enable (a) aggregate spectral analyses at junctures where a vertical-only or lateral-only gesture could be employed more naturalistically for sustained sounds, along with (b) a more robust counter-balanced presentation of the vertical-only and lateral-only conducting gestures.

In this respect, it should be remembered that aside from the traditional pattern-only condition, the lateral and vertical conditions for LTAS analyses (though not for perceptual pitch and listener assessments) in this study were hybrid conditions, i.e., the traditional pattern (37%) combined with lateral-only or vertical-only moments (63%). Thus, the possibility cannot be excluded that at the particular moments lateral-only or vertical-only gestures are employed, the timbral energy differences occasioned by these gestures could be larger.


Some previous research (e.g., Ford, 2003) indicates listeners may prefer choral sound with reduced resonance energy in higher frequency partials. That appears to be the case with the expert listeners in the present study. On the whole, majorities of expert listeners readily reported (a) hearing differences between the choir's performances under the three gestural conditions and (b) preferring the global, overall sound of the vertical-only condition over either the traditional pattern or lateral-only conditions.

As indicated by pitch analyses, factors associated with intonation may have been contributing factors as well, because the lateral-only condition was on the whole some 14 cents flat in comparison to the scored pitches, and some 10 cents more flat than the vertical-only condition. As indicated by Sundberg (1982), variations of  $\pm 7$  cents could constitute just noticeable intonation differences for listeners.

In this study the vertical-only gesture had the palm facing down and the lateral-only gesture included the palm facing to the side. Future studies might include employment of vertical and lateral conditions where the palm posture remained consistent.

This study acquired data from one microphone located in a mixed to diffuse field conductor position. Future studies may well wish to incorporate several microphone locations in order to compare data acquired from conductor, front audience, mid audience, and back audience positions.

Increasingly, researchers are giving attention to a variety of nonverbal choral conducting behaviors. This focus may be due, in part, to considerations of efficient time use, because nonverbal directions take less time to implement than verbal descriptions.

At present, there seem to be two basic orientations to such research. Some investigations (e.g., Morrison & Selvey, 2011; Price, Morrison, & Mann, 2011) focus on conductor gesture apart from any relationship it may have to singers' sound. Other investigations (e.g., Fuelberth, 2003b, 2004; Manternach, 2009, 2011) focus on the potential effects of gestural behaviors on actual singer performance. This study falls into the latter category of investigations. As such, it appears to be one of the first studies to test specific conductor gestural behaviors in a non-laboratory setting with respect to group, choral sound, as opposed to the sound of singers tested individually. Results of this exploratory study warrant subsequent investigation of nonverbal gestural vocabulary in general, and vertical vs. lateral direction of gestures in particular.  IJRCS

### Institutional Review Board Approval and Compliance

The author obtained approval from an appropriate Institutional Review Board to conduct this research in a manner that assured the ethical treatment of participants and the confidentiality of participant information.

### Declaration of Conflicting Interests

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*Appendix A*

## PARTICIPANT DEMOGRAPHIC QUESTIONNAIRE

Participant Number: \_\_\_\_\_

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

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. If less than one year, write less than 1 year):

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

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

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

YOUNG ADULT AND/OR COLLEGE AGE Choir Participation: \_\_\_\_\_ years

ADULT AND/OR 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. If less than one year, write less than 1 year):

\_\_\_\_\_ years

Please indicate number of years of any regular, ongoing CHORAL CONDUCTING experience (If none, write zero. If less than one year, write less than 1 year):

\_\_\_\_\_ years

Please indicate number of years of any regular, ongoing INSTRUMENTAL CONDUCTING experience (If none, write zero. If less than one year, write less than 1 year):

\_\_\_\_\_ years

## Appendix B

Participant Number: \_\_\_\_\_

Circle one: Male Female Age in years: \_\_\_\_\_

Years of experience in choral conducting: \_\_\_\_\_

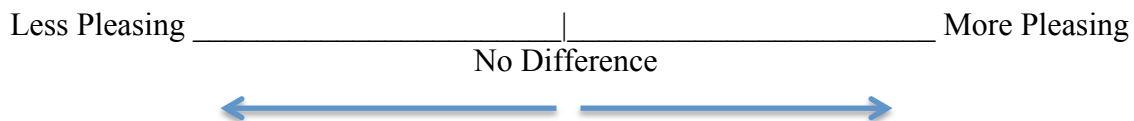
Do you have any known hearing difficulties? (circle one) yes no

PAIR 1: Listen carefully to each of these two sung excerpts. After hearing both excerpts, respond to the items below.

Comparing the overall sound of the choir in these two excerpts, I heard (circle one):

No difference Little difference Not sure Much difference Very much difference

Place a single vertical mark on the line below for how much more or less pleasing you perceived the **overall tone quality** of the *second excerpt* to be in comparison with the first performance.

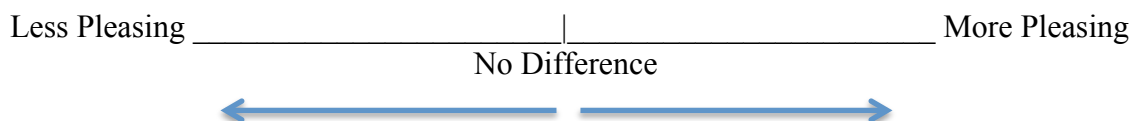


PAIR 2: Listen carefully to each of these two sung excerpts. After hearing both excerpts, respond to the items below.

Comparing the overall sound of the choir in these two excerpts, I heard (circle one):

No difference Little difference Not sure Much difference Very much difference

Place a single vertical mark on the line below for how much more or less pleasing you perceived the **overall tone quality** of the *second excerpt* to be in comparison with the first performance.

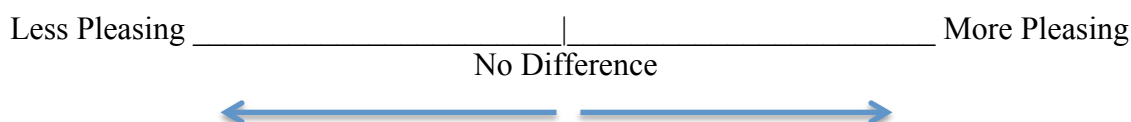


PAIR 3: Listen carefully to each of these two sung excerpts. After hearing both excerpts, respond to the items below.

Comparing the overall sound of the choir in these two excerpts, I heard (circle one):

No difference   Little difference   Not sure   Much difference   Very much difference

Place a single vertical mark on the line below for how much more or less pleasing you perceived the **overall tone quality** of the *second excerpt* to be in comparison with the first performance.

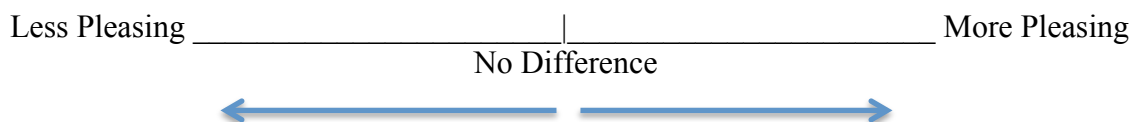


PAIR 4: Listen carefully to each of these two sung excerpts. After hearing both excerpts, respond to the items below.

Comparing the overall sound of the choir in these two excerpts, I heard (circle one):

No difference   Little difference   Not sure   Much difference   Very much difference

Place a single vertical mark on the line below for how much more or less pleasing you perceived the **overall tone quality** of the *second excerpt* to be in comparison with the first performance.

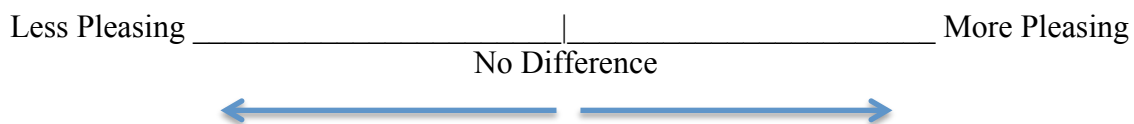


PAIR 5: Listen carefully to each of these two sung excerpts. After hearing both excerpts, respond to the items below.

Comparing the overall sound of the choir in these two excerpts, I heard (circle one):

No difference   Little difference   Not sure   Much difference   Very much difference

Place a single vertical mark on the line below for how much more or less pleasing you perceived the **overall tone quality** of the *second excerpt* to be in comparison with the first performance.



PAIR 6: Listen carefully to each of these two sung excerpts. After hearing both excerpts, respond to the items below.

Comparing the overall sound of the choir in these two excerpts, I heard (circle one):

No difference   Little difference   Not sure   Much difference   Very much difference

Place a single vertical mark on the line below for how much more or less pleasing you perceived the **overall tone quality** of the *second excerpt* to be in comparison with the first performance.

