

Effects of Solo and Choral Singing Modes on Vibrato Rate, Extent, and Duration Exhibited by Undergraduate Female Singers

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Abstract

This study explored potential changes in vibrato among female undergraduate singers ($N = 30$) majoring in voice performance ($n = 15$) and choral music education ($n = 15$) as they transitioned between solo and choral singing modes. Participants sang the same contrasting excerpts ($N = 2$) from standard choral literature. Each of these singing contexts included a soprano solo and a four-part choral harmonization where the soprano line used the same musical material as the solo. Both singing mode (solo or choral) and singing context (which of the two musical excerpts) were counterbalanced among participants to control for potential order effects. As they performed individually, participants heard pre-recorded accompaniments and chorus voices presented to one ear via headphone. The other ear remained uncovered for participants to receive acoustic feedback from their own voices as they sang. Results indicated significant differences between the solo and choral singing modes across three measurements of vibrato (faster rate, wider extent, and longer duration of vibrato) in both singing contexts, with no significant differences according to major area of study. Responses to a brief questionnaire administered following the recorded singing trials indicated that all participants (100%) believed singers needed to make vocal adjustments between solo and choral singing modes, with half (50%) of the participants citing blend (50%), followed by volume or dynamics (47%), and vibrato (37%) adjustments. When asked specifically about the singing tasks for this study, 83% of participants stated they actively adjusted their vocal techniques between singing modes, with half (50%) of the participants mentioning vibrato (50%), followed by volume/dynamics (37%), and blend (17%) adjustments. Seventeen participants (57%), however, reported that they did not actively adjust their vocal techniques according to the contrasting nature of the two musical excerpts sung.

Keywords

vibrato, singing modes, choral singing, solo singing, vocal technique

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Young, undergraduate singers, whether majoring in vocal performance or music education, often face the task of discriminating between vocal production for choir and vocal production as a soloist. A student of singing typically has two authorities from whom to learn vocal production: the choir director and the applied voice teacher. Although performances and recordings can provide meaningful teaching examples, these two authorities remain the primary sources for education in vocal technique.

Unfortunately, these authorities do not always agree in their pedagogical philosophies and practices, which can cause confusion for students. Trade journals contain numerous articles addressing this divide. McCoy (2011), for instance, addressed three commonly debated concerns of voice teachers with respect to choral singing: vibrato, pure vowels in high tessitura, and rehearsal length. Hansen, Henderson, McCoy, Simonson, and Smith (2011) highlighted prevalent issues raised by roundtable discussions at the 2009 and 2011 national conventions of the American Choral Directors Association (ACDA) and the National Association of Teachers of Singing (NATS), which included tone quality, dynamics, vocal fatigue, and terminology.

After a survey of voice students, voice teachers, and choral directors from colleges and universities in Ohio, Slusher (1991) identified some divergent teaching practices and expectations between voice teachers and choral directors. He found conflict between studio teaching and choral rehearsal expectations, as well as perceived differences in desired intensity levels between solo and choral singing, i.e., whether a *forte* dynamic from the studio would be accepted in the choral rehearsal. Detwiler (2008) identified some challenges faced by undergraduate performance majors who alternate between solo and choral singing. She suggested that singers with developed upper partial resonance may experience diminished vocal efficiency in order

achieve blend with surrounding singers in choir, and recommended that choir directors not construe choral singing technique as a "one size fits all" phenomenon.

Fagnan (2005) studied the use of solo vocal technique in the choral rehearsals of five different types of choirs by teaching three *bel canto* methods: (a) the *coup de glotte*, or vocal fold (glottal) closure; (b) *chiaroscuro*, a term describing the balance of bright and dark timbre in vocal production; and (c) *messa di voce*, the technique of *crescendo* and *decrescendo* on a sustained pitch while maintaining spectral energy. He asserted that use of these techniques effectively enhanced the intensity of 2.3 - 3.5 kHz spectral energy in choral singing and resulted in a more homogeneous sound and improved intonation.

Various researchers have investigated perceptions of vibrato, a particularly debated technique in both choral and solo singing. Brown (1991) studied the location of musical pitch within vibrato tones. Geringer, MacLeod, and Allen (2010) investigated the pitch matching abilities of string players and non-string players to stimulus tones played with and without vibrato on stringed instruments. Listeners perceived the pitch of the vibrato tones to be very near the mean frequency of the vibrato. Van Besouw, Brereton, and Howard (2008) studied the range of acceptable tuning (RAT) for tones with and without vibrato. Participants perceived tones with vibrato to have a 10 cents greater RAT than tones without vibrato.

Seashore (1938), Miller (1986), Prame (1997), Nair (1999), and Bretos and Sundberg (2003) described parameters of performance practice regarding the rate and extent of vibrato in singers. Seashore proposed an extent of 100 cents and mean rate of 6.5 cycles per second. Miller asserted that vibrato rates should fall around 6 cycles per second. Nair offered a wider range of acceptable rates: 4.5 – 6.5 cycles per second. Bretos and Sundberg analyzed ten recordings of famous sopranos for vibrato rate

($M = 6.25\text{Hz}$), extent, and intonation over time. Findings indicated that vibrato rate, extent, and intonation all changed over time on long sustained tones. Prame, in his examination of 10 professional recordings, found a wider scope of performance practices with regard to extent, ranging from ± 34 cents to ± 123 cents, with a mean of ± 71 cents.

Researchers have also focused on singer vibrato in a pedagogical context. Mitchell and Kenny (2010) investigated the development of vibrato rate and extent of undergraduates throughout their degree programs. With training, the mean vibrato rate decreased, and the mean vibrato extent increased. Dromey, Carter, and Hopkins (2003) explored acoustical changes as singers attempted to match their vibrato rate to a stimulus tone; slower rates were associated with lower intensity and less steady vibrato, and faster rates were associated with increased intensity in the head register and increased vibrato extent in the chest register. Singers also demonstrated the ability to adjust their vibrato rate to match a stimulus tone. Continuing this line of inquiry, the researchers defined techniques used to change vibrato rate while matching a stimulus tone (Carter, Hopkins, & Dromey, 2010). Placement and breath energy were the most notable techniques employed; a fast vibrato became slower with diminished breath energy and more backwards placement, and vice versa. Weber (1992) looked at changes in intensity levels of varying pitches with and without vibrato. Participants sang vibrato tones with significantly more intensity than straight tones at the high pitch level.

Other researchers have sought to define the changes made by singers in solo and choral modes. In studies utilizing spectral analysis of acoustical data, Goodwin (1980) and Rossing, Sundberg, and Ternström (1986) concluded that the singers in their respective studies produced a stronger fundamental frequency in combination with fewer and weaker upper partials (less singer's formant) in choral mode

than in solo mode. While comparing baritone singers at varying stages of training, Carter (2007) found differences in the amount of spectral variation between choral and solo modes as age and training increased. Ekholm (2000) found that choral directors, when given a choice between choral excerpts sung with and without singer's formant energy, preferred choral excerpts sung with less singer's formant. Voice teachers, by contrast, did not show a preference for either of the choral passages, regardless of mode, but they did prefer the solo passages sung with more singer's formant energy.

Ford (2003) evaluated auditor preferences for strong or weak singer's formant in choral singing. All auditor subgroups preferred choral performances with less singer's formant energy. Those listeners with choral training preferred the less resonant tone by a wider margin. However, the performances in Ford's study evidenced a disparity in vibrato usage between the two excerpts sung with either strong or weak singer's formant, which may have been a confounding variable.

Reid et al. (2007) conducted a study of professional opera singers as they engaged in solo and opera chorus modes of singing. Specifically, these researchers compared vibrato rate and extent as well as singer's formant in both singing modes, and found little or no difference between modes. Howard, Daffern, and Brereton (2011) explored changes in one soprano singing early music in three different performance styles: (a) operatic, (b) early music mainstream, and (c) *clear smooth sweet chaste*, which described a tone with very little vibrato. While vibrato rate remained constant between operatic and early music mainstream, vibrato extents and durations varied between the three styles, with the operatic style of singing evidencing the largest extents and durations.

The literature to date has delineated varying performance practices and preferences with respect to spectral energy differences between

solo and choral modes of singing. Although Reid et al. (2007) examined vibrato in solo and opera chorus modes and Howard et al. examined vibrato with one soprano singing early music in various styles, no study has yet explored the effects of solo and traditional choral singing modes on multiple singers' use of vibrato. Moreover, researchers have yet to explore whether or not undergraduate voice performance majors, who focus primarily on the development of solo singing technique, and undergraduate choral music education majors, who focus primarily on group singing, differ in vibrato behaviors exhibited during solo and choral singing. Vocal music educators could find data regarding vibrato performances in different contexts, i.e. different composers, different historical periods, different accompaniments, and different stimulus choirs, useful in informing their pedagogical practices.

The purpose of the present study, therefore, was to explore the potential effects of solo and choral modes of singing on vibrato with female undergraduate singers ($N = 30$) majoring in voice performance ($n = 15$) and choral music education ($n = 15$) as they transitioned from solo to choral singing while performing two contrasting excerpts from choral literature that featured a soprano solo and a four-part choral harmonization where the soprano line used the same musical material as the solo. These research questions guided the present investigation:

1. Will vibrato rate, extent, and duration change as these performers move from solo to choral singing modes?
2. Will participants adjust their vibrato rate, extent, and duration when singing in two, contrasting musical contexts ("Laudate Dominum" from *Solemn Vespers* by W. A. Mozart; "Thy Perfect Love," by John Rutter)?
3. Will there be differences between the sung performances according to participants' majors (voice performance or choral music education)?
4. What are the singers' perceptions about

what, if any, changes are necessary when transitioning between solo and choral modes of singing?

Method

Thirty volunteer female undergraduate music majors, 15 choral music education students and 15 voice performance students, participated in this investigation. I recruited these women from the choral ensembles at a large school of music in the southeastern United States. Participants were all between 19 and 22 years of age ($M = 21.1$, $SD = 1.1$), with a range of 1-10 years of solo voice study ($M = 5.4$, $SD = 2.4$), and a range of 4-17 years of choir experience ($M = 10.4$, $SD = 2.4$).

Singers prepared several measures from two compositions: Mozart's "Laudate Dominum" from the *Solemn Vespers*, and "Thy Perfect Love" by John Rutter (see Figures 1 and 2). Each of these scores begins with a soprano solo followed by a four-part harmonization of the solo melody, in which the soprano choral part matches identically to the solo line.

Each participant was recorded as a soloist and as a soprano member of the choir. In order to control for potential order effects, I used a counterbalanced order for both singing mode and singing context.

One week prior to the recording task, participants received scores and by email an mp3 recording of the four excerpts (Mozart Solo, Mozart Choir, Rutter Solo, and Rutter Choir) in order to prepare the excerpts ahead of time. The Mozart example's accompaniment and chorus were transferred from a CD recording of the Bavarian Radio Orchestra and Chorus (EMI CDM-7690232). The Rutter example was a recording of the Cambridge Singers (Collegium B00030E525). Audio recordings included accompaniment only for the solo excerpts (orchestra for the Mozart, and organ for the Rutter), accompaniment and choir for the Mozart, and a cappella choir for the Rutter choral excerpts. Participants were asked

to prepare as if they were the soloists in the solo excerpts, and as if they were members of the soprano section of the stimulus choir for the choral excerpts.

The researcher recorded participants individually in a studio designed for solo and small chamber ensemble recording, using a

Zoom H2 portable digital recorder at 24 bit resolution with a 44.1kHz sampling rate. Only an individual participant and the researcher were present in the room at the time of recording. Participants stood 1.5 meters from the audio recorder.



Figure 1. Musical excerpt from Mozart's "Laudate Dominum," performed in both solo and choral mode. Circled notes were used for analysis.

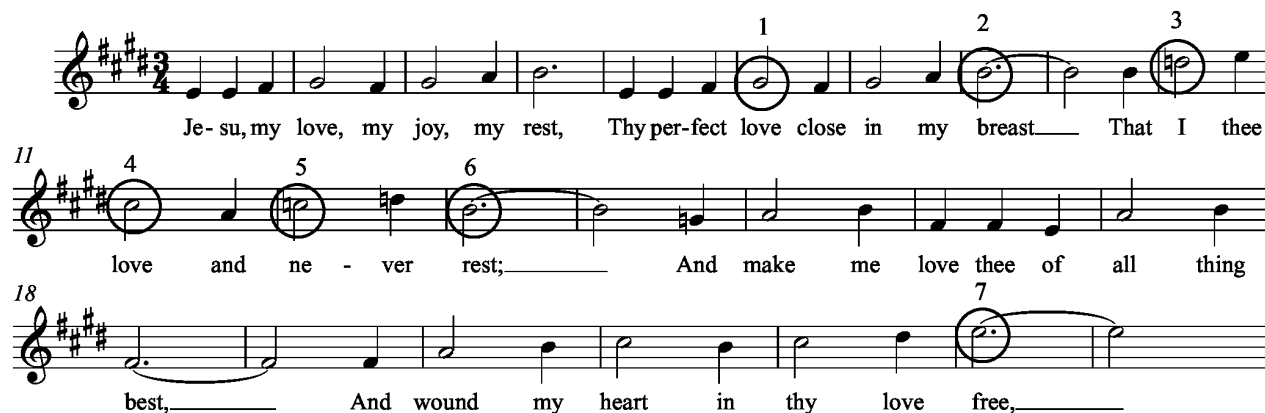


Figure 2. Musical excerpt from Rutter's "Thy Perfect Love," performed in both solo and choral modes. Circled notes were used for analysis.

Use of pre-recorded accompaniments, presented via headphones, allowed for recording the vocalists in both solo and choral modes in isolation from both the accompaniments and the other, pre-recorded choir voices. Participants sang with one ear uncovered in order to receive acoustic feedback from their own voices. The audio excerpts included a few measures of introduction, allowing for accuracy in cueing and tempo. Because the participants received the excerpts to practice ahead of time, very few needed to record any excerpt more than once.

At the conclusion of the recording tasks, participants completed a short questionnaire (see

Appendix). Because the purpose of this study was to examine both perceptual and acoustical measures, the researcher developed this questionnaire to explore participants' general perceptions on singing in two modes, as well as their perceptions of their performances in the specific tasks of this study. Each participant completed the entire recording session in less than 15 minutes.

Analysis of the digital recordings utilized Praat software (Boersma & Weenink, 2012). Analysis of notes was set at a sampling rate of 100 Hz (one sample each .01 second). Seven notes were chosen on the basis of duration from

each piece for analysis in both solo and choral modes, (see Figures 1 & 2). The use of longer notes facilitated both singers' use of vibrato and analyses of tones. Each note analyzed had a minimum duration of 1.25 seconds.

For each pitch, the researcher measured three characteristics of vibrato. I calculated vibrato rate by first identifying the number of discernable vibrato cycles within the length of a note, and dividing the number of cycles by the duration of the note in seconds. In order to ascertain the extent of vibrato, I determined the minimum and maximum frequencies within the duration of a note. After subtracting the minimum from the maximum, that difference in Hertz was converted to cents. I assessed vibrato duration by dividing the amount of time (in seconds) vibratory cycles could be discerned by the total duration (in seconds) of the pitch. This fraction represented the percentage of time vibrato was present for each analyzed tone.

To establish reliability of the vibrato measurements, two independent observers analyzed 20% of the tones. The vibrato rates,

mean frequencies, minimum and maximum values of vibrato extents, and the percentages of each tone that participants performed with vibrato were compared by computing correlation coefficients for each category of analysis. Reliability coefficients were high for all measures: vibrato rates ($r = .91$), mean frequencies ($r = .97$), minimum values ($r = .94$), maximum values ($r = .97$), and percentage of each tone performed with vibrato ($r = .89$). Two independent observers coded twenty percent of the questionnaire responses with 82% agreement.

Results

Data consisted of individual singers' vibrato rates, extents, and vibrato durations within seven selected tones. Calculation of the means from the seven tones provided a single score for each of the vibrato measures. Table 1 displays the means and standard deviations of participants' vibrato performances.

Table 1. *Mean Scores of Vibrato Rate, Extent and Duration by Mode and Composer*

Measure	Solo	Choral	Mozart	Rutter
Rate (Hz)	5.4	5.1	5.4	5.1
Standard Deviation	0.5	0.9	0.5	0.9
Extent (cents)	225.6	202.7	221.8	206.5
Standard Deviation	63.1	50.9	59.7	53.3
Duration (%)	78.0	62.3	76.2	64.1
Standard Deviation	15.3	22.5	17.0	20.3

Note: All mean scores between modes and between composers were significantly different, $p < .05$

Vibrato rates were faster for solo mode versus choral mode, as well as for Mozart versus Rutter contexts. Similarly, participants

employed wider vibrato extents for solo mode versus choral mode and for the Mozart versus Rutter excerpts. Participants also sang with

vibrato for a greater percentage of time in solo mode than choral mode, and greater again for Mozart than for Rutter.

A predetermined alpha level of .05 indicated significance for all statistical tests. I used a repeated measures three-way ANOVA with one between subjects variable (major area of study) and two within subject variables (singing mode and context) to compare vibrato rates. Vibrato rates exhibited a significant difference between modes of singing, $F(1, 28) = 4.71, p < .05, \eta_p^2 = .14$. Vibrato in solo mode ($M = 5.41$ Hz) was performed at a faster rate than the choral mode ($M = 5.13$ Hz). A significant difference was also found between compositions, $F(1, 28) = 7.06, p < .05, \eta_p^2 = .20$. Participants performed faster vibrato rates during Mozart (5.43 Hz) performances than Rutter (5.10 Hz). No significant difference in vibrato rate was found according to participants' majors (voice performance and choral music education) or for any of the interactions between major, mode, and context.

A second three-way ANOVA compared possible differences in vibrato extent. Significance was again found between modes, $F(1, 28) = 17.49, p < .05, \eta_p^2 = .38$ and context, $F(1, 28) = 13.18, p < .05, \eta_p^2 = .32$. Vibrato extents were greater for solo mode ($M = 225.6$ cents) than for choral mode ($M = 202.7$ cents), and greater for the Mozart ($M = 221.8$ cents) than Rutter ($M = 206.5$ cents) excerpts. Again, no significant difference was found according to participants' majors, or for any of the interactions of mode, major, and context.

I computed a third three-way ANOVA to determine differences in vibrato duration, defined as the percentage of time a discernable vibrato cycle was present within the duration of a pitch. Significant differences were found between contexts, $F(1, 28) = 32.28, p < .05, \eta_p^2 = .54$, mode of singing, $F(1, 28) = 20.02, p < .05, \eta_p^2 = .51$, and in the interaction between context and mode, $F(1, 28) = 10.25, p < .05, \eta_p^2 = .27$. Mean vibrato durations were longer in solo mode ($M = 78\%$) than in choral mode ($M =$

62%), and longer in the Mozart example ($M = 77\%$) than the Rutter example ($M = 64\%$). Mean durations were similar for voice performance ($M = 71\%$) and choral music education ($M = 70\%$) students. None of the other interactions was significant.

Figure 3 shows the interaction of context and mode. Differences in duration of vibrato were greater between the two modes for the Rutter example (21% difference) than for the Mozart example (10% difference).

Upon completion of the recording task, participants completed a brief questionnaire that solicited feedback from these singers regarding their perceptions of singing in the two modes (solo and choral) and in two different contexts (Mozart/orchestral and Rutter/organ or unaccompanied). The questionnaire consisted of yes/no responses as well as short answer responses. For the short answer responses, I categorized keywords and analyzed them by frequency.

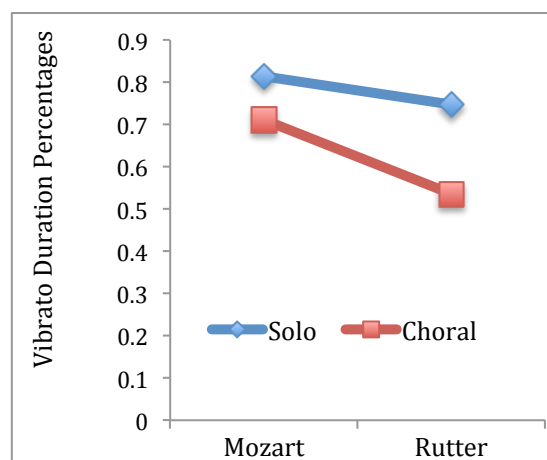


Figure 3. Interaction between mode and context for vibrato duration percentages

The first question solicited participants' perceptions about general practice. One hundred percent of respondents agreed that there are vocal adjustments to be made between solo and choral modes of singing. When asked to specify what those adjustments might entail, participants most frequently cited blend (50%),

followed by volume or dynamics (47%), and vibrato (37%).

The second question focused on what participants thought they actually did when transitioning from solo to choral singing modes during the recording sessions. Twenty-five respondents (83%) stated that they actively adjusted their vocal technique for the singing tasks of this study, with vibrato being the most frequent response (50%), followed by volume/dynamics (37%), and blend (17%).

The third and fourth questions explored participant perceptions regarding their performances of the two, contrasting musical

excerpts that constituted the singing contexts for this study. Despite significant differences in performed vibrato rates, extents, and durations between contexts, 17 respondents (57%) stated that they did not actively adjust their technique when changing contexts, which included changes in style, accompaniment, and choirs.

However, many participants listed several musical elements as appropriate possibilities for adjustment between the contrasting musical excerpts (Mozart, Rutter). Table 2 summarizes the frequency of descriptive terms mentioned by participants in each of the major questionnaire items.

Table 2. *Frequency of Descriptive Terms Mentioned by Participants (N = 30)*

1) What vocal adjustments might be made between solo and choral modes?	2) What adjustments did you make between solo and choral modes?	3) What adjustments might be made between historical style periods?	4) What adjustments did you actively make between Mozart and Rutter?
15 Blend	15 Vibrato	9 Vibrato	4 Vibrato
14 Volume/ Dynamics	11 Volume/ Dynamics	6 Timbre	2 Timbre
11 Vibrato	5 Blend	5 Breath	2 Vowels
11 Vocal Freedom	4 Vocal Freedom	4 Vowels	1 Language
5 Tone/Timbre	4 Tone/Timbre	3 Text Stress	1 Intonation
4 Vowels	3 Breath	3 Color	1 Vocal Freedom
3 Individuality	1 Lighter	3 Dynamics	1 Resonance
2 Diction	1 Singing "off the voice"	2 Articulation	1 Rolled [r]s
2 Phrasing	1 Individuality	2 Phrasing	1 Dynamics
1 Distortion	1 Listening	2 Trills	1 Registration
1 Interpretation	1 Vowels	1 Blend	1 Color
1 Intonation	1 Resonance	1 Technique	
1 Listening	1 Support	1 Placement	
1 Note to Note			
1 Resonance			
1 Technique			

Note: Participants could supply more than one descriptive term per survey item

Discussion

The goals of singers in choral ensembles and as soloists are relatively disparate. In the solo mode, singers are expected and taught to cultivate their individuality – to set themselves apart from the crowd. In the choral mode, the goal becomes ensemble unanimity, often described by those in the choral field as blend or balance (Davids & LaTour, 2012, Olson, 2010). Tuning within the ensemble can be critical to that blend, and vibrato tones can create challenges in tuning. Therefore, the major finding of this study, i.e., that its participants vary vibrato usage between the two singing modes regardless of musical context or training, is not unexpected.

Although vibrato rates differ significantly between singing modes in the present study, the practical difference in these rates merits some discussion. It remains to be seen if listeners could discriminate between the mean difference in rates of the solo recordings ($M = 5.41$ Hz) and the choral recordings ($M = 5.13$ Hz). While statistically significant, in reality these rates may be perceived as very close. However, this tendency for a slower rate in choral singing may indicate other technical adjustments made by singers, as explored by Dromey, Carter, and Hopkins (2003, 2010). Future study might also explore, in a manner akin to Detwiler's 2008 study, the perceptions of listeners, including singers, choral directors, and voice teachers, of the vibrato performances of singers in the two modes.

The only significant interaction found between variables in this study pertains to vibrato duration differences in modes for the two contexts (a 21% difference between modes in the Rutter excerpts compared to a 10% difference in the Mozart excerpts). This interaction was likely influenced by the stimulus recordings, which included different choirs with different accompaniments. The Mozart recordings were accompanied by orchestra in both modes, while the Rutter

recordings used organ for the solo mode but were unaccompanied for the choral mode. One participant recognized this possibility: "Since the Mozart is sung with an orchestra, I would think a choir would be able to sing with a full voice to balance. The Rutter, since a cappella, should be sung with a more 'aware' tone, not necessarily straight, but to match the voices around them." Future studies may examine vibrato performance of varying pieces with choirs and accompaniments performed by the same personnel and instrumentation. Regardless of this influence, singers in this study performed differently between modes in both contexts, indicating that these particular singers changed their vocal production between the solo and choral modes regardless of the differently scored musical excerpts.

One of the most commonly observed techniques in this study is that singers often began a tone without vibrato in the choral mode, a procedure that may allow for more precise tuning, and then "warmed up" the sound with vibrato. In the solo mode, participants more often used vibrato for the entire length of the pitch. Participants in this study were told only that the project concerned current performance practices in choral and solo singing; the researcher never mentioned vibrato as a specific technique of interest. Future studies might explore intonation, both measured and perceptually, with choirs using vibrato, less vibrato, and with a delayed onset of vibrato within musical tones.

The results of this study concur with previous literature in a number of ways. The mean vibrato rates fall within the range (4.5-6.5 Hz) set forth by Nair (1999), and the duration measure supports the premise of Bretos and Sundberg (2003) that rate and extent change over time. Mean vibrato extents in this study are higher than those observed in some other studies. Prame (1997), for example, found a mean extent of 140 cents. Such discrepancies likely result from the method of measurement used. To determine vibrato extent in this study,

individual tones were selected, and maximum and minimum pitches were recorded within the entire length of the tones that were sampled each .01 second. One disadvantage of this method of measurement is that outliers may have caused extents to appear larger than other means of data collection and analysis might have shown. For example, Prame (1997) averaged the peaks and valleys of the vibratory cycle to determine extent, which resulted in a more restricted measurement of extent. Although alternative methods may be adopted in future studies, the data for this study may still be considered appropriate for comparison between and within the participants of this study.

The questionnaire given upon completion of the recording task illuminated some interesting phenomena. Participants articulated that they changed something between modes, but often had difficulty identifying a specific vocal technique that accounted for that change. Among typical responses were such statements as, "I try to blend with the choir," which does little to explain specific vocal techniques. One particularly self-aware singer said, "I try to minimize the width of my vibrato. I do still keep it (unless specifically asked not to), but in choral music, I try to use it as a way of keeping the tone vibrant and active, whereas in performance (opera), I use it as an artistic tool." This participant's actual vibrato performances seemed consistent with her verbalization: her vibrato extents were less in choral mode than for solo mode, and her duration percentages were much smaller in choral mode than solo mode. Pedagogues, both choral and applied voice, may consider encouraging students to articulate their technique with suitable vocabulary, which may serve to decrease the confusion between modes.

One important caution for this study concerns the manufactured reality of the choral singing experience. In the choral mode, participants were asked to sing as if they were members of the stimulus recording ensembles.

Although this method has some history in the literature (Rossing, Sundberg & Ternström, 1986), the setting is not fully realistic. Participants did not complain about the difficulty of this task, but one singer stated, "I tried to adjust my [technique], (vibrato, for instance), but it is hard to adjust without singing with a full choir around you." Future research should aim to identify a method for obtaining separate singer recordings within a more authentic choral setting.

The participants' general inability to articulate their methods of technical adjustment between modes and contexts provides an opportunity for practical application. Applied teachers might dedicate some time in voice lessons to help students identify strategies for making vocally efficient adjustments between modes and contexts, a practice they likely already undertake when addressing the variety of solo literature. Choral directors might consider increasing specificity when referring to vibrato. Before asking students to remove vibrato entirely, addressing the rate or extent of the vibrato could achieve desired results. Studies by Dromey, Carter and Hopkins (2003, 2010) demonstrate the ability of singers to adjust their vibrato performance when called upon to do so.

Additionally, the phenomenon of "voicing" a section, whereby a choral director places singers in a configuration where their voices do not "fight," a method made popular by Weston Noble (Giardiniere, 1991, Noble, 2005), may be associated with vibrato rates. This idea of compatible voice placement presents an interesting opportunity for future research of vibrato in choral singing. In a similar manner, Daugherty's work (1999, 2003, 2013) on the use of lateral spacing in choir formations has shown improved conglomerate sound as indicated by perceptual and acoustical measures. Future studies may examine individual performances of singers in varying choir configurations, using a variety of measures: vibrato, intonation, and spectral analysis.

This study contributes to the research literature about differences between solo and choral singing modes by documenting among a particular group of singers that vibrato usage can vary according to singing mode without specific verbal instruction to change vibrato. This difference, moreover, appears to occur in the varied sung literature used for this study and regardless of participants' major focus of voice training. Data from this study thus augment the anecdotal discussions of vibrato taking place within the vocal education community, and they provide an empirical starting point for discussion between voice teachers and choral directors about vibrato usage in solo and choral singing.  [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.

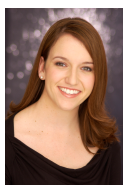
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Appendix Participant Questionnaire

Demographic Information:

Participant Number _____ Age _____
Major _____
How many years have you studied private voice? _____
How many years have you sung in choir? _____

Questionnaire:

- 1) Do you feel there are any vocal adjustments to be made between singing as a soloist and singing as a member of a choral ensemble? Y or N (Circle One)
- 2) If yes, please describe: (Continue on back if more space needed.)

- 3) Did you actively adjust your vocal technique when changing between the solo and choral excerpts?
Y or No (Circle One)
- 4) If yes, please describe:

- 5) What changes, if any, do you think are appropriate to be made to singing technique between music of Mozart (Classic Period) and Rutter (Contemporary)?

- 6) Did you actively adjust your vocal technique when changing between the Rutter and Mozart? Y or No (Circle One)

If yes, please describe:

