

Effects of a Straw Phonation Protocol on Acoustic and Perceptual Measures of an SATB Chorus

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Summary: Background. Recent scholarship has suggested that semi-occluded vocal tract (SOVT) exercises may increase vocal economy of individuals by reducing vocal effort while maintaining or increasing acoustic output. Choral singers, however, may use different resonance techniques or change voicing behaviors in an effort to hear their own sound in relation to others. One investigation revealed significant increases in a choir's mean spectral energy after participating in a straw phonation protocol. However, that study reported only acoustic measures and did not include choristers' perceptions of the choral sound and their own voicing efficiency.

Objective. The purpose of this study was to measure the effect of a straw phonation protocol on acoustic (long-term average spectrum) and perceptual (self-report) measures of the choral sound of an intact soprano, alto, tenor, and bass (SATB) choir.

Study design. This is a quasi-experimental, one-group, pretest-posttest design.

Methods. An SATB choir (N = 48 singers) performed a Renaissance motet, participated in a 4-minute voicing protocol with a small straw, and then sang the motet a second time. They completed the same procedure later in the rehearsal.

Results. Long-term average spectrum results indicated no statistically significant mean changes in spectral energy after the SOVT protocols. Most participants, however, perceived that the choir sounded better (78.26%) and that their own vocal production was more efficient or comfortable (73.91%) following the protocol.

Conclusion. Choristers perceived less vocal effort while maintaining vocal output after straw phonation, which may feasibly align with extant solo research. More research may determine whether this result is due specifically to SOVTs.

Key Words: Semi-occluded–SOVT–Straw phonation–Choral acoustics–Choral pedagogy.

INTRODUCTION

Private voice instructors, choral directors, and voice therapists utilize a wide array of techniques to evoke efficient voicing from their singers or clients. One common technique involves the narrowing of the vocal tract to create a partial constriction of airflow between the vocal folds and the lips. Voice professionals of all types have advocated the use of these semi-occluded vocal tract (SOVT) exercises,^{1–12} which may include lip or tongue trills, nasal consonants, sustained voiced fricatives, raspberries, voicing through a small opening in the lips, and voicing through a straw or tube. These varied exercises are all used to elicit improvements to vocal sound while reducing effort and easing the stresses inflicted on the vocal folds during phonation. Research with solo singers has indicated that SOVT exercises result in changes in vocal tract impedance and increases in pressures within the airway, both above and below the larynx.^{13,14} These changes may result in reduced vocal fold collision force during phonation and increased acoustic energy created by each collision.¹⁵ They may also evoke a decrease in phonation threshold pressure (ie, the minimum subglottal pressure required to initiate and sustain phonation),¹⁶ which could result in a perception of less voicing effort.

Several researchers have further investigated the effects of various SOVT exercises in individuals. Laukkanen et al,¹⁷ for example, used surface electromyography to measure anterior neck muscle activity during a spoken vowel task in six participants. In four cases, participants evidenced reduced neck muscle activity in posttest measurements immediately after an exercise using a bilabial fricative /β:/ (ie, vocalizing through a small opening in the lips). These reductions took place without changes to the voice source. The researchers argued that results may have been an indication of increased vocal economy, “characterized by the possibility to achieve the same acoustic output with less laryngeal effort.”¹⁷

Others have measured the effect of various SOVT exercises on vocal fold closed quotient (CQ), a ratio of vocal fold closure time divided by the duration of a glottal cycle.¹⁸ The CQ is thought to be a potential measure of vocal fold impact stress.¹⁸ Dargin and Searl found that four singers who sustained an /a/ vowel on a comfortable pitch evidenced increased CQ after completing straw phonation, lip trill, and tongue trill exercises.¹⁹ Other researchers found increases in CQ of both healthy and disordered voice participants as they performed various SOVT exercises.^{19,20}

In another pre/post design, however, Gaskill and Erickson measured decreases in CQ of both trained (n = 10) and untrained (n = 8) participants as they sustained a lip trill for approximately 1 minute on a spoken pitch.²¹ The untrained singers experienced a subsequent significant increase in posttest measurements, whereas the trained singers' CQ measurements remained slightly below baseline levels. In another study, a male singer participant had lower CQ on a spoken repetition of a syllable after 5 minutes of both straw and tube phonation.²² In addition, he increased spectral prominence in the singer or speaker's formant cluster region (ie, vocal “ring”) and was rated by four judges

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to have improved voice quality after both protocols. Both the acoustic and the listener effects were more robust with a narrow straw (2.5 mm × 13.7 cm) than with a larger tube (9 mm × 27 cm). These researchers argued that the acoustic benefits and decrease in CQ indicated improved “vocal efficiency and vocal economy (more loudness without an increase of vocal loading due to increased vocal fold collision).”²²

In addition to measuring CQ, Dargin and Searl¹⁹ also measured several physiological and acoustic parameters of four singers before and after they engaged in lip trill, tongue trill, and straw phonation exercises. They found that sound pressure level and air flow during a sustained comfortable pitch tended to increase compared with baseline after engaging in the SOVT exercises. They noted that the magnitude and consistency of these changes varied between participants. In a follow-up study, Dargin et al²³ reported generally positive effects of various SOVT exercises while observing laryngeal and pharyngeal activity through stroboscopy during voicing. The effects again differed in magnitude and by SOVT exercise between participants.

In another study,²⁴ 30 contemporary commercial singer participants performed a short sung excerpt and a sustained /a/ vowel that the researchers used to examine various acoustic parameters. The experimental group (n = 15) then performed a warm-up exercise while wearing a facemask that created a semi-occlusion, whereas the control group performed the exercise without the mask (n = 15). Participants in the experimental group experienced significant benefits to jitter, shimmer, and singing power ratio, whereas the control group did not. They also reported increased voicing comfort, sensation, and stability more than the control group.

These studies have quantified some potential benefits that many voice clinicians and studio instructors have experienced anecdotally in their clinics and studios. Their findings, however, are limited to effects on individuals. SOVT exercises, on the other hand, have also been widely recommended for choruses.^{9–12} Chorus America recently estimated that roughly 43 million people in the United States participate in some kind of chorus, with the highest participation rate identified as volunteer or community choruses (Chorus America).¹ Many vocalists may receive the bulk of their voice training in these nonprofessional ensembles. In such settings, choristers contend with varied challenges because of their need to hear themselves in relation to those around them (self-to-other ratio).²⁵ Researchers also found that a group of male singers used less singer’s formant cluster energy when singing in “choral mode” instead of “solo mode.”²⁶ Listeners in another study tended to prefer the sound of a group that intentionally used less singer’s formant resonance.²⁷ Therefore, the acoustic and functional changes reported in studies with individual singers may not directly apply to choristers.

To address this deficit in the extant literature, we previously tested the effect of a straw phonation protocol on a small soprano, alto, tenor, and bass (SATB) choir (N = 15 singers) who performed two pieces of varied styles and tempos.²⁸ The choir performed the two pieces while following a pre-recorded conductor and subsequently took part in a 4-minute straw phonation protocol. The protocol was based on the instructional video by the National Center for Voice and Speech in which Ingo Titze

demonstrated various voicing tasks through a small stirring straw.²⁹ The choir then performed the pieces a second time immediately after completing the protocol. We measured choral timbre using long-term average spectrum (LTAS) analysis, which is the mean of the acoustic energy across a spectrum (eg, 0–10 or 2–4 kHz) over a period of time (typically around 1 minute or more). Researchers have used LTAS to measure conglomerate, choral sound related to various conductor gestural conditions,³⁰ choral formations,^{31,32} chorister spacing conditions,³³ and chorister register and dynamic conditions.³⁴ In addition to measuring the spectrum in the 0–10 kHz region, we measured the 2–4 kHz region, which is the area in which the human ear is most sensitive³⁵ and also encompasses the approximate location of the “singer’s formant” cluster.³⁶

Results indicated small, statistically significant increases in the mean spectral energy in the 0–10 kHz (0.32 and 0.20 dB SPL) and 2–4 kHz regions (0.46 and 0.25 dB SPL) on both pieces after the group straw-phonation protocol. The increase in mean spectral energy and that of all individual data points did not constitute a “just noticeable”³⁷ change (ie, about 1 dB SPL or greater) for normal-hearing humans. Results, however, seemed consistent with the solo literature that has demonstrated similar or increased vocal output with reduced vocal effort after taking part in a SOVT protocol. We recommended that investigators replicate the study with different ensembles and include singer perceptual data to determine whether singers would report changes in their perceived vocal efficiency and the sound of the choir after taking part in the straw phonation protocols.

To that end, the purpose of this investigation was to measure the effect of a SOVT protocol (ie, straw phonation) on acoustic (LTAS) and perceptual (self-report) measures of conglomerate, choral sound of an intact SATB choir. The following research questions guided the investigation.

- (1) Will there be significant changes in the choir’s mean spectral energy (0–10 kHz) as the choir sings before and after taking part in a 4-minute straw phonation protocol at the beginning and midpoint of a 2-hour rehearsal?
- (2) Will there be significant changes in the choir’s mean spectral energy in the acoustic region in which the human ear is most sensitive (2–4 kHz)?
- (3) Will any mean spectral differences be 1 dB or greater, possibly making them audible to normal-hearing humans?
- (4) Will participants report changes in the overall choral sound and in their own vocal efficiency or comfort after participating in the straw phonation protocol?

METHOD

Participants

Singer participants (N = 48) in this study constituted an intact SATB (n = 15 sopranos, n = 10 altos, n = 8 tenors, and n = 13 basses) choir made up of male (n = 21) and female (n = 25) university community singers (ie, n = 35 university students, n = 1 university teaching faculty, n = 5 graduate students, and n = 5 community members). Singers were 17 to 56 years old (*M* = 21.5, *SD* = 6.2). Ten of the participants (21.7%) identified themselves

as music majors. These students were pursuing undergraduate degrees in music therapy ($n = 4$), vocal performance ($n = 2$), piano performance ($n = 2$), vocal performance, and music education ($n = 1$), or a Master's degree in choral conducting ($n = 1$). Two additional students were pursuing minors in music. The remaining 34 participants were not pursuing a music degree.

The ensemble met twice weekly for 2 hours and performed multiple times each semester. Rehearsals included a roughly 10-minute vocal warm-up before rehearsal of concert repertoire. These warm-up procedures consisted of various vocal exercises, including some that were semi-occluded (eg, lip trill, sustained humming), but did not include straw phonation until the experimental procedures during data collection. The data collection took place in early October of a semester that ran from mid-August through early December.

Procedures

The recording procedures took place in the choir's regular rehearsal room. Choristers stood on a set of tiered platforms with the chairs removed and with 2 feet between their shoulders, which conformed to "lateral" spacing used in previous research.³³ This spacing allows favorable self-to-other ratios for singers when compared with "close" spacing (ie, shoulder-to-shoulder). After they convened on the platforms, we distributed strips of masking tape to the participants and instructed them to place the tape on the outside of their left feet, starting at the toe and extending toward the heel. They then wrote their initials on the tape and used the strips to maintain consistent formation and spacing through the study protocols.

Conductor stimulus

We used a pre-recorded conductor to ensure consistency in the choir's visual stimulus (ie, conductor gesture size, facial expression, posture, tempo, etc.).^{28,30,33,38-40} The conductor's image was from the upper thigh to just above his head. A projector suspended from the ceiling cast the conductor image onto a screen in the front of the room. Participants could clearly see the projected image from their standing positions. The choir rehearsed with the conductor stimulus video in the rehearsal before the evening of data collection (2 days before) to become familiar with the conductor tempo and expressive gestures.

Repertoire

Immediately after taking places on the risers, the choir performed from memory "Jesu Dulcis Memoria" by Tomás Luis de Victoria. The unaccompanied, largely homophonic (ie, all parts singing simultaneously in the same rhythm) motet was 1 minute 47 seconds in duration. This initial run-through served as a memorization check and re-familiarized the ensemble with the conductor stimulus. We then led the choir through a 4-minute warm-up session that included typical vocal exercises used by their regular conductor (observed in previous rehearsals) but excluded exercises consisting solely of vowels or consonants that could semi-occlude the vocal tract. These exercises included (a) an ascending and descending /i/ vowel on the first three notes of the major scale, (b) a faster, marcato ascending and descending pattern on the repeated syllable /bo/, (c) a descending arpeggio

on the syllables /ju-hu/, (d) an arpeggio starting on the fifth note of the scale that ascended and then descended on the phrase "I sigh to sing," and (e) a pattern that ascended and then descended by thirds on alternating vowels (/i/ and /o/). Following the warm-up session, we began audio recording. We then asked participants to check their standing positions, face the projection screen, and follow the conductor.

Straw protocol

Following the first recording of the motet, we distributed to each participant a 12.7-cm stirring straw with an opening diameter of 2.55 mm. The straw measurements were comparable with those used in studies of vocal tract pressure, which indicated that a small straw created among the highest levels of intraoral pressures of varied SOVT exercises.¹⁴ After distributing the straws, we led singers through a protocol that was based on the YouTube video produced by the National Center for Voice and Speech (NCVS).²⁹ We chose this video because (a) it was produced by researchers who have investigated SOVT exercises, (b) it is easily accessible to choral directors, and (c) we had used the protocol in our initial study related to straw phonation protocols in choral settings.

Before beginning the straw protocol, we gave a short tutorial on straw phonation technique based on Titze's recommendations in the video. First, we noted that air should not escape through the nose or sides of the mouth while phonating through the straw. Participants then practiced by phonating through the straw while monitoring air flow and while plugging their noses periodically. Next, we instructed participants to make sure they used effective breath flow and that they should use "belly accents"²⁹ rather than neck muscle tension to maintain vocal energy. Participants phonated again on a single note while monitoring extrinsic neck tension and their use of abdominal muscle support. They could also use their hands to manually palpate the neck and abdominal area. Finally, we instructed participants to phonate through the straw as though they were creating a large sound even though the sound through the straw would be small.²⁹ Participants practiced a final time while focusing on these three instructions.

Following the tutorial, participants took part in the protocol. It began with a series of vocal glides, each around 10–15 seconds, starting very low in the range, ascending to very high in the range, and descending gradually again to the lowest note. Participants completed six glides over the course of roughly 1 minute and 45 seconds. Next, participants completed a variation on a vocal glide with added "accents,"²⁹ as demonstrated by Titze in the NCVS video. As participants began each ascending pitch glide, they used abdominal pulses to add a specified number of accents, each of which caused a temporary increase in pitch and volume as the glide ascended through the range. We encouraged participants to create these "hills" through abdominal support. Following the hills, participants then completed each glide by gradually descending again to the lowest note. Participants performed glides with accents six times, beginning with three pulses and adding one until reaching seven pulses (performed twice), over the course of roughly 1 minute and 30 seconds. Finally, participants sang a unison rendition of the "Star Spangled Banner"

through the straw while omitting the second repetition of the initial melodic line (“Whose broad stripes. . .”). We again encouraged participants to use breath energy and abdominal support with as little neck tension as possible. This rendition, in the key of A major, took roughly 1 minute and 15 seconds.

After the completion of the straw protocol, we directed participants to check their standing positions, look at the projection screen in the front of the room, and follow the conductor. They then sang the piece again while following the pre-recorded conductor.

After the initial recording procedures, the rehearsal continued under the direction of the ensemble’s assistant conductor for roughly 45 minutes before a 10-minute mid-rehearsal break. The choir then re-convened and began rehearsal again. After a roughly 10-minute rehearsal period, we then directed the ensemble to face the projection screen and take their places on the platforms. We recorded “Jesu Dulcis Memoria,” led the ensemble in the same straw protocol (with an abbreviated tutorial), and recorded the motet a final time.

Recording equipment

We audio recorded the choir at a 96 kHz sampling rate (24 bits) in .wav format using a ZOOM H6 device with a MSH-6 MS microphone capsule. The device stood 10 feet from the front of the choir and 5 feet 8 inches from the front wall of the rehearsal hall and was adjusted to conductor ear height. Long-term average spectra, which are often used to measure overall choral timbre,^{28,30–34} provided acoustic data for pre- and posttest comparisons. We used *KayPENTAX Multi-Speech Model 3700* (version 3.4.1, PENTAX Medical, Montvale, New Jersey, U.S.A.) software to analyze the recordings. The software extracted the LTAS data using a window analysis size of 512 points with no pre-emphasis or smoothing, a bandwidth of 187.5 Hz, and a Blackman window.

Questionnaire

Following the recording procedures, we distributed a short questionnaire designed to elicit participant perceptions about the overall choral sound and their own vocal production before and after the straw phonation protocols during the mid-rehearsal data collection. The first question was “I thought the choir as a whole sounded best on the following excerpt.” Participants circled either “first” or “second” and then completed an open-ended question as to why they believed that was the case (ie, “Why?”). They then followed the same procedure for the question “I thought my own vocal production was most efficient/comfortable on the following excerpt.” They circled either “first” or “second” and completed another open-ended question as to why they believed that was the case.

RESULTS

LTAS results

0–10 kHz region

Figure 1 displays all acoustical data from the beginning and mid-rehearsal data collections. Pre- and post-straw protocol LTAS data at the beginning of the rehearsal revealed a mean increase of 0.04 dB SPL (*range* = –0.44 to 0.63 dB SPL, *SD* = 0.23) in

overall spectral energy across the 0–10 kHz spectrum. Paired *t* test analyses, however, indicated that the increase was not statistically significant, $t(53) = 1.37$, $P = 0.18$. In addition, no individual data points across the 0–10 kHz spectrum changed by at least 1 dB SPL.

Similarly, pre- and post-straw LTAS data in the mid-rehearsal data collection revealed a mean increase of 0.05 dB SPL (*range* = –0.81 to 1.07 dB SPL, *SD* = 0.39) in overall spectral energy. That increase was also not statistically significant, $t(53) = 0.98$, $P = 0.33$. There was one data point (of 54) that exceeded a 1 dB SPL difference and three other surrounding points that were above 0.83 dB SPL in the 5.0–5.7 kHz region.

2–4 kHz region

We conducted additional paired *t* test analyses for pre- and posttest LTAS data for the data points in the 2–4 kHz region. There was a slight decrease in mean spectral energy of 0.09 dB SPL at the beginning of rehearsal that was not statistically significant, $t(10) = 0.94$, $P = 0.37$. Results indicated no change in the mean spectral energy between 2 and 4 kHz at the mid-rehearsal data collection, $t(10) = 0.03$, $P = 0.97$. No individual data points in this region approached a difference of 1 dB SPL at either rehearsal point.

Questionnaire responses

Choral sound

Forty-six participants responded to a brief questionnaire that solicited perceptions of the choir’s performance related to the mid-rehearsal round of straw phonation protocols. Thirty-six participants (78.26%) reported that the choir as a whole sounded best after the straw protocols compared with 9 participants (19.56%) who thought the choir sounded better before the protocols. One participant (2.17%) was “not sure.” Participants gave 51 discrete reasons for preferring the sound of the choir as a whole during one excerpt over another. The most frequent categories were those related to vocal timbre ($n = 22$) and vocal technique or efficiency ($n = 18$). Of the 40 comments related to vocal technique (eg, “more supported,” “more warmed up,” more supported breath use) or vocal timbre (eg, “sound was fuller and seemed more mature,” better clarity of sound,” the blend sounded better in the second), 38 (95.00%) indicated a preference for the post-straw excerpt. The remaining comments were related to dynamics ($n = 4$), timing ($n = 3$), confidence ($n = 2$), fatigue ($n = 1$), and diction ($n = 1$).

Individual vocal efficiency

Similarly, 34 participants (73.91%) perceived that their own vocal production was most efficient or comfortable after the straw protocols compared with 12 (26.09%) who believed it was most efficient or comfortable before the protocols. Participants gave 47 discrete reasons for noting which excerpt they perceived their own vocal production to be most efficient or comfortable. Forty-two of those comments were related to vocal technique. Of those 42 comments, 34 (80.95%) indicated a preference for their technique after the straw protocol (eg, “lot more supported sound,” “was less strained,” “felt clearer and stronger without pushing”) and 8 (19.05%) indicated a preference for their technique before

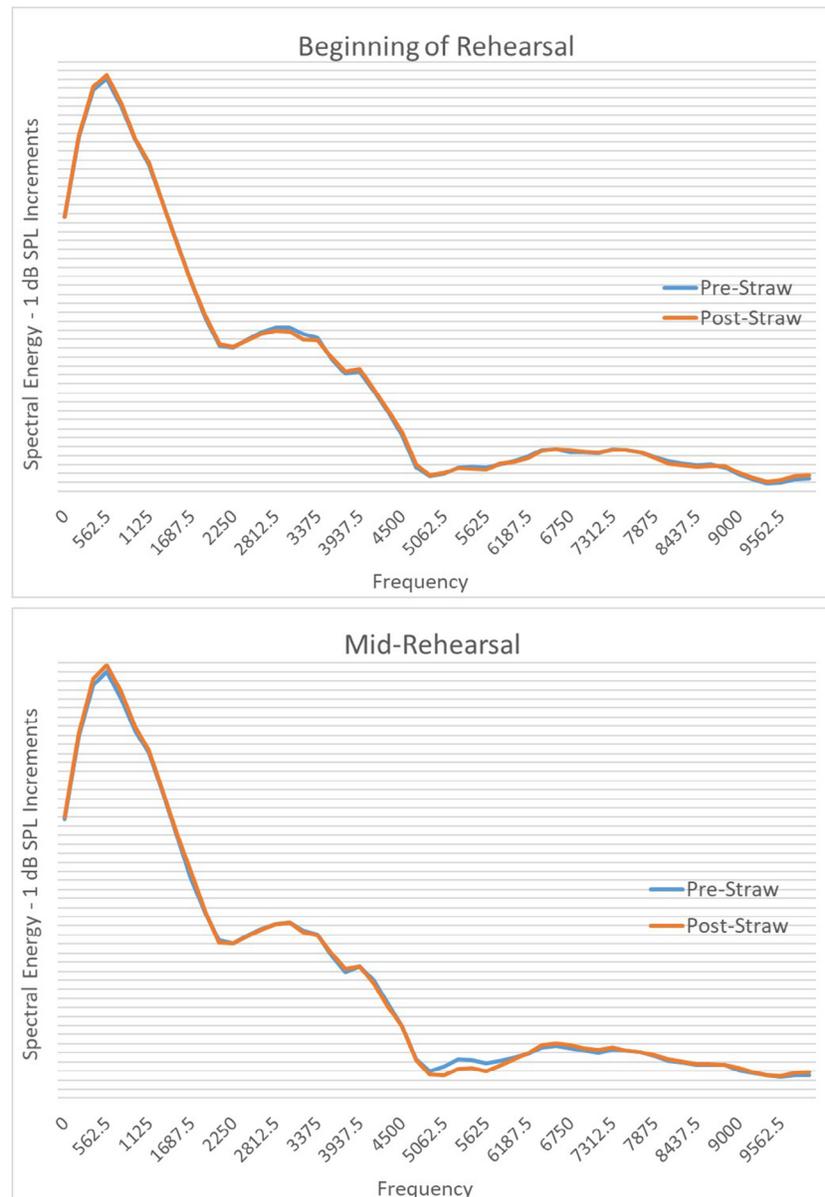


FIGURE 1. Pre- and posttest spectral energy, 0–10 kHz for the beginning (top) and mid-rehearsal (bottom) data collections.

the straw protocol (eg, “I could breathe easier,” “I didn’t run out of breath,” “I could sing more effortlessly”). The remaining comments were related to fatigue ($n = 2$), timbre ($n = 2$), and timing ($n = 1$).

DISCUSSION

The purpose of this investigation was to measure the effect of a SOVT protocol (ie, straw phonation) on acoustic (LTAS) and perceptual (self-report) measures of conglomerate, choral sound of an intact SATB choir. The results indicate that changes in mean spectral energy in the 0–10 and 2–4 kHz regions were not statistically significant after straw phonation either at the beginning of a 2-hour rehearsal or at the midpoint of this extended rehearsal period. Participants, however, perceived that the choir sounded better and that they individually sang more efficiently after taking part in the straw phonation protocol.

The results of the study are specific to the specific choir and choristers in this investigation and may not be generalizable. However, these findings raise some matters that merit consideration by researchers and choral conductors alike. Moreover, the paucity of empirical data thus far with respect to possible effects of straw phonation protocols in a choir setting, as opposed to solo voice contexts, suggests an obvious need for further research.

To our knowledge, there is only one previously published study in which researchers have tested the effect of a straw phonation protocol in a choral setting on LTAS measures of choir sound.²⁸ In that previous investigation, we found small but statistically significant increases in mean spectral energy of choral sound attributable to a straw phonation protocol. Those increases occurred regardless of the contrasting, choral literature performed. Such results align with findings of the present study,

in that LTAS analyses in both studies revealed small mean energy variances (less than 1 dB SPL) attributable to a straw phonation protocol. In the previous investigation, which contrasted the effects of straw protocol measures according to diverse literature sung, these differences were statistically significant; in the present study, which compared a straw phonation protocol instituted at different time points within a choral rehearsal, these differences were not statistically significant. Thus far, in other words, employing a straw phonation protocol with two different choirs, which performed various sung excerpts in different venues, appears to result in small, perhaps inconsequential, mean differences in the spectral energy of choral sound.

Subsequent studies may confirm or deny this apparent pattern in LTAS measures. Because of the nigh ubiquitous presence of choral singing in human populations across the globe, obtaining a truly random sample to represent “choir” would be a difficult, if not impossible, task. Yet, future research studies can continue to test incrementally the stability of LTAS findings to date by utilizing choirs of different ages, ability levels, singing a variety of scored or improvised musical excerpts in various styles, performing in different venues with varying degrees of inter-chorister spacing. Subsequent investigations might also employ a longitudinal, rather than cross-sectional design, acquiring LTAS from the same choral ensemble across multiple rehearsals.

Perceptual findings from the present study indicate that from their positions within the immediate soundscape of the choir, participants, on the whole, report a preference for the overall sound of the choir following straw phonation, as well as a perception that they as individuals sang more efficiently after the straw protocol. This finding may likely be the more consequential result of the present study in terms of future research. Certainly, dependent perceptual measures, including reports from an array of listeners from an audience perspective in addition to chorister reports, should be incorporated in subsequent investigations along with consideration of the variables sketched above with respect to LTAS measures.

The perceptions of participants in this study are important for at least three major reasons.

First, it could well be that any effect of a straw phonation protocol with choirs is not best measured with LTAS. This possibility makes sense in that LTAS analyses evaluate conglomerate sound after it has passed through the vocal tracts of individual sound sources and interacted as well with room acoustics. Straw phonation and other SOVT exercises, on the other hand, primarily address efficiency of phonation at and near the vocal folds.

Second, that singers in this study perceive benefits from participating in a straw phonation protocol during a choir rehearsal naturally raises the question of whether this perceived benefit results from a “masterclass effect.” That is, because of the one-group pretest/posttest design of this investigation, participants may have been primed to think that the protocol would be useful, regardless of the actual efficacy of the technique. Researchers may wish to replicate straw phonation protocols with a control group of singers from the same choir that performs the same protocol on an unoccluded vowel (eg, /a/) to test this possibility.

Third, acquisition of data in naturalistic settings, such as choir rehearsals, limits the types of measurements that might feasibly be employed, as does the number of singers phonating simultaneously in a choir. Although we did not collect physiological data from individual choristers in this investigation, future researchers might well consider employment with selected choristers of such noninvasive physiological measurement tools as ambulatory electroglottography, voice dosimetry, noise dosimetry, and perhaps surface electromyography in addition to collecting LTAS and perceptual data. In that manner, investigations might explore possible associations between individual chorister perceptions and individual physiological and source-acoustic data acquired while participants sang chorally.

It may also be informative for some studies to forgo a naturalistic setting in favor of testing individual singers in choir-like or semi-naturalistic circumstances. For instance, replicating some measurements employed in previous SOVT studies of solo singers as individual singers simultaneously experience a semblance of choral singing, perhaps through hearing and singing along with others via a headphone placed on one ear or through speakers in a semi-anechoic room, could be instructive. It might be, for example, that utilizing SOVT exercises such as straw phonation during choir rehearsals does not change dramatically the timbre of the choir as a whole as much as they enable more efficient, easy production of the sound already being made. That is, it is plausible that choral singers may also enjoy benefits of SOVT exercises previously reported in the solo literature (eg, reductions in phonation threshold pressure).¹⁶ Such benefits, which could be indications of increased “vocal efficiency and vocal economy,”²² could inform participants’ generally favorable perceptions of straw phonation.

In this regard, researchers may wish to have a qualified voice instructor observe the technique of individual singers as they perform straw protocols in a choir context to ensure that they are, in fact, utilizing appropriate “abdominal support.” Subsequent investigations might also include post facto laryngeal examinations to determine whether participants who find straw phonation to be difficult may have a visible physical impairment.

We decided to use used small stirring straws (2.55 mm diameter) in this investigation. These straws were similar to our previous study on straw phonation in a choral ensemble²⁸ and to the straw recommended by Titze in the NCVS instructional video.²⁹ They were also similar to the straws shown to create some of the greatest increases in vocal tract pressures among SOVT exercises.¹⁴ Titze has suggested that straw users might consider using semi-occlusives “in the order ‘greatest effect, but most artificial’ to ‘smallest effect, but closest to natural.’”¹⁵ However, we noted that the dramatic increase in impedance seemed to create difficulty for participants who had not previously experienced straw phonation. Indeed, one singer noted that her vocal technique suffered because she experienced dizziness after prolonged use of the straw. Given that observation, researchers may also consider using larger straws and moving toward a straw that has greater impedance as singers become more acquainted with the technique.⁴¹ Future studies could also use multiple straw sizes and allow participants to choose the straw they prefer.

CONCLUSION

In sum, participants in this study perceived the straw phonation protocol as beneficial both to choir's sound and their own vocal production, even though LTAS analyses yielded very small differences in mean spectral energy following the straw phonation protocol. Future studies should explore this phenomenon carefully, as sketched above. At present, the limited research to date gives little reason to doubt that employment of a straw phonation protocol in a choir rehearsal setting may have merit, and some reason to suspect it may have benefits, at least perceptually. At the same time, ongoing systematic research in choir or choir-like settings is warranted.

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