On The Voice

Sharon Hansen, editor

Rethinking How Voices Work In a Choral Ensemble

by James F. Daugherty

CHORAL DIRECTORS traditionally study pedagogy of the solo voice. Moreover, they often take a number of years of private voice lessons, and, if they are fortunate, may also avail themselves of work in vocal anatomy, voice care, and how to teach voices in various stages of development.[1] Choral teachers are invited to approach choral sound as a whole, on its own terms. Much pedagogical literature evidences a decided gap when it comes to scientific understanding of the acoustical properties of choral sound and how they can inform choral singing.

The intent of this article is to focus on some common assumptions about choral pedagogy and choral sound in light of a small, but growing, body of empirical research in the acoustics of choir singing. Its aim is to encourage those who work with voices in choral contexts to become aware of such research and its potential significance for the pedagogy of choral sound.

A Reconsideration of Choral Singing

In a very broad and general sense, singing is singing. Human beings, after all, share a similar physiology for respiration, phonation, resonance, and articulation. Many vocal pedagogy and choral methods materials tend to reason and speak exclusively from this sort of global perspective. To the degree that there are traits and processes common to all human vocal production, this "one size fits all" approach is valuable, particularly in conjunction with scientific research on the individual human voice in the past thirty years.[2]

Beyond this generality, however, discourse on singing is often ambiguous, for human beings are also individually unique. No two vocal instruments are constructed precisely the same way (e.g., size and shape of the vocal cavities and resonating chambers, and length and tension of the vocal cords). Moreover, the likelihood of any two people developing identical patterns in the way agents of vocal articulation are used and programmed over time is extremely remote.[3]

Even more important for the present discussion, human beings sing in a variety of contexts and styles that impact how voices operate. Choral singing or group singing is one such context. Misunderstandings may arise when one continues to reason exclusively on a general level, i.e., "singing is singing," while operating in the more specific context of choir singing and conglomerate sound.

Howard Swan, in an influential essay, articulated an assumption common to much choral pedagogy when he described choral sound as primarily a summative event dependent on individual voices. This conceptual movement between individual and group was crystallized in Swan's final evaluations of six types or schools of choral sound. Within each school he first isolated the "Tonal Elements in One Voice" and then described the "Tonal Elements in the Chorus." Said Swan: "The tonal elements in each single voice relate directly to these group characteristics."[4]

This approach to choral singing rests on the premise that the whole is the sum of its parts, that choral sound is simply the product of the individual sound sources that contribute to it. From this perspective, mechanics of desirable choral sound vary little from the characteristic elements associated with individual vocal sound. The pedagogical implication is that working with the conglomerate sound of a choral ensemble differs only in degree from coaching an individual singer in a studio.[5]

Canons of logic refer to this kind of thinking as the fallacy of composition. The assumption is that characteristics of the parts transfer to characteristics of the whole, e.g., "Each part of this machine is

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light, therefore this must be a very light machine." Expressed in terms of choral pedagogy: "Each tenor in this choir has a wonderful voice, therefore this tenor section will sound wonderful."

If, however, as sociologists have long noted, people often behave differently in groups than they do as individuals, perhaps singers behave differently in ensembles than they do as soloists. Perhaps ensembles, moreover, have some life of their own over and beyond the individual behaviors of their members. Recent research suggests that such may be the case.

Choral Sound

Defined scientifically, choral sound is decidedly more than the sum of the individual sound sources that contribute to it. According to Sten Ternström, the "chorusing effect" occurs when

> many voices and their reflections create a quasi-random sound of such complexity that the normal mechanisms of auditory localization and fusion are disrupted. In a cognitive sense, the chorus effect can magically dissociate the sound from its sources and endow it with an independent, almost ethereal existence of its own.

Choral sound, as opposed to individual vocal sound, has properties of both complex tones and very narrow-band noise. Its sound pressure level (SPL), moreover, has large, random short-term variations due to beats produced by a sum of sounds that are similar, yet not phase coherent. Choral sound has a nuanced life of its own apart from the discrete individual sound sources that contribute to it.[6]

Choral Phonation

Moreover, individual singers in a choral context tend not to phonate the same way they do as soloists. In choral singing, there is an emphasis on fundamental tones rather than partials. Such emphasis on the fundamental tone in choral singing appears to be accomplished through adjustment in formant frequencies and a glottal change in waveform.[7] Sopranos (those singing higher frequencies), for instance, use a softer voice and weaker higher spectrum partials when asked to blend with other voices.[8] In fact, controlled research to date finds a significant preference among auditors for less resonant choral tone, i.e., emphasizing the fundamental tone without singer's formant.[9]

Venue Acoustics

Most choral methods materials tend to treat choral sound as a phenomenon controlled solely by the choir. That is, only occasionally do their discussions and recommendations consider the symbiotic relationship between choirs and the particular acoustic properties of venues in which ensembles rehearse and perform. The physical environment in which a choir sings, however, "is as much a part of the 'instrument' . . . as are the individual human resonators. . . ."[10] Many issues in choral singing are related, directly and indirectly, to the direct sound, early reflections, diffuse field, and reverberation time afforded by particular performance and rehearsal environments. As a case in point, Ternström found that choristers tended to raise their larynxes in more absorbent rooms and to lower them in more reverberant venues.[11]

Choir Formation

Choir formation and seating arrangements are another example of how misunderstandings occur when we carry assumptions about the voice on a general level ("singing is singing") over into the specific context of choir sound and choral pedagogy. Figures 1 and 2 represent the sorts of diagrams typically employed in the methods literature to show the contours of sectional and mixed formations. Beliefs about the acoustical effect of these formations typically accompany such illustrations. According to one author, "each arrangement will create an entirely different sound,"[11] while another likens choir formations to "the proper disposition of troops on a field to achieve a definite objective."[12] These and other broad claims, such as that sectional formation *per se* aids core sound,[13] or that mixed formation *per se* will fix intonation problems and improve blend,[14] are commonly repeated as gospel from one generation of choral methods literature to the next.[15]

There appears to be neither logical nor quantitative evidence for such assertions. For these claims to be universally true, one would need to assume that all choirs are alike, that all individuals within those choirs are alike and that all ensembles sing in similar acoustic venues. Such is not the case. Beyond the commonality that choirs are groups of human beings with larynxes, it is obvious upon reflection that choral ensembles are composed of varying and often uneven numbers of singers of different age levels, different voicings, distinct abilities, and unlike prior experiences, who sing in a surprising variety of acoustic environments. In other words, individual voices within a choir constitute neither equal nor universal units of measurement. As a case in point, research finds that individual singers within the same choir, subject to the same choral training, can vary greatly in their vocal output power.[16]

By the same token voice sections within choirs are not equal and universal units. Formation strategies that suggest, for example, sopranos (or altos or men) gener-

ally sound better when placed in one part of the choir as opposed to another location, suppose there exists some universal, acoustic construct of "soprano" independent of context. However, just as all sopranos are not alike, so do choir soprano sections differ in their sonic character, i.e., their abilities to find and match their particular group average in such matters as frequency, amplitude, and timbre. The only universal characteristic may be that these choristers happen to be reading the same vocal line, i.e., singing similar frequencies symbolized by shared notation.[17]

Canons of logic refer to this type of reasoning as the fallacy of division, the presumption that the parts are necessarily equal or like divisions of the whole. Not surprisingly, research suggests that traditional choir formations or seating arrangements based on the assumption that individual singers and voice sections are equal units of measurement play very little role in choral sound. In five studies to date that included choir formation as a variable, auditors reported virtually no statistically significant sound differences between sectional and mixed formations.[18]

Choir Spacing

Studies suggest that the spacing of singers in choirs contributes a desirable nuance to choir sound and also assists healthy phonation among choral singers. In a series of controlled studies, Daugherty assessed high school and college ensembles in three spacings: close, lateral, and circumambient (Figure 3).[19]

Using standing risers, lateral spacing was achieved with a distance of two lateral feet between singers standing on each of the three riser rows. Circumambient spacing was achieved by adding space between each row as well. The first row of singers stood on the floor eighteen inches from the risers, while the other two rows stood on the first and third risers, leaving the second vacant.

Results indicated significant preference for spread spacing, especially circumambient spacing, among both choristers and their auditors. Choristers reported significantly less vocal tension and better vocal production in spread spacing, and more independent singing and improved ability to hear themselves and the choir. With college-age singers, auditors favored circumambient spacing for female singers and lateral spacing for male voices. High school singers significantly preferred spread spacing; however, some less experienced singers felt uncomfortable with circumambient spacing. Directors of all ensembles involved thought spread spacing made a noticeable, positive contribution to their choirs' sound.

Feedback and Reference Sounds

In other studies, Ternström investigates what he terms Self-to-Other Ratio (SOR) in choir singing.[20] This phenomenon may ultimately relate to singer preference for spread spacing and thus contribute to understanding space within the soundscape of the choir.

According to Ternström's research, choir singers apparently have rather defined preferences for the balance between self-sound and other-sound. When the reference sound of the rest of the choir overpowers the airborne feedback received from one's own voice, as might happen in a choir singing with cramped spacing between and among singers, potentially all manner of chaos may ensue: over-singing, intonation problems, and less than ideal vocal production. Venue acoustics, of course, could exacerbate such problems still further.

Ternström's studies also suggest that SOR preferences may differ according to phonation frequency and position within the choir. The center section of a choir may facilitate lower SORs, while higher SOR preferences are found at the ends of a choir. Higher-frequency singers, moreover, tend to have a higher SOR, and lower-frequency singers have a lower SOR. This phenomenon may relate to the fact that human voices at higher frequencies produce more sound, yet these sound waves do not refract sound around the mouth to the ear as readily as at lower frequencies.

Mixed Formation and Voice Compatibility Placement

Choral pedagogy literature frequently contains anecdotal opinions about mixed formation and voice compatibility placement. Voice compatibility placement, sometimes referred to as acoustic placement, is an approach popularized by F. Melius Christiansen with the St. Olaf College Choir in the 1920s To achieve such placement, a director listens to sing-

SSSSSBBBBBTTTTTAAAAA

SSSSSBBBBBTTTTTAAAAA

SSSSSBBBBBTTTTTAAAAA

Figure 1. A Block Sectional Formation

ers individually and in various combinations according to director-determined criteria. Compatibility placement can be used with a variety of formations. Mixed formation, on the other hand, is a formation-specific strategy that involves placing singers, typically in quartets, so that singers of the same voice part do not stand contiguously.

Empirical studies to date suggest that mixed formation does not produce a noticeably better choral sound for the audience. Within the soundscape of the choir, however, experienced singers in close spacing may prefer a mixed formation to a sectional formation.[21]

The matter of voice compatibility placement is an intriguing one that merits further research. Four studies to date yield rather mixed or questionable results, perhaps because of inherent difficulties in research design and methodology with this variable.[22] A logical advantage to this approach is that it is contextual, i.e., grounded in the particular characteristics of particular singers in particular choirs in particular venues. By the same token, an empirical disadvantage to researching it is that this approach is largely idiosyncratic, i.e., dependent upon varying approaches and criteria of different choral directors. As such, the voice compatibility approach lacks a standardized, measurable protocol that lends itself to objective replication by other directors with other choirs.

Daugherty suggested that the process of compatibility placement had pedagogical benefit with choirs of all ages, regardless of whether significant acoustical differences ensued, because it encouraged sensitivity to ensemble sound, while giving singers permission to consider their own comfort in phonation and hearing within that context.[23] He proposed that this strategy might work best pedagogically when the whole choir, not simply the director, had a voice in deciding where in the ensemble individual choristers appeared to phonate and hear their best.

It may be that both mixed formation and compatibility placement are essentially smaller scale manifestations of the spacing phenomenon. Both aspire at close level to what spread spacing may accomplish even with random assignment of singers, i.e., a distancing of shared vocal frequencies or incompatible vocal characteristics, including perceived loudness of surrounding voices.

S A T B S A T B S A T B S A T B S A T B

S A T B S A T B S A T B S A T B S A T B

S A T B S A T B S A T B S A T B S A T B

Figure 2. A Mixed or Scrambled Formation

XXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXX
Close Spacing

XXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXX
Lateral Spacing

X X X X X X X X X X X X X X X X X
X X X X X X X X X X X X X X X X X
X X X X X X X X X X X X X X X X X
Circumambient Spacing

Figure 3. Close Spacing and Two Types of Spread Spacing (Lateral and Circumambient)

Experimenting With Different Arrangements

Because of the contextual, conglomerate nature of choral sound, some choral directors intuitively experiment with various strategies of placing singers to arrive at the most pleasing choral sound and ease of vocal production for a particular ensemble in a particular venue. Research indicates that different spacing among singers and sensitivity to optimal balance between feedback and reference sounds are likely the most helpful variables in this process.

There are several factors to consider in this regard. First, what works well in the rehearsal room may not transfer to the performance hall if the amount of reverberation is significantly different. By the same token, an arrangement that works well in an empty performance venue may not work similarly when an audience, absorbing sound waves, sits in the hall.

Secondly, while it is not yet documented in choral research, empirical studies in other areas sometimes note the presence of a novelty effect. That is, any change in placement may seem to produce some temporary benefit to choral sound. Such an effect may explain the

apparent success of those who demonstrate particular placement strategies with ensembles in uncontrolled environments such as conventions and conferences. The test is whether the perceived benefit abides over a period of time.

Third, it may be that treble voices and changed male voices benefit from different spacing dimensions. Lower-frequency sound waves of changed male voices can give those voices more feedback sound because they are longer in length and more able to diffract around the mouth to the ear. Treble voices, especially mature sopranos singing at higher frequencies, typically require more space to hear themselves in a balanced way with the sound of the whole choir. Changed male voices, especially basses, may sometimes prefer to sing at the center of the choir because lower Self-to-Other ratios obtain there.[24]

Finally, one might consider abandoning portable standing risers, where feasible. Their design and use appear to enhance more the visual aspects of choral singing rather than its acoustic principles.[25]

Effect of Music Folders

Use of scores and music folders in performance yields both positive and negative nuances in choral sound. Within the soundscape of the choir and depending upon their angle and construction, choir folders can sometimes reflect the airborne feedback from one's own voice, especially for higher-frequency sounds. In terms of the conglomerate sound reaching the ears of an audience, folders can be either sound absorbers (for higher frequencies) or sound boosters (at some lower frequencies). A practical insight from this research is that sopranos holding folders at a certain angle may be able to hear and monitor their own voices better, but these same folders may prevent some of that sound from reaching the audience.[26]

Choir Size

The size of a choir can also influence its potential sound and the vocal production of its individual singers. Large choirs, for instance, decrease the ability of singers to hear feedback from their own voices adequately, particularly if the choir performs on standing risers that necessitate close spacing. A sectional formation in particularly large choirs may also decrease the ability of singers to hear the reference sound of the choir as a whole. Both instances may exacerbate problems with intonation or vocal production. Acoustically, especially in terms of loudness, there is little reason for very large choirs. Here, there seems to be a law of diminishing returns: doubling the number of choir singers, for example, increases sound level at the most by only three decibels.[27]

Conclusion

Some of the variables discussed here, in isolation, may not be dramatically significant. How such factors combine in specific contexts, however, is likely more important than the factors themselves. The reciprocity and interaction between them can produce desirable nuances in choral music-making. Happily, such variables often assist healthy phonation, hearing, and comfort for individual choral singers as well.

In sum, choral singing and conglomerate sound are complex, multidimensional phenomena that appear to be contextual and interactive.[28] Research findings offer isolated snapshots rather than a completed understanding. Clearly, more research is needed. The amount and quality of empirical data in this area are increasing, and data already obtained tend to suggest a need to think more vigorously about practices and assumptions associated with voices in a choral context.

Notes

[1] Nothing in this discussion should be construed as devaluing the worth of such pedagogy. It is appropriate and essential if one is to work effectively with choirs. My point is that understanding of individual vocal technique, while necessary, is not the only ingredient in enabling healthy, desirable choral sound. One must also understand what voices do collectively and what happens to them in ensemble.

[2] Useful compilations of work by early pioneers in the scientific study of the human voice include William Vennard, *Singing: The Mechanism and Technic* (New York: Carl Fischer, 1967); and Johann Sundberg, *The Science of the Singing Voice* (Dekalb, IL: Northern Illinois University Press, 1987). A most valuable and comprehensive contemporary work is the three-volume *Bodymind and Voice: Foundations of Voice Education* (revised edition), edited by Leon Thurman and Graham Welch (Collegeville, MN: The Voice Care Network, 2000).

[3] Spectrographic voice identification, or the voice print, is increasingly discussed as a forensic tool and security measure. See, for example, Bruce E. Koenig, "Spectrographic Voice Identification: A Forensic Survey," *Journal of the Acoustical Society of America* 79 (1986): 2088–90. That voice prints might be electronically altered does not negate the fundamental principle behind them: human voices may be seen as individually unique.

[4] Howard Swan, "The Development of a Choral Instrument," in *Choral Conducting: A Symposium*, ed. Harold A. Decker and Julius Herford (Englewood Cliffs, NJ: Prentice-Hall, Inc., 1973), 41.

[5] See, for instance, Brenda Smith and Robert Sataloff, "Choral Pedagogy," in *Vocal*

Health and Pedagogy, Robert Sataloff (San Diego: Singular Publishing Group, 1988), 339–43.

[6] Sten Ternström, Acoustical aspects of choir singing. *Speech Transmission Laboratory Quarterly Progress and Status Report,* 3 (Stockholm: Department of Speech Communication and Music Acoustics, Royal Institute of Technology, 1989), 10. This volume, constituting Ternström's Ph.D. dissertation, is in many ways the foundational document that shapes the field of choral acoustics.

[7] Thomas D. Rossing, Johann Sundberg, and Sten Ternström, "Acoustical Comparison of Voice Use in Solo and Choir Singing," *Journal of the Acoustical Society of America,* 79 (1986): 1975–81; and Thomas D. Rossing, Johann Sundberg, and Sten Ternström, "Acoustic Comparison of Soprano Solo and Choir Singing," *Journal of the Acoustical Society of America,* 82 (1987): 830–6.

[8] Allen Goodwin, "An Acoustical Study of Individual Voices in Choral Blend," *Journal of Research in Music Education,* 28 , no. 2(1980): 119–28

[9] Joseph K. Ford, "The Preference for Strong or Weak Singer's Formant Resonance in Choral Tone Quality," (Ph.D. dissertation, Florida State University, 1999).

[10] J. Kramme, "Applications of Acoustical Principles to Selected Problems Arising During Choral Rehearsals," *Choral Journal,* 18, no. 9 (1978): 5.

[11] Barbara A. Brinson, *Choral music: Methods and Materials.* (New York: Schirmer Books, 1996): 49.

[12] Noble Cain, *Choral Music and Its Practice* (New York: M. Witmark and Sons, 1932): 118. This statement, penned toward the first part of the twentieth century, along with the preceding comment made toward the latter part of the century, illustrate the longevity of such opinions in twentieth-century choral pedagogy materials.

[13] Don L. Collins, *Teaching Choral Music,* Second edition (Englewood Cliffs, NJ: Prentice Hall, 1998): 353; Guy B. Webb, "The Tools of a Choral Musician," Guy B. Webb, ed., *Up front! Becoming the Complete Choral Conductor* (Boston: E. C. Schirmer, 1993): 233–64.

[14] Barbara A. Brinson, *Choral music: Methods and materials* (New York: Schirmer Books, 1996): 45; Paul F. Roe, *Choral Music Education* (Englewood Cliffs, NJ: Prentice-Hall, Inc., 1970): 41.

[15] Whether or not certain seating arrangements may aid the choir in other ways, e.g., administratively, socially, etc., is not at issue here. The present discussion concerns only acoustic claims made for choir formations.

[16] R. F. Coleman, "Dynamic Intensity Variations of Individual Choir Singers," *Journal of Voice,* 8 , no. 3 (1994): 196–201.

[17] The shift from qualitative to quantitative thinking in Western Europe that bequeathed to us the clock, useful maps, operational notation for mathematics and perspective in painting, also produced the musical staff, "Europe's first graph," according to Alfred W. Crosby, *The Measure of Reality: Quantification and Western Society, 1250–1600* (Cambridge, UK: Cambridge University Press, 1997): 144. In an emerging worldview that defined reality quantitatively and visually, the staff sought to make hearing visual, that is, a concrete, architectural blueprint for sound. In this way, "sounds" notated or graphed on paper, though at best metaphors or approximations of aural events, gradually became equated with sounds in abstract time. For an interesting discussion of the history of ideas associated with this phenomenon, see Daniel K. L. Chua, *Absolute Music and the Construction of Meaning.* (Cambridge, UK: Cambridge University Press, 1999). Such ideas are relevant to the present discussion in that they suggest how misunderstandings about choral sound sometimes occur in pedagogical literature that is grounded in a primarily musicological, or score based, perspective. For example, Wilhelm Ehmann asserts "The musical form of the musical work determines the formation of the choir" in *Choral Directing* (Minneapolis: Augsburg Publishing House, 1968); Alfred North Whitehead aptly terms such thinking, in this case where the properties of choral sound are assumed to be enshrined in and visualized by the score, the "fallacy of misplaced concreteness," i.e., mistaking the abstract for the concrete, *Process and Reality* (New York: Free Press, 1978).

[18] James F. Daugherty, "Differences in Choral Sound as Perceived by Auditors and Choristers Relative to Physical Positioning and Spacing of Singers in a High School Choir: A Pilot Study" (paper presented at the National Biennial In-Service Conference of the Music Educators National Conference, Kansas City, MO, April 1996); idem, "Spacing, Formation, and Choral Sound: Preferences and Perceptions of Auditors and Choristers," *Journal of Research in Music Education,* 4, no. 3 (1999): 224–38; idem, "Choir Spacing and Formation: Choral Sound Preferences in Random, Synergistic, and Gender Specific Placements" (paper presented at the National Convention of the American Choral Directors Association, San Antonio, TX, March 2001); Arthur R. Lambson, "An Evaluation of Various Seating Placements Used in Choral Singing," *Journal of Research in Music Education,* 9 (1961): 47–54; and Robert D. Tocheff, "Acoustical Placement of Voices in Choral Formations (Ph.D. dissertation, Ohio State University, 1990).

[19] Daugherty, "Differences in Choral Sound"; "Spacing, Formation and Choral Sound"; and "Random, Synergistic, and Gender Specific Placements."

[20] Sten Ternström, "Hearing Myself with Others: Sound Levels in Choral Performance Measured with Separation of One's Own Voice from the Rest of the Choir," *Journal of Voice,* no. 4 (1994): 293–302; idem, "Self-to-Other Ratios Measured in Choral Performance," Proceedings of the 15th International Congress on Acoustics, 2 (1995): 681-184; idem, "Preferred Self-to-Other Ratios in Choir Singing," *Journal of the Acoustical Society of America,* 105, no. 6 (1999): 3563–74.

[21] Daugherty, "Spacing, Formation, and Choral Sound."

[22] D. C. Giardinare, "Voice Matching: A Perceptual Study of Vocal Matches, Their Effect on Choral Sound, and Procedures of Inquiry Conducted," by Weston Noble (Ph.D. dissertation, New York University, 1991); Elizabeth Ekholm, "The Effect of Singing Mode and Seating Arrangement on Choral Blend and Overall Choral Sound," *Journal of Research in Music Education,* no. 2 (2000): 123–35; Lambson, "An

Evaluation of Various Seating Plans"; Tocheff, "Acoustical Placement of Voices in Choral Formations."

[23] James F. Daugherty, "Choir Spacing and Choral Sound: Physical, Pedagogical, and Philosophical Dimensions," ed. Brian A. Roberts and Andrea Rose, *Conference Proceedings of the International Symposium Sharing the Voices: The Phenomenon of Singing II* (St. John's, Newfoundland: Memorial University of Newfoundland Press, 2000): 77–88.

[24] Daugherty, "Preferences in Random, Synergistic, and Gender-Specific Formations"; Ternström, "Preferred Self-to-Other Ratios."

[25] Mass production of the present portable standing choral riser appears to have begun after World War II, around 1948–49. Elsewhere, I have suggested that its introduction can be viewed as a physical manifestation of the aesthetic/musicological concept of choral sound as art object separated from contextual experience. For a fuller discussion, see Daugherty, "Physical, Pedagogical, and Philosophical Dimensions"; and Daugherty, "Multi-dimensional Aspects of Choir Spacing and Choral Sound: Putting Research Into Practice" (Address before the International Symposium on Choral Conducting, The University of Surrey Roehampton, London, April 2000).

[26] Ternström, *Acoustical Aspects of Choir Singing.*

[27] Choir size, particularly very large choirs, may also be of concern for pedagogical and sociological reasons. In this respect, see Judy Bowers, "Classroom Management in Choral Settings," in the *Florida Music Director* (October, 1999); and Paul E. Guise, "Beyond Gesture: A Case for the Consideration of Group Dynamics," manuscript submitted for publication.

[28] For a helpful overview of research in choir acoustics, see Sten Ternström, "Choir Acoustics–An Overview of Research to Date," in the *International Journal of Research in Choral Singing* (in press). Also informative is a chapter by Ternström and Karna, "Choral Singing: Acoustics for the Choir Director" (forthcoming, Oxford University Press).

—CJ—