IJRCS *International Journal of Research in Choral Singing 4* (2), 37-51

The Effects of Watching Three Types of Conductor Gestures and Performing Varied Gestures Along with the Conductor on Measures of Singers' Intonation and Tone Quality: A Pilot Study

Melissa C. Brunkan
Louisiana State University

Abstract

This three-phase investigation assessed the effects of three conducting gestures (standard conducting pattern; low, circular arm gesture; high, circular hand gesture), singer gestural training, and two singer gestures (low, circular arm gesture; high, circular hand gesture) on the intonation and perceived tone quality of individual singers' (*N* = 58) performances of a sung /u/ vowel in the context of the final phrase of a familiar song ("Happy Birthday to You"). Singer perceptions of performing while either viewing or doing specific gestures was a concomitant matter of interest.

In phase one of the study, all participants sang the song while watching a videotaped conductor who alternately employed three conducting gestures (standard pattern, high, circular hand gesture and low, circular arm gesture). In phase two, 38 singer participants were randomly assigned to two performance groups: a control group (*n* =19), which practiced singing to the sound of a metronome, and an experimental group (*n* = 19), which received gestural training by practicing with a videotaped instructor. In phase three, a second experimental group (*n* = 20) physically replicated the displayed conductor circular gestures as they sang. All singer performances were digitally recorded for subsequent analysis of fundamental frequency and for listener evaluations. A panel of experienced voice educators (*N* = 10) rated singers' tone quality (breathy, balanced, pressed-edgy) and intonation (flat, in tune, sharp) on a continuous visual-analog scale upon hearing pre-and posttest audio samples from each participant.

Among primary findings: (a) statistically significant main intonation effects for type of gesture by group in posttests, though not in the baseline pretest; (b) significant differences in cents deviation from target fundamental frequency according to gestural condition among participants who mimicked the conductor's gestures (more in tune singing with the low, circular arm gesture in the post-test); (c) significant differences in expert ratings, indicating that the most balanced singer tone quality occurred while either observing or doing the low gesture, and the most pressed and breathy perceptions of tone quality occurred while either observing or doing the high gesture; and (d) singers most frequently reported that the low gesture evoked a feeling of deeper breath, the high gesture abetted a lighter, though tense sound, and the standard gesture afforded a sense of familiarity.

Results were discussed in terms of singing pedagogy, limitations of the study, and suggestions for further research.

Keywords

singing with gestures, solo singing, choral pedagogy, singer intonation, singer tone quality

Corresponding Author: Melissa C. Brunkan. Email: mbrunkan@lsu.edu

Although the use of movement has long been incorporated in general music curricula associated with pedagogies advanced by Orff, Kodaly, and Dalcroze (Elliott, 2005), a segment of modern choral methods literature increasingly references singer gesture as a tool for evoking certain nuances in choral ensemble sound. For example, Cooksey (1992) recommended, "utilizing kinesthetic movement as an essential element of warm-ups and choral singing," suggesting that "the body's physical, emotional, and intellectual responses are released through appropriate movement activities" (p. 37). Pierce (2007) advocated movement as a means to vitalize musical elements such as melody, rhythm, phrase shaping, and tone. Linklater (1976) offered that physical awareness is necessary to achieving full vocal efficiency. Thurman and Welch (2000) suggested that singer movement during rehearsal time assists in such vocal training goals as efficient breath flow, easy inhalation and exhalation, efficient sound production, and body awareness.

According to Eichenberger (Eichenberger & Thomas, 1994), particular singer gestures, such as low arm circles and high circles, will energize singing, give tone more depth, aid intonation, and connect the sound to the breath. Eichenberger (2001) also suggested that once singers have experienced performing particular gestures and movements, teachers who incorporate aspects of these actions into conducting behaviors will remind choristers of what they experienced previously, and thus evoke the sound achieved when singers actually performed the particular movements or gestures.

Some anecdotal articles have discussed singer movement in choral rehearsals and vocal lessons. One such article (Peterson, 2000) recommended having singers mirror the conductor's gestures in order to evoke certain sounds. Several descriptive dissertations have also explored these matters. Krause (1983) advocated the use of body movements and gestures to develop posture and breathing skills as well as find and develop the head voice. Wis (1993) theorized that the use of gesture and movement in a choral rehearsal might facilitate learning and enhance musical experience. She suggested that movement activities allowed choral singers to use the natural inclination of bodily-based learning, may encourage more active participation from the singer, and are less subject to misinterpretation than words.

Chagnon (2001) examined the writings of Hibbard (1994) and Wis (1993) in order to understand their respective theories of singer movement as a teaching tool in a choral rehearsal. He concluded that movement could be used to modify musical qualities such as dynamics, rhythm, tempo, articulation and intonation, as well as improving vocal skills such as breath management, posture, and projection.

Some researchers have looked at the effects of very specific conductor gestures on vocal sound. Madsen (1991), for instance, investigated the effects of conductor gestures in evoking desired sound from a choir. A chorus of university singers (N = 20) performed Orlando di Lasso's "O Occhi Manza Mia" two times under the direction of a conductor with whom they had never worked. The conductor utilized an amorphous group of simultaneous gestures intended to evoke good vocal sound every one or two phrases and another simultaneous group of gestures intended to evoke bad vocal sound. Thirty-six music majors and thirty-six non-music majors evaluated recordings. Ratings indicated no significant differences in preference for choral sound under either gestural condition. However, listeners most often preferred the sound of the first recording even though the recordings were counter balanced in presentation.

Grady (2012) examined whether three conducting gestures affected perceptual and acoustical measures of SATB choral sound. Participants (N = 29) performed "All Through the Night" while observing a videotaped conductor displaying (a) a traditional conducting pattern, (b) a vertical conducting gesture, and (c) a lateral conducting gesture. Results indicated that singer participants had the most positive comments about the vertical gesture, expert listeners preferred recordings of both the vertical

and traditional gesture over the lateral gesture, and pitch analyses indicated that the excerpt sung to the vertical gesture condition was most in tune while the traditional gesture condition led to the most out of tune singing.

Fuelberth conducted a series of studies in singing contexts on the effects of conductor gesture on singer tension both perceived (2003a, 2004) and actual (2003b). She found that several of these nonverbal gestures could either evoke tension or the perception of tension in singers. In another study of conductor gesture, Manternach (2011) explored potential effects of conductor preparatory gestures and conductor head and shoulder movements on the upper body movement of individual choral singers. Results showed that singers moved their heads in the vertical direction more when the conductor moved his head upwards. Participants also showed more vertical shoulder movement during conductor shoulder movement. Results indicated that singers may mimic certain conductor movements.

Daugherty and Brunkan (2013) investigated possible singer mimicry of conductor lip rounding behavior. Participants (N = 114) performed the opening phrase of "Ave Verum Corpus" by Mozart while watching a videotaped conductor who alternately displayed neutral and rounded lips on the two /u/ vowels in the phrase. Expert judges (N = 7) viewed counterbalanced still photos of all participants for each condition and steady state portions of all sung /u/ vowels were excerpted for acoustical analysis. Visual analysis results indicated that 90% of participants showed more lip rounding while singing both /u/ vowels in the experimental condition as compared with baseline. Formant frequency profiles indicated that 90% of singers lowered all examined formant frequencies each time the conductor rounded his lips. In a subsequent study, Manternach (2012), using infrared motion capture technology, obtained similar results with respect to singer mimicry of conductor lip rounding. The singers (N = 47) in his study, moreover, rounded their lips more in posttest conductorless singing compared to pretest conductorless singing, suggesting a possible training effect.

These investigations by Madsen (1991), Fuelberth (2003a, 2003b, 2004), Grady (2012), Manternach (2011, 2012) and Daugherty and Brunkan (2013) have begun to assess singer responses to gestural, postural, and facial behaviors displayed by conductors, using a variety of measurements. No empirical study to date, however, tests whether singers who watch or simultaneously watch and perform particular gestures recommended in pedagogical literature will evidence changes in intonation and tone quality.

The purpose of this three-phase exploratory investigation was to assess the effects of three conducting gestures (standard conducting pattern; low, circular arm gesture; high, circular hand gesture), singer gestural training, and two singer gestures (low, circular arm gesture; high, circular hand gesture) on the intonation and perceived tone quality of individual singers' (N = 58) performances of a sung /u/ vowel in the context of a familiar song.

The following research questions guided the three phases of this investigation.

Phase One:

1. Are there significant baseline differences in fundamental frequency among participants' (N = 58) performances of a sung /u/ vowel as they observed a conductor alternately displaying three gestural conditions (standard gesture, low gesture, and high gesture)?

Phase Two:

2. Are there significant pre- and posttest differences in (a) fundamental frequency, (b) intonation (according to expert panel perceptions) or (c) tone quality (according to expert panel perceptions) in performances of a sung /u/ vowel as singers observed and performed gestures with a conductor alternately displaying three gestural conditions (standard gesture, low gesture, and high gesture) among participants who observe the gestures (Singer Observation of Gesture (SOG) Group) and those who do not observe the gestures (Control Group) (N = 38)?

3. What do participant comments suggest about perceptions of Control Group and Singer Observation of Gesture (SOG) Group performances?

Phase Three

4. Are there significant pre- and posttest differences in (a) fundamental frequency, (b) intonation (according to expert panel perceptions) or (c) tone quality (according to expert panel perceptions) among performances of a sung /u/ vowel by participants in the Singer Performance of Gesture (SPG) group ($N = 20$) as singers both observed and performed gestures with a conductor alternately displaying three gestural conditions (standard gesture, low gesture, and high gesture)?

5. What do participant comments suggest about perceptions of Singer Performance of Gesture (SPG) group performances?

Definitions

The following definitions inform this study:

High, circular hand gesture: hands on either side of head at eye level, with fingers together pointing towards the face, moving upward and outward in circles (see Figure 1).

Figure 1. Participant performing the high, circular hand gesture

Low, circular arm gesture: hands, with fingers together, moving upward and outward in circles in front of the torso (see Figure 2).

Figure 2. Participant performing the low, circular arm gesture

Training: singers in two experimental groups (SOG and SPG) sang while watching a conductor doing the circular gestures, three times with high circles and three times with low circles. One experimental group simply watched (SOG) and sang (phase 2), the other experimental group was asked to do the gestures (SPG) as they sang (phase 3).

Deviation in the cents from target fundamental frequency: For each participant, the fundamental frequency (F_o) of each sung /u/ vowel and the target fundamental frequency as notated by the score were compared by converting the difference in measurements in Hz to measurement in cents (1200 cents are equal to one octave). Deviations from target fundamental frequency were then expressed in deviations in cents.

Intonation: For purposes of this study, in tune or out of tune singing was qualified by the measurement of ±7 cents difference from target fundamental frequency, a measurement possibly perceived by the human ear (Lindgren & Sundberg, 1972). Any deviation greater than 7 cents was considered out of tune.

Method

Singer Participants

Participants (N = 58) constituted a convenience sample (males = 21, 36% and females = 37, 64%) recruited by word of mouth from music classes at a large University. Most participants were music majors (n = 55, 95%). Participants ranged in age from 18-31 years (M = 21 years). A majority of participants reported previous choir singing experience (n = 57, 98%). Twenty-six (45%) participants reported previous private voice study, twenty-one had prior experience in dance lessons (36%) and thirty-seven participants (64%) indicated more than two years of conducting experience. All participants stated that they were familiar with the song excerpt and could sing it without reference to a score.

Prior to the commencement of phase one of the study, I randomly assigned all singers to one of three groups for phases two and three of the study: (a) a control group (practice with a metronome), (b) a Singer Observation of Gesture (SOG) training group, and (c) a Singer Performance of Gesture (SPG) training group. Participants in each group sang the phrase while watching a videotaped conductor under three conditions for the pretest and posttest (standard conducting pattern, high, circular gesture, and low, circular gesture).

Expert Participants

An expert listening panel (N = 10) of experienced voice educators participated in a portion of this study. Panel members' experience in choral conducting and private voice teaching ranged from two to thirty years (M = 11 years, SD = 9 years). Panelist ranged in age from 28 to 54 years of age (M = 36.4 years, SD = 7 years).

Materials

The sung musical excerpt utilized for this study consisted of the final phrase of the melody line of "Happy Birthday to You." This particular phrase was selected because it was likely familiar to participants, lent itself to a moderate tempo, and it contained two /u/ vowels in the words "to" and "you." I used the sustained /u/ vowel on the word "you" for analyses.

Videotaped conducting served as a control for potential variability in conductor behaviors and to ensure all participants were responding to the same stimuli. The conductor used a metronome (MM = 85) and a mirror to develop a consistent production within the three conducting conditions: (a) standard conducting pattern in 3/4, (b) a low, circular arm gesture (experimental condition 1), and (c) a high, circular hand gesture (experimental condition 2). The conductor employed each gesture throughout the conducted phrase, one gesture or condition for each repetition of the phrase.

Video recordings were digitally acquired with a Sony HVR-CIU camcorder in standard deviation mode and audio was acquired through the internal microphone on the camcorder. The researcher/conductor was lit with two diffused video lights, one on each side, and a third overhead video light to provide separation from a blue screen backdrop. The video was framed to contain the conductor from waist-level to approximately one foot above the head.

Preparation of the video entailed frequent visual examinations for consistency of conducting plane, gestures, and facial affect as measured by (a) freeze framed comparisons both within and between conditions and (b) viewing a screen with real-time playback of the video. A panel of three experienced voice educators reviewed the final stimulus DVD with respect to consistency of facial affect and conducting

gestures. Each evaluator attested the only change noticeable was the size and plane of the arm movement in the experimental conditions.

Procedures

Upon entering the research room, participants completed an information sheet/signed consent form and a brief questionnaire that solicited demographic information such as singing experience, age, and training. Upon completion of the questionnaire, I played the musical excerpt once on a keyboard (MM = 85) in the key of D Major. All participants sang individually. Participants rehearsed the phrase until they felt comfortable singing the phrase in the given key and at the given tempo.

The stimulus videotape was projected such that the conductor appeared life size, as determined by having the conductor stand beside the projected image prior to the study. Prior to each condition, participants stood with toes on a marked line 10 feet from the projected image. Next, participants heard the starting pitch blown live on a pitch pipe (G4) by the researcher and were given instructions on following the videotaped conductor. Participants then sang the excerpt a cappella and from memory as they viewed the videotaped conductor in each of the conducting conditions.

Singers viewed the conducting conditions in an order varied for each participant according to a Latin square, creating a random and unique ordering of conditions for each participant. Six versions of ordering were presented in each group and balanced by assigning each version to every sixth participant.

The second phase of this study included the same control group and an experimental group, each of which participated in a pretest (referenced in phase 1) and posttest. All participants sang the phrase six times for the pretest, twice each while viewing a (a) standard conducting gesture, (b) high circular hand gesture, and (c) low circular arm gesture. Following the pretest, individual participants in the experimental groups viewed a training video on the song phrase they sang that included a conductor doing two gestures (low circles and high circles) with a brief verbal explanation of the gestures. Participants in the control group did not receive video training ~~n~~or watch the conductor as they sang, but instead simply sang the phrase six times to the sound of a metronome following a live blown pitch from the pitch pipe for each repetition of the phrase. Participants in Singer Observation of Gesture (SOG) Group sang each condition (low circle and high circle) three times while viewing a conductor doing the gestures. Participants in Singer Performance of Gesture (SPG) Group sang the phrase while watching a conductor as well as doing the gestures themselves. For the post-test, all participants repeated the song phrase six times as in the pre-test. All conditions were repeated three times in order to obtain a mean of effects and to control for possible novelty effect. The treatment phase of this experiment did not include the standard conducting gesture because it was used as a control condition, not performed by participants, and thought to be familiar to participants.

An Edirol R-09HR digital audio recorder acquired the individual vocal sound samples (44.1 Hz, 16 bits) used for analysis. A RCA Small Wonder EZ2000 digital video camera filmed all proceedings for reliability and archival purposes. Distance from recording devices was consistent for all participants (audio recorder: 12 inches, video camera: 20 inches).

Acoustical Measures

Audio samples were band pass filtered between 130 Hz and 13000 Hz in Adobe Audition to remove extraneous noise in the digital recordings. Following filtering, portions of the audio recording corresponding to the word "you," the end of the final phrase, were edited and coded for each participant under each condition and take. I edited the sound samples using Praat software, version 5.1.43 (Boersma & Weenink, 2010). I then examined these final /u/ vowels for fundamental frequency. The middle

one second of each /u/ vowel was highlighted within the F_o contour by measuring from the beginning of the sound sample to the end, subtracting one second from the total time, and dividing the remaining time in half. The 'get pitch' function within Praat was then utilized. This tool gave a mean frequency in Hertz for each selection. Differences in frequencies were converted to cents for comparison of mean differences between sung pitch and target pitch. A mean of these differences was utilized for statistical analysis. Equal temperament was used for measurement of fundamental frequency (female (D_4) = 293.66 Hz and male (D_3) = 146.83 Hz).

Psycho-Acoustical Measures

Expert panelists individually listened at a consistent, comfortable volume level in a quiet room to twelve audio samples (six pretest and six posttest samples) from each singer participant (for a total of 696 sound samples) through AKG 240 headphones connected to a Dell Latitude E6420 laptop computer. Experts rated each sample on two visual analog scales (0 – 100): (a) intonation (*flat* = 0, *in tune* = 50, *sharp* =100) and (b) tone quality (*breathy* = 0, *balanced* = 50, *pressed-edgy* = 100).

All singer participants completed a brief survey following their post-test performances. Singer participants were asked what differences, if any, they noticed in their singing when watching the conductor doing low circles, high circles, and a standard conducting pattern. Participants in phase three of the study (SPG group) completed an additional survey that asked what differences, if any, they noticed in their singing when doing the low circles and high circles during the training phase. I coded all surveys with participant number and group identifiers for subsequent analysis.

Results

Results are presented in order of research questions posed for this investigation. A predetermined alpha level of .05 (adjusted as necessary by Bonferroni corrections) served to indicate significance for all statistical procedures.

Research Question One (Phase One)

The first research question asked if there were significant baseline differences in fundamental frequency among participants' (N = 58) performances of a sung /u/ vowel as they observed a conductor alternately displaying three gestural conditions (standard conducting pattern, low circular arm gesture, and high circular hand gesture).

A one-way repeated measures ANOVA was performed on the mean deviation in the cents from target fundamental frequency averaged over six trials with gesture type as a within subjects factor for all participants in this baseline, pretest condition. No significant variances were found.

Research Question Two (Phase Two Fundamental Frequency, Intonation, and Tone Quality)

The second research question asked if there were significant pretest and posttest differences in intonation or tone quality between control and SOG group participants' performances of the sung /u/ vowel.

A three-way repeated measures ANOVA of the control and SOG groups on deviation in the cents from target fundamental frequency with test and gesture as within subjects factors and group as the between-subjects factor indicated significant main effects in intonation according to gesture ($F(1, 35) = 3.218$, $p = .014$) and test ($F(2, 35) = 2.464$, $p = .001$).

Three follow-up paired *t*-tests (two-tailed) for each group with a Bonferroni adjustment of alpha levels (p = .05/3 = .017) yielded significant differences between conditions in the pre- versus the posttest. In the control group, the standard gesture differed significantly ($t(18)$ = .021, p<.017) pre- to posttest in deviation in cents from target frequency. In the SOG group, two conditions showed significant differences between pre- to posttest deviations in the cents from target frequency (Standard $t(19)$ = .013, p<.05 and High $t(18)$ = .000, p<.017) .

Figure 3 shows the mean deviations from target fundamental frequency by condition and group for the pre- and posttests of the control group. In the control group, participants were closer to the target fundamental frequency (sang more 'in tune') in the posttest for the viewed standard and low gestures, while they went further from the target with the viewed high gesture.

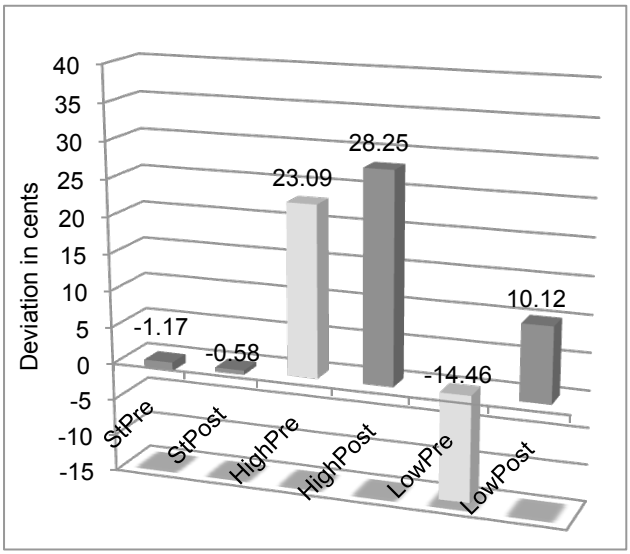


Figure 3. Control group: Mean deviation in cents from target frequency, pretest and posttest measures. ST = standard conducting pattern, High = high, circular hand gesture, Low = low, circular arm gesture.

Figure 4 shows the mean deviations from target fundamental frequency by condition and group for the pre- and posttests of the SOG group. Participants went further out of tune while watching the standard and high gestures in the posttest, but were more in tune when watching the low gesture in the posttest. The low gesture in the SOG group was the only measure that would be perceived as in tune.

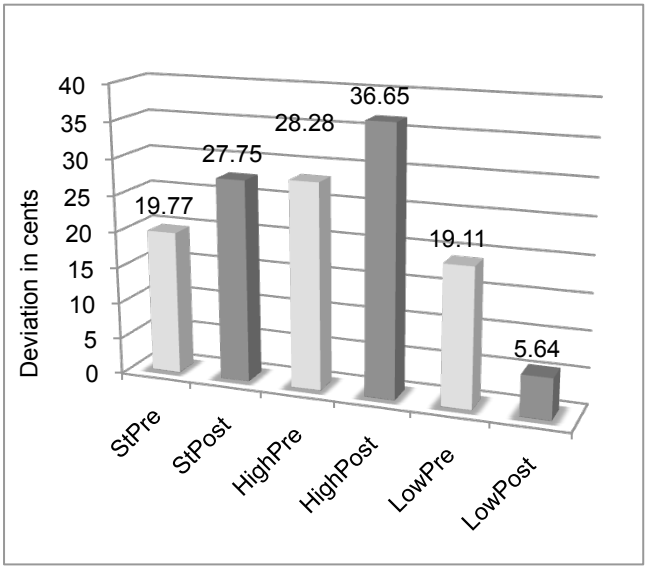


Figure 4. Singer Observation of Gesture (SOG) group: Mean deviation in cents from target frequency, pretest and posttest measures. ST = standard conducting pattern, High = high, circular hand gesture, Low = low, circular arm gesture.

Comparison of posttest measures. Paired sample t-tests of the two groups comparing conditions during the posttest measured specific differences in the model with a Bonferroni adjustment of alpha levels to provide conservative tests of significance (p = .05/2 = .025) and indicated some significant differences. In the control group, two comparisons were significant: (high/standard $t(18)$ = .024, p<.025 and low/standard $t(18)$ = .007, p<.025). For the SOG group, one comparison indicated significant differences in deviation in the cents from target fundamental frequency (high/standard $t(19)$ = .000, p<.025).

Expert panel perceptions of intonation. In both the control (M = 54.43, SD =11.25) and SOG (M = 56.73, SD = 9.27) group

performances, listeners rated intonation most "sharp" during the viewed high gesture condition. They perceived intonation as most "in tune" during the low gesture observations of both the SOG group (M = 50.25, SD =11.18) and the control group (M = 49.85, SD =9.72). There were significant differences between posttest ratings of intonation by gesture for the SOG group ($F(2, 54) = 8.484$, $p = .001$) and for the control group ($F(2, 54) = 1.748$, $p = .18$).

For both the control and the SOG groups, the F_o measures and perceptions of experts indicated that singers sang more 'sharp' during the high gesture in the posttest compared to the pretest. Expert ratings indicated that singers sang most in tune during the low gesture condition in both the pretest and posttest.

Expert panel perceptions of tone quality. Listeners assessed the tone quality of sound samples on a visual analog scale (0 – 100: *breathy* = 0, *balanced* = 50, *pressed-edgy* = 100). Results of a one-way repeated measures ANOVA with gesture as the within subjects factor indicated significant variance between posttest ratings of tone quality for the SOG group ($F(2, 54) = 11.22$, $p < .01$) but no significant variance for the control group ($F(2, 54) = 1.748$, $p = .05$). The instances judged as presenting the most balanced phonation were the control (M = 50.25, SD =10.25) and the SOG group (M = 49.85, SD = 14.36) performances while observing the low gesture. When hearing the control group performances, listeners perceived the most pressed phonation during the high gesture observation (M = 59.93, SD = 9.53). In the SOG group performances, listeners judged the high gesture observation singing as most breathy (M = 47.67, SD = 12.58).

Research Question Three (Phase Two Participant Perceptual Data)

The third research question inquired about singer perceptions of control and SOG group performances.

Singers in the control and the SOG groups responded to a questionnaire that asked: What difference(s), if any, did you notice in your singing when watching conductor movement with (a) low arm circles, (b) high arm circles, and (c) standard conducting pattern? I sorted discrete comments about each gesture into mutually exclusive and exhaustive categories. Comments about the low gesture fell into three categories: (a) breath, (b) volume, and (c) tone. I sorted comments on the high gesture into five categories: (a) tempo, (b) pitch, (c) overall sound, (d) breath, and (e) physical sensation and comments regarding the standard gesture fell into two categories: (a) familiarity/comfort and (b) energy. Percentages reflect the number of participants who offered comments in each category.

The most frequent singer comments with respect to observing the low, circular arm gesture described the singing as (a) engaging a deeper breath (n = 17, 29.3%), e.g., "lower breath support," "deeper breath from diaphragm;" (b) as louder (n = 12, 21%), e.g., "louder singing due to more air movement," "louder;" and (c) as conducive to a fuller tone (n = 7, 12%), e.g., "tone was fuller," "tone felt more full and musical."

The most frequent comments with respect to the high, circular gesture referred to (a) perceived faster tempo (n = 11, 18.96%), e.g. "seemed faster," "felt quicker;" (b) perceived higher pitch (n = 7, 12.06%), e.g., "higher pitched sound," "sang higher;" (c) lighter sound (n = 9, 15.51%), e.g., "more head voice and lighter," "my sound felt lighter;" (d) more shallow breath (n = 7, 12.06%), e.g., "quicker, shallow breath," "less depth to breath;" and (e) a more restricted feeling (n = 7, 12.06%), e.g., "felt more tense," "produced a narrower, more tense sound."

Comments about watching a standard conducting gesture mostly reflected these singers' familiarity with this standard pattern. Singers thought the gesture was easy to follow (n = 9, 15.52%) and comfortable (n = 7, 12.06%). Some comments, however, suggested that singing with

the standard conducting gesture prompted a feeling of less energy in the sound (n = 4, 6.89%). The variety of responses to this survey appeared to indicate that, to singers, there were perceivable acoustical and physical changes in their vocal production based on which gesture they were observing.

Research Question Four (Phase Three Fundamental Frequency, Intonation, and Tone Quality)

The fourth research question asked if there were significant pre- and posttest differences in intonation or tone quality between the SPG group participants' performances of the sung /u/ vowel as they mimicked two of the conductor's gestures (high/hand, low/arm) while singing.

Fundamental frequency. A three-way repeated measures ANOVA of the SPG group (participants who performed the gesture while singing) on deviation in the cents from target fundamental frequency with test and gestural condition as within subjects factor and group as a between-subjects factor indicated significant variance by condition ($F(2,17) = 7.573$, $p = .004$). Post hoc t-tests of pretest and posttest measures indicated that both conditions (high and low circular gestures) showed significant differences in the SPG group (high, $t(18)=.001$, $p<.025$; low, $t(18)=.01$, $p<.025$).

Figure 5 displays the mean deviation in the cents from target fundamental frequency in the pre- and posttests. The largest deviation in the cents from target fundamental frequency occurred in the pretest condition of the SPG group when observing the standard gesture (M = 14.09 cents, SD = 11.29 cents).

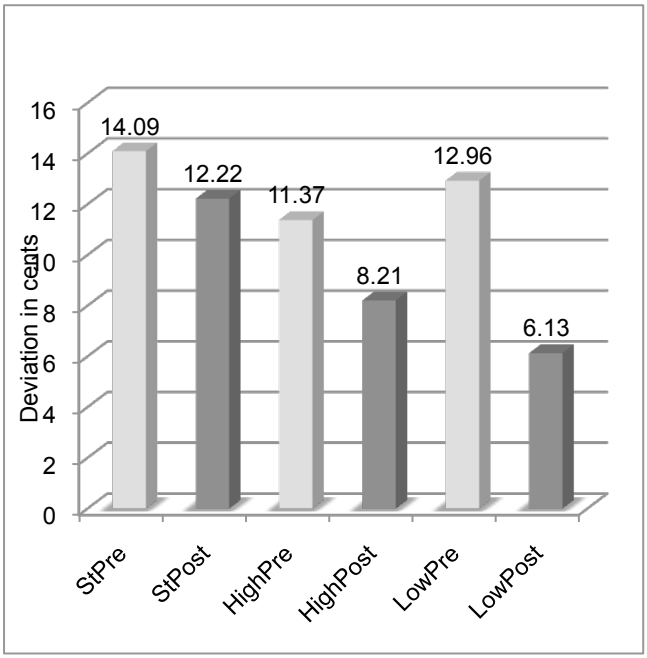


Figure 5. Singer Performance of Gesture (SPG) group: Mean deviation in cents from target frequency, pretest and posttest measures. ST = standard conducting pattern, High = high, circular hand gesture, Low = low, circular arm gesture.

Participants in the SPG group sang more in tune while watching the high and low gestures in the posttest, perhaps indicating that the high and low circular gesture and training with those gestures had the effect of more "in tune" singing following training. The low circular gesture posttest was the only instance measured as in tune (M = 6.13 cents, SD = 16.53 cents).

Measures of singing with singer gesture. Next, possible significant differences in frequency with participants in the SPG group when doing the two circular gestures during training were examined. A one-way repeated measures ANOVA of the SPG group with gestural condition and repetition as within subjects factors and deviation in the cents from target fundamental frequency as a dependent variable on the pitch indicated a significant variance according to mean deviation in the cents from target fundamental frequency by gestural condition ($F(2,16) = 7.573$, $p = .004$). A paired t-

test showed significant differences when participants sang while doing the gestures (low/high, $t(19) < .001$, $p<.05$). Singers were closer to target frequency while performing with the low gesture (M = 5.49 cents from target fundamental frequency, SD = 3.27 cents) as compared to the high gesture (M = 14.66 cents from target fundamental frequency, SD = 8.32 cents). This finding may suggest that whether singers observed a gesture or executed a gesture, the height of the gesture may have impacted the sung pitch.

Expert panel perceptions of intonation. Listeners rated intonation as most "sharp" during the high gesture (M = 59.70, SD = 11.27) and most "in tune" during the low gesture (M = 53.81, SD =10.74). Results of a one-way repeated measures ANOVA with gesture as the within subjects factor indicated significant differences between posttest ratings of tone quality ($F(2, 57) = 4.19$, $p = .02$).

Intonation measures and perceptions of experts both indicated that singers sang more 'sharp' in the posttest compared to the pretest during the high gesture condition.

Expert panel perceptions of tone quality. Listeners assessed the tone quality of sound samples from the SPG group on a visual analog scale (0 – 100: *breathy* = 0, *balanced* = 50, *pressed-edgy* = 100). Results of a one-way repeated measures ANOVA indicated significant differences between posttest ratings of tone quality with gesture as a within subjects factor ($F(2, 57) = 5.21$, $p = .008$). In terms of tone quality, the instances judged as evidencing the most balanced phonation were during the low gesture (M = 48.26, SD = 11.28) compared to the standard (M = 54.99, SD = 14.22) and high gestures (M = 59.79, SD = 12.73). Listeners perceived the most pressed during the high gesture (M = 54.08, SD = 15.20) in comparison to the low (M = 48.28, SD = 12.09) and standard (M = 54.98, SD = 16.33) gestures.

Research Question Five
(Phase Three, Perceptual Analyses)

The fifth research question inquired about singer perceptions of their SPG group performances.

Singers in the SPG Group were asked, following all posttests, what change, if any, they noticed in their singing while doing the gestures. Singer comments about the low circle included more supported/deeper breath (n = 5, 27%), louder singing (n = 5, 27%), more resonant singing (n = 3, 16%), more legato singing (n = 3, 16%), and "I noticed that my voice was more connected to my body" (n = 1). Singers perceived that performing the high gesture elicited tighter, more tense sound (n = 5, 27%), faster tempo (n = 3, 16%), lighter singing (n = 3, 16%), wavering pitch (n = 3, 16%), and lack of breath support (n = 3, 16%).

Discussion

The major finding of this pilot investigation is that the particular gestures employed for this study, whether produced by a conductor or a singer, appear to influence in some specific respects both acoustic and perceptual measures of sung /u/ vowels. These findings are limited to the particular participants and procedures of this investigation. However, because this study documents and tests specific singing behaviors reported and recommended anecdotally in some pedagogy literature (e.g., Eichenberger & Thomas, 1994; Thurman & Welch, 2000), its findings may be of interest to vocal music educators and researchers alike.

Interestingly, results indicate significant intonation differences in the training phase and posttest measures of the participant groups by gesture, but no significant difference in intonation according to pretest comparisons. This finding may indicate that in order for conductor gesture to affect the intonation of singing, the length of exposure to the gestures could be

important. Future studies might explore potential contributions of training over time with varying gestures to singer intonation. Further, differences in gestural performance by the conductor or teacher, such as intensity of gesture, facial expression, personality characteristics, or relationship between conductor/teacher, may be of interest for future investigations.

During post-test conditions, all groups evidence significant pitch differences between the gestures, with the high gesture producing the most out of tune singing (sharp) for the control and SOG groups. This sharping is most pronounced when participants observe the high conductor gesture. The low gesture, by contrast, appears to contribute overall to more in tune singing. This finding may support anecdotal claims that a low circle will assist singers' pitch accuracy (Eichenberger & Thomas, 1994).

Much of the anecdotal choral pedagogy and music education literature to date promotes gesture and movement, in general, as beneficial to singing. The significant intonation differences between high and low gestures in this study, however, raises the question of whether all gestures may be beneficial for singers to observe or perform. High gestures, for instance, may produce some undesirable effects. Future research might examine the plane of gestures, whether conductor gestures or singer gestures, particularly in relation to desired singer intonation.

Singer perceptual responses, overall, seem to suggest some association between the low, circular gesture and singing louder, taking a deeper breath, and producing a fuller tone. Because breath is essential to each of these observations, it makes sense that the lower gesture might enable singers to focus more on their lower abdominal muscles, and thus, a deeper, fuller breath that would support a louder, fuller tone. Measures of amplitude may be of interest to future research in order to further assess these findings.

Singer perceptions of breath and tone quality in relation to gesture may suggest that future research in this area might well utilize dependent measures other than those that focus exclusively upon frequency and intonation. Singers perceived more restricted singing while observing or performing the higher gesture. Although the frequency data collected for this study indicate that gestures may affect sung frequency (usually above the target frequency), these data cannot measure physical restriction. Future research may wish to examine this potential variable's effect on the external laryngeal muscles with technologies such as EMG.

Some singer participants also indicate that the high gesture seems to exhibit a faster tempo, even though all samples were set to the same metronome marking. Singers also thought that the higher gesture elicits a lighter sound, a more shallow breath, and a restricted feeling. Such observations would make sense if the higher gesture caused the larynx to rise and an upper torso breath. The present investigation, however, did not examine the position of the larynx or movement/position or the torso. Future research may investigate these matters.

Singers in all groups appeared to respond similarly to the gestures. For instance, singers in SPG group, who did the gestures while singing, responded in much the same way as singers who simply observed the gestures while singing. Whether observing or executing gesture, participants perceived that the low gesture seemed to lead to a fuller, more legato sound with fuller breath, while the higher gesture led to a lighter, more constricted sound.

The perceptions of the expert listening panel may also provide insight for voice educators. Expert perceptual evaluations of intonation in this investigation are largely consistent with findings on deviation in the cents from target fundamental frequency for most measures. Such results may indicate that experts can hear and accurately assess most differences in intonation for singers.

One purpose of a pilot investigation, particularly in an area where very little research has been done, is to discover ways that future research might be refined. Some unanticipated

confounding variables contributed to two primary limitations of this pilot study. First, the circular gestures employed for this investigation, although suggested by the anecdotal literature (Eichenberger & Thomas, 1994), are hybrid gestures. Thus, it is not possible to attribute particular effects solely to the "high" circular gesture or the "low" circular gesture. The high gesture, for example, was also a hand gesture, while the low gesture was an arm gesture. Moreover, performance of the high circular gesture, whether by conductor or singers, entailed a lifting of the shoulders beyond their traditional position recommended for singer's posture, and thus may have been inefficient for optimal breath management, potentially contributing to more muscular tension. Future investigations should employ non-hybrid gestures.

Secondly, although two participant groups had gestural training, that training was brief (six minutes). The same groups were measured during phase 1 and phase 2 of the study; therefore, the participants experienced the gestures before training. Although the first measurements functioned as a pretest, the pretest may have influenced the training phrase measures because participants experienced the gestures more than once. Moreover, the gestures performed by the singers in the SPG group, although controlled as much as possible through instruction, varied somewhat, perhaps due to factors such as singer comfort with movement, singer arm and hand shape, singer energy level, and other physical qualities of the singers. Future studies could institute longer periods of training, as well as first ascertain from participants their comfort with doing gestural movement in order to disaggregate data according to that variable.

In a similar vein, the control group in this study practiced with a metronome between pretest and posttest measurements. While that activity was gesture-free, it may have unintentionally affected singer intonation because control group participants repeated the phrase several times, possibly becoming more familiar with the phrase over time or even fatigued by the repetition. It is possible, for example, that simply repeating a sung phrase, while attending solely to its tempo via a metronome could impact intonation, particularly in the case of less secure singers. Future studies that focus on singer intonation in relation to gesture may wish to design the control group task differently.

Another factor that may be of considerable interest is the hearing acuity of the participants. Participants in this study were not screened for either hearing loss or pitch perception accuracy. This omission may have impacted results. Future research may wish to include such screening.

Although the acoustical focus of this investigation was on frequency, future studies may wish to calibrate the microphone used in order to assess possible differences in amplitude attributable to gesture. Moreover, the present study tests only melodic intonation. Future studies might consider harmonic intonation as well, by assessing singers in small groups with one voice per scored part.

The expert listeners in this study heard recorded singer performances under consistent conditions and the audio samples were band pass filtered between 130 Hz and 13000 Hz to remove extraneous noise in the digital recordings. The perceptions of the listeners offered interesting insights into the performance and possible perceptions of singers. Nonetheless, future investigations might consider utilization of longer samples, randomly selected samples, or samples that have not been band pass filtered.

Whether conductor gesture, singer gesture, or both could affect such variables as timbre, acoustically measured amplitude, or efficiency of vocal production was not a focus of this pilot study. Future studies might consider a wider array of dependent measures. Similarly, future investigations of singer gesture may wish to explore singer-chosen movement instead of conductor or researcher prescribed gestures, as well as use of gestures based on pedagogical goals for individual singers or groups such as breath flow, vowel shape, or jaw tension.

If possible, future studies should also consider a truly random selection of participants. Although participants in this study were randomly assigned to treatment and control groups, they constituted a convenience, i.e., non-random, population. Moreover, future investigations may wish to consider some stratification of random group assignments, e.g., in terms of sex, previous singing experience, and secure or less secure intonation.

A primary contribution of this pilot investigation is its collection and analysis of data relative to a much discussed but as yet under-investigated area of interest to vocal music educators. Research-based awareness of the potential effects of using particular gestures with singers may assist choral conductors and singing teachers in deciding which gestures to recommend for their singers. Data from this study, along with identification of the potential confounding variables discussed above, provide a rich resource for the design of future studies that investigate gesture and singer sound. ✪ 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
The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
The author received no financial support for the research, authorship, and/or publication of this article.

Images
The *IJRCS* obtained permissions to publish the images of persons pictured in this article. These images may not be copied, transmitted, or otherwise used except as they are embedded in the entirety of the article.

References

Boersma, P. & Weenink, D. (2010). Praat 5.1.43. Amsterdam, The Netherlands: University of Amsterdam. Retrieved from http://www.fon.hum.uva.nl /praat.

Chagnon, R. D. (2001). *A comparison of five choral directors' use of movement to facilitate learning in rehearsals* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (AAT No. 3002819)

Cooksey, J. (1992). *Working with adolescent voices.* St. Louis: Concordia Publishing House.

Daugherty, J. F., & Brunkan, M. C. (2013). Monkey See, monkey do? The effect of nonverbal conductor lip rounding on visual and acoustic measures of singers' lip postures. *Journal of Research in Music Education, 60,* 345 - 362.

Deutsch, D. (1999). *The psychology of music*. Academic Press Series in Cognition and Perception. London: Academic Press.

Eichenberger, R. & Thomas, A. (1994, videotape). *What they see is what you get: Linking the visual, the aural, and the kinetic to promote artistic choral singing*. Chapel Hill, NC: Hinshaw Music, Inc.

Eichenberger, R. (2001, videotape). *Enhancing musicality through movement*. Santa Barbara, CA: Santa Barbara Music Publishing.

Elliott, D. (2005). *Praxial music education reflections and dialogues.* New York: Oxford University Press.

Fadiga, L., Fogassi, L., Pavesi, G., & Rizzolatti, G., (1995). Motor facilitation during action observation: A magnetic stimulation study. *Journal of Neurophysiology, 73,* 2608 – 2611.

Fuelberth, R. J. V. (2003a). The effect of conducting gesture on singers' perceptions of inappropriate vocal tension. *International Journal of Research in Choral Singing, 1,* 13 -21.

Fuelberth, R. J. V. (2003b). The effect of left hand conducting gesture on inappropriate vocal tension in individual singers. *Bulletin of the Council for Research in Music Education, 157,* 62-70.

Fuelberth, R. J. V. (2004). The effect of various left hand on conducting gestures on perceptions of anticipated vocal tension in singers. *International Journal of Research in Choral Singing, 2,* 27-38.

Grady, M. L. (2012, June). *Effects of traditional, lateral and vertical conducting gestures on perceptual and acoustic measures of conglomerate choral sound*. Paper Presented at the Voice Foundation Symposium, Philadelphia, PA.

Greschesky, R. N. (1985). *An analysis of nonverbal and verbal conducting behaviors and their relationship to expressive musical performance*. Unpublished PhD Thesis, University of Wisconsin-Madison.

Hibbard, T. T. (1994). *The use of movement as an instructional technique in choral rehearsals* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (AAT 9418994)

Krause, D. W. (1983). *The positive use of conducting stance and motion to affect vocal production and to assist musicality in the training of children's choirs* (Doctoral Dissertation). Retrieved from ProQuest Dissertations and Theses database. (AAT No. 0552760)

Lindgren, H. & Sundberg, J. (1972). *Grundfrekvensförlopp och falsksäng,* stencil, University of Stockholm, Department of Musicology.

Linklater, K. (1976). *Freeing the natural voice.* New York: Drama Book Publishers.

Madsen, M. K. (1991). *The effect of specific conducting gestures on vocal sound.* (Unpublished Master's Thesis). Florida State University, Tallahassee, FL.

Manternach, J. N. (2011). The effect of varied conductor preparatory gestures on singer upper body movement. *Journal of Music Teacher Education, 22,* 20–34.

Manternach, J. N. (2012). The effect of nonverbal conductor lip rounding and eyebrow lifting on singers' lip and eyebrow postures: A motion capture study. *International Journal of Research in Choral Singing, 4(1),* 36-46.

Peterssen, V. & Westgaard, R. (2004). The association between upper trapezius activity and thorax movement in classical singing. *Journal of Voice, 18*(4), 500-512.

Peterssen, V., Bjorkoy, K., Torp, H., & Westgaard, R. (2005). Neck and shoulder muscle activity and thorax movement in singing and speaking tasks with variation in vocal loudness and pitch. *Journal of Voice, 19* (4), 623-634.

Peterson, C. W. (2000). Moving musical experience in chorus: Movement that is explored and utilized in the choral rehearsal can be a powerful tool for music expression. *Music Educators Journal, 18*(3), 25-28.

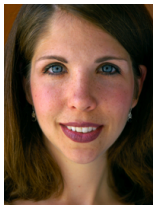
Pierce, A. (2007). *Deepening Musical Performance through Movement.* Indianapolis: Indiana University Press.

Rizzolatti, G., Fadiga, L., Matelli, M., Bettinardi, V., Paulesu, E., Perani, D., & Fazio, F. (1996). Localization of grasp representations in humans by PET: 1. Observation versus execution. *Experimental Brain Research, 111,* 246 – 252.

Sundberg, J. (1982). *In tune or not? A study of fundamental frequency in music practice* (STL-QPSR 1). Stockholm: Department of Speech Communication, Jungl Tekniska Högskolan.

Sundberg, J. Thurman, L. & Welch, G. (2000). Forewords to this book: Sunsets, elephants, vocal self-expression, and life-long learning. In L. Thurman & G. Welch (Eds.), *Bodymind and Voice: Foundations of Voice Education* (pp. xi-xxiv). Collegeville, MN: The VoiceCare Network, National Center for Voice and Speech, Fairview Voice Center.

Wis, R. M. (1993). *Gesture and body movement as physical metaphor to facilitate learning and to enhance musical experience in the choral rehearsal* (Doctoral Dissertation). Retrieved from ProQuest Dissertations and Theses database. (AAT No. 9327319)



Melissa C. Brunkan is assistant professor of music education at Louisiana State University (USA). Her primary research interests include the use of gesture in choral/vocal pedagogy, lifespan voice pedagogy, conductor gesture and behaviors, and the adolescent voice.