

The Effects of Three Physical and Vocal Warm-Up Procedures on Acoustic and Perceptual Measures of Choral Sound

*Sheri L. Cook-Cunningham and †Melissa L. Grady, *Conway, Arkansas, and †Lawrence, Kansas

Summary: Objective. The purpose of this investigation was to assess the effects of three warm-up procedures (vocal-only, physical-only, physical/vocal combination) on acoustic and perceptual measures of choir sound.

Methods. The researchers tested three videotaped, 5-minute, choral warm-up procedures on three university choirs. After participating in a warm-up procedure, each choir was recorded singing a folk song for long-term average spectra and pitch analysis. Singer participants responded to a questionnaire about preferences after each warm-up procedure. Warm-up procedures and recording sessions occurred during each choir's regular rehearsal time and in each choir's regular rehearsal space during three consecutive rehearsals.

Results. Long-term average spectra results demonstrated more resonant singing after the physical/vocal warm-up for two of the three choirs. Pitch analysis results indicate that all three choirs sang "in-tune" or with the least pitch deviation after participating in the physical/vocal warm-up. Singer questionnaire responses showed general preference for the physical/vocal combination warm-up, and singer ranking of the three procedures indicated the physical/vocal warm-up as the most favored for readiness to sing.

Conclusions. In the context of this study with these three university choir participants, it seems that a combination choral warm-up that includes physical and vocal aspects is preferred by singers, enables more resonant singing, and more in-tune singing. Findings from this study could provide teachers and choral directors with important information as they structure and experiment with their choral warm-up procedures.

Key Words: Warm-up–Choir–Physical–Vocal–Acoustic and perceptual measures.

REVIEW OF LITERATURE

Warming up the body before physical activity has been a long-accepted and established practice. Athletes spend a great deal of time warming up before participating in any sports practice or competition. Voice users, particularly singers, have also been encouraged to warm-up the vocal structures before engaging in any vocal activity. Choral conductors are advised to provide a warm-up segment at the beginning of their rehearsal. However, there exists a scarcity of empirical data that has established the need for a choral warm-up, the goals of a choral warm-up, or reliable testing methods regarding the effectiveness of choral warm-ups.

Athletes use a wide variety of warm-ups to achieve positive physical results. Bishop^{1,2} discussed the acceptance of warming-up before general physical exercise even though there was a lack of scientific evidence as to the effectiveness of specific warm-ups. His findings suggested that an active warm-up (jogging, swimming, calisthenics) of 3–5 minutes in duration and of moderate intensity could improve short-term performance, due mostly to an increase in muscle temperature.

Researchers compared singers with athletes with the same warm-up and training principles applied to both. Sundberg and Rossing³ believed that the vocal folds, which consist of muscle tissue as a major component, require efficient blood flow to work

at an optimum level. They surmised that good circulation would be a result of an appropriate warm-up procedure.

Saxon and Berry⁴ attempted to establish a relationship between exercise physiology and voice training, suggesting overloading the muscles used and gradually increasing the resistance placed on those muscles.

Voice pedagogues in particular wrote much about the necessity of warming up the vocal instrument before attempting any type of singing. McKinney⁵ recommended a gradual warm-up of the voice, starting in the most comfortable part of the voice's range and using exercises of a limited range. Miller⁶ stated that any singer who did not feel he or she needed a warm-up was deluding himself or herself. He encouraged warm-up of the entire body, not just the larynx.

Although the goals and types of a warm-up have appeared to be many and varied, there also exists a great deal of confusion regarding measurement parameters. Elliot et al⁷ hypothesized that a vocal warm-up would lower phonation threshold pressure (PTP). Although subjects reported positive perceptual results (improved voice timbre, easier to sing at high pitches, voice was in better condition), PTP data varied greatly. Results indicated PTP pressure increased with pitch among some participants, decreased in others, and remained unchanged in other subjects.

Researchers⁸ measured the effects of vocal warm-ups on PTP among solo soprano singers (N = 10). They reported PTP levels increased after warm-up for high pitch phonation but remained the same for comfortable and low pitch phonation. These results contradicted the perceptual results from Elliott et al⁷ and suggested that PTP may not be a reliable measure of warm-up effectiveness.

Amir et al⁹ studied the effectiveness of vocal warm-ups on young female singers (N = 20) using acoustic analysis. Their

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From the *The University of Central Arkansas, Conway, Arkansas; and the †The University of Kansas, Lawrence, Kansas.

Address correspondence and reprint requests to Sheri L. Cook-Cunningham, The University of Central Arkansas, 201 Donaghey Ave., Conway, AR 72035. E-mail: scookcunningham@uca.edu

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results indicated reduced frequency-perturbation and amplitude-perturbation values, increased singer's formant amplitude, and improved noise-to-harmonics ratio. The warm-up did not have a significant effect on participants' tone-matching accuracy. Their results suggested that vocal warm-ups positively impacted vocal quality and that acoustic analysis could assist in quantifying this impact.

McHenry et al¹⁰ tested the effectiveness of vocal-only warm-up exercises versus vocal warm-up exercises combined with aerobic activity on spoken vocal production of 20 actors. Their study measured acoustic parameters (jitter, noise-to-harmonics-ratio), PTP, and self-perceived vocal effort. Results indicated a significant decrease in PTP values for women in the combined versus the specific warm-up and no significant difference for men. Jitter percent values for men were significantly lower for men in the specific warm-up than the combined warm-up.

McHenry and Evans¹¹ studied the effects of a 30-minute aerobic workout on sound pressure levels of vocal performance majors (N = 22). Results indicated that 17 participants maintained or increased sound pressure level after the aerobic workout and that most participants exhibited positive aerodynamic changes during singing after the workout.

Although the majority of research to date has focused on warm-up procedures used by speakers or singers in a solo context, warming up the voice in a choral setting has been a much-discussed topic in choral journals. Titze¹² discussed the benefits of a vocal warm-up in terms of motor skills, with muscles and tissue responding differently after they have already undergone the same movement. He suggested individual vocal warm-ups for singers, similar to that of instrumentalists, followed by group choral warm-ups focusing on tuning and achieving choral blend.

Choral directors suggested additional benefits for choir warm-ups, including using the warm-up as a means to prepare the mind and body for the upcoming rehearsal and for teaching vocal skills and concepts. Other goals of a warm-up could include ear training, mind training, and tuning the voices in the choir.¹³⁻¹⁵

Physical fitness trends also influenced choral warm-ups. Kuhn¹⁶ advocated for adding yoga to singing warm-ups to improve breath, posture, vocal accuracy, and concentration, whereas Park¹⁷ suggested incorporating tai chi into the choral warm-up as a means of improving natural breathing, body alignment, and muscle relaxation around the laryngeal area.

Choral textbooks that are commonly used in undergraduate choral methods classes often devote entire sections or chapters to the subject of choral warm-ups. Many of the writers of these

texts suggested that the focus of the warm-up period was to develop vocal technique. Although their methods and order of warm-ups varied from author to author, they discussed many of the same technical goals, such as posture, breath support, tone, range, intonation, and flexibility.

Incorporating some type of physical activity at the start of the rehearsal was recommended by several authors.¹⁸⁻²¹

The purpose of this study was to assess with intact university choirs (N = 3) the potential effects of three different choral warm-up procedures (vocal-only, physical-only, physical/vocal combination) on acoustic and perceptual measures of choral sound. The following research questions guided this investigation:

- (1) What effect, if any, do three different warm-up procedures (vocal-only, physical-only, physical/vocal combination) have on the choral sound of intact choirs, according to long-term average spectra (LTAS) analysis?
- (2) What effect, if any, do three different warm-up procedures (vocal-only, physical-only, physical/vocal combination) have on the intonation of intact choirs, according to pitch analysis?
- (3) What effect, if any, do three different warm-up procedures (vocal-only, physical-only, physical/vocal combination) have on perceptual measures of intact choirs, according to participant questionnaires?

METHODS

Singer participants

Participants (N = 61) constituted three established university choirs (two mixed voices and one female-only voice; [Table 1](#)).

Warm-up videos

Researchers used three videotaped warm-up procedures (physical-only, vocal-only, physical/vocal combination) to insure consistency between the multiple choirs. The same conductor appeared in all three stimulus videos. Each warm-up video lasted 5 minutes.

Vocal-only warm-up video

Researchers selected the vocal exercises (n = 13) used in the vocal-only warm-up video from a popular choral methods textbook (Brinson and Demorest, 2014). Vocal exercises began with gentle humming and transitioned into singing on multiple vowels and consonants, at varying tempos, multiple keys, and both major and minor tonalities. The video conductor demonstrated each

TABLE 1.
Demographics of Participating Choirs Including Level and Type of Choir, Number of Singers, Mean Age, and Number of Music Majors or Non-Majors

Choir	Voicing	Number of Singers	Mean Age of Singers	University Major	
				Music	Non-Music
Choir A	SATB	n = 22	22.68 years	n = 6	n = 16
Choir B	SATB	n = 21	21.50 years	n = 7	n = 14
Choir C	SSA	n = 18	21.00 years	n = 7	n = 11

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