IJRCS International Journal of Research in Choral Singing
choralresearch.org

Choir Spacing and Formation: Choral Sound Preferences in Random, Synergistic, and Gender-Specific Chamber Choir Placements

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Abstract

This investigation assessed preferences of choristers (N = 20) and auditors (N = 60) relative to the choral sound of a university chamber choir and its male and female voice sections in three spacings (closed, lateral, circumambient) and two formations (random block sectional and synergistic). Five conditions of an SATB homophonic choral excerpt, and three conditions each of a male choir and female choir homophonic choral excerpt, were sung and recorded digitally. Auditors listened to 12 pairs of randomly ordered excerpts, expressing preference for most pleasing choral sound. Choristers completed the Singer Evaluation Form. Results indicated significant singer and auditor preference for spread spacing, and auditor preference for the sound of the random rather than synergistic choir formation. Auditors significantly favored circumambient spacing for female singers and lateral spacing for male singers. Choristers (100%) thought spacing exercised positive influence upon the choir's sound. Singers reported less vocal tension and better vocal production in spread spacing. Results were discussed (a) in terms of choir spacing as one means of contributing to both ease of vocal production and a desirable choral sound, and (b) in terms of the persistence of certain assumptions in choral pedagogy materials that may confuse the distributive and collective parameters of choral sound.

Where individual singers stand in choral ensembles is a historied concern, particularly among choral music educators in North America. Choral methods textbooks and materials throughout much of the past century, for example, typically diagram and endorse various sectional and mixed formations to achieve desired choral sound. Empirical investigations to date (Daugherty, 1999; Lambson, 1961; Tocheff, 1990), however, find scant basis overall for acoustic claims regarding mixed or sectional formations per se.

Some choral directors advocate "compatibility" placement of voices in choral ensemble, an approach popularized by F. Melius Christiansen and the St. Olaf College Choir in the 1920's (Decker and Herford, 1973). To achieve such placement, a director listens to singers individually and in various combinations according to idiosyncratic, director-determined criteria.

Six studies (Folger, 2002; Woodruff, 2002; Ekholm, 2000; Giardinare, 1991; Lambson, 1961; Tocheff, 1990) sought to investigate this phenomenon using both full ensembles and smaller trios. Yet, this placement perspective has not lent itself readily to objective, universal replication by other directors with other choral ensembles, and many such investigations to date have evidenced difficulties with methodology and data analysis. Daugherty (2000) suggested that this method of placement had pedagogical benefit, regardless of whether significant acoustical differences ensued, because it encouraged singers' sensitivity to their individual contributions toward ensemble sound. He proposed that this strategy might work well pedagogically when the whole choir, not simply the director, had a voice in deciding where in the ensemble individual choristers appeared to sound their best.

Choral methods textbooks have suggested still other strategies for placing singers, among them: height, sight-reading skill, rhythmic ability, voice timbre ("reed" vs. "flute), and whether a singer is "strong" or "weak" overall. While such criteria have

not been investigated empirically with respect to acoustical contributions, choral directors have commonly reported using various synergistic combinations of these ideas to arrive at pleasing choral sound.

In two empirical studies that yielded significant differences in preference for choral sound attributable to replicable singer placement, Daugherty (1996, 1999) found that spacing of singers, not formation per se, engendered perceptions of desirable choral sound among both auditors and choristers. For sound clips from Daugherty (1999) click here.

In a related vein, Ternström (1994, 1995, 1999) investigated what he termed "self to other ratio" (SOR) among singers. Results of Ternström's studies suggested that the reference sound of the rest of the choir could overpower the airborne feedback received from one's own voice, perhaps resulting in oversinging and poor intonation. Venue acoustics, of course, could exacerbate such problems still further. Ternström, moreover, suggested that SOR preferences may tend to differ among voice types and position within the choir.

The purpose of the present investigation was to assess preferences of choristers (N = 20) and auditors (N = 60) relative to choral sound of an SATB university chamber choir in three spacings (closed, lateral, circumambient) and two formations (random block sectional and synergistic), employing sung excerpts from both SATB and TTBB/SSAA antiphonal choral literature. To this end, the following research questions were devised: (1) Are there differences in choral sound perceived and preferred by participants (auditors and choristers) when the physical position of choral singers on risers varies from close to spread spacing among singers? (2) Are there differences in choral sound perceived and preferred by participants (auditors and choristers) when the physical position of choral singers on risers varies between random block sectional formation and a conductor devised synergistic formation? (3) Are there differences in choral sound perceived and preferred by participants (auditors and choristers) when gender specific (SSAA or TTBB) ensembles are employed? (4) Do perceptions and preferences of auditors differ according to gender; and do perceptions and preferences of choristers differ according to voice part sung, gender, or acoustic environment (rehearsal room and auditorium)?

For purposes of this study a synergistic formation (from "synergy, the interaction of two or more agents or forces so that their combined effect is greater than the sum of their individual effects," *American Heritage Dictionary*) was defined as the accustomed formation of choristers in the chamber choir (N=20) participating in this study. According to the choir's director, singers were placed in this formation using the following successive criteria: (a) grouping singers into ten couples by height, though not necessarily by gender; (b) placing those couples with comparatively louder, more resonant voices (in this case, four couples) toward the center; (c) putting the most rhythmically accurate voices still available as the outside voice on the ends of rows (in this case each of the back two rows); and (d) arranging the ten couples in a windowed arrangement with approximately 18 inches between couples (though not between persons within a couple) in four rows that included the three riser rows and the stage floor. These criteria are potentially replicable with choral ensembles of similar size and composition. Moreover, they reflect a combination of measures often mentioned in choral methods literature. The particular synergistic formation used in this study is illustrated in Figure 1.

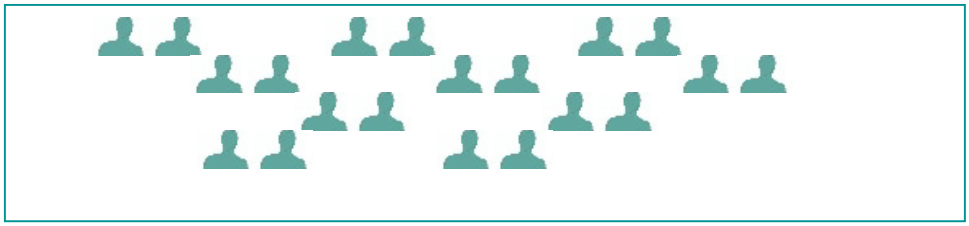

Figure 1. The synergistic chamber choir formation used in this study.

METHOD

Participants

Choristers. One concern of this study was to investigate choir spacing with a small, college-age choir. Previous investigations of this type (Daugherty, 1996, 1999) focused on larger high school choruses. The choir employed for this study was a select undergraduate chamber ensemble from a university in the Midwestern United States. Members (*N* = 20) ranged in age from 19 to 27 years, with most choristers (64%) at 21 years of age. Most choristers (80%) were juniors or seniors. All but two (*n* = 18) of these singers were music majors. There were 10 male and 10 female singers. This choir was chosen in part because its membership consisted of well-trained, experienced choral voices. All members had taken private voice lessons.

Auditors. Auditors for this study constituted a haphazard array (*N*=60) of individuals with choral music experience. There were 30 female and 30 male auditors. Choral music experience was defined as current membership in or leadership of a choral ensemble, as well as two or more years' continuous membership in a choral group since the first year of high school (following Daugherty, 1999). All auditors were music majors, most (*n*= 44) with either under-graduate (*n* = 26) or graduate degrees (*n* = 8) in choral conducting or choral music education.

Auditors ranged in age from 19-40 years. Upon recommendation of an audiologist, individuals above 40 years of age were excluded from this group as a general precaution against possible presence of hearing loss. Otherwise, auditors were self-screened for hearing acuity by responding to two questions: (a) Have you ever been told you have a hearing loss? and (b)How would you evaluate your hearing? (Responses could be chosen from: "normal, better than normal, slight hearing loss, moderate hearing loss, severe hearing loss.") Since results of a previous study (Daugherty, 1999) found almost no significant differences overall between preferences and perceptions of experienced and inexperienced auditors with reference to choral sound, auditors in this study were limited to those individuals with choral experience.

Materials, Procedure, and Equipment

Choral music. Choral music was excerpted from "Adoramus Te" by Giovanni da Palestrina for SATB voices, and "O Admirabile Commercium" by Jacob Handl for SSAA/TTBB voices, edited by Ernest White. These compositions were selected from music the choir was then rehearsing because they were a cappella, largely homophonic, and had a Latin text. Daugherty (1996) reported that auditors stated a foreign language facilitated concentration on choral sound. For the SATB trials, the first phrase of the Palestrina, "Adoramus te, Christe" was sung. Ex post facto analysis of the DAT from the recording session revealed that each sung excerpt was 18.5 seconds in duration. Ex post facto analysis of the DAT from the recording session revealed that the men's excerpt was 8 seconds in duration in all trials, while the women's excerpt was 12 seconds in all trials. Sung excerpts for both male and female ensemble were taken from the Handl "O Admirabile Commercium."

Placement of singers. Singers were placed randomly in the three row sectional formation. This measure controlled for possible variables that were not concerns of this study, such as situating strong and weak singers, "compatibility" placement of voices, height, or voice quality.

For random sectional formation, choristers stood in contiguous sectional blocks according to the voice part sung; members of each of the choir's voice sections occupied all three rows of the riser units. Choristers stood on portable Wenger choral standing risers. Each riser unit contained three steps. Each step was 18 inches wide. Elevation between steps was eight inches. Seven contiguous units were used, connected per manufacturer instructions to form a modest semicircular curve. Each formation used a windowed arrangement, allowing singers a sight line to the conductor between the heads of singers in the row ahead.

Choir spacings employed for this study are illustrated in Figure 2. For close spacing, the upper arm of one singer was no farther than one inch from the upper arm of another singer. For lateral spacing, 24-inch dowel rods were placed between the upper arm of singer and the upper arm of a neighboring singer; dowels were collected before singing.

Circumambient spacing followed the same procedure for lateral spacing while adding a vacant row's space between each row of singers. The second riser step was left vacant, and the front row of the choir stood 18 inches in front of those choristers on the first riser step. Circumambient spacing was achieved by leaving the front row of singers in place while moving the riser units back 18 inches. Distance between the front row of the choir and the microphones was precisely the same in all recordings to insure integrity of the choral soundscape. For video clips of this choir as recorded in close and circumambient spacings, click here.

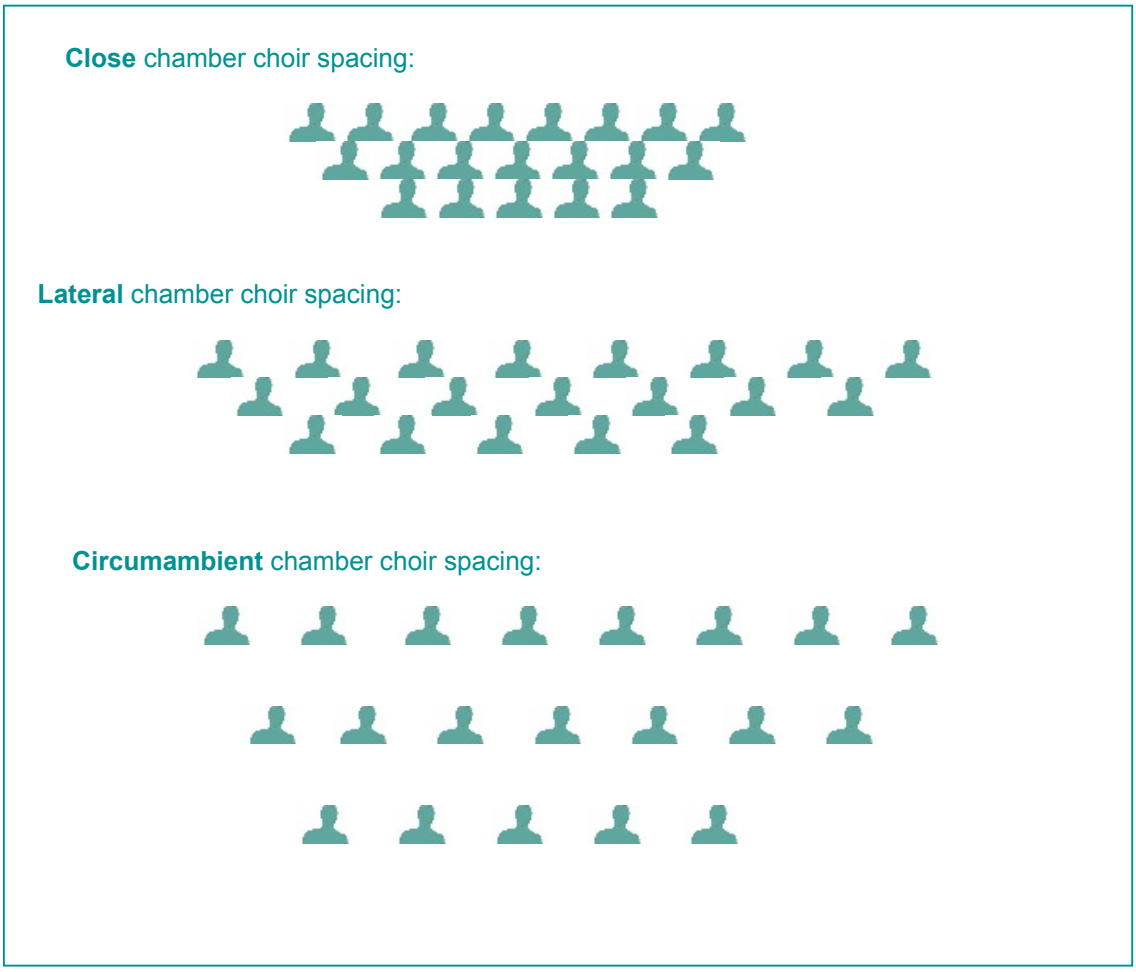

Figure 2. Chamber choir spacings in a random block choir formation.

Spacing procedures for the male ensemble and female ensemble were the same as for the full choir, except that the gender-specific arrangements used only two riser-rows. Singers stood on the first two riser rows for close and lateral spacing, and on the first and third riser rows for circumambient spacing. Gender specific spacings are illustrated in Figure 3.

The choir rehearsed a like amount of time in all three spacings prior to the recording session. Choristers were aware only that the ensemble would sing in different positions for a recording session. The researcher asked choristers and conductor not to discuss or share non-verbally their perceptions of various placements until after the recording session.

Consistency of tempo and conductor behavior. To insure consistency of both tempo and conductor behavior in each condition, singers followed the conductor via pre-recorded videotape on a 21 inch television monitor. The choir practiced with the videotaped conducting prior to the recording session. The video monitor was centrally placed 8 feet in front of the choir during recording. The backs of the monitor and the video playback device were covered with thick material to eliminate any equipment noise. A chorister controlled playback of the videotape.

Recording venue. The recording venue was a recital auditorium at a university school of music. Seating capacity of the hall was 600 persons. The auditorium was 100 feet long with an average height of 40 feet and a fanned width. Irregularly shaped sound diffusion panels were in place on side and back walls, and acoustical clouds were suspended several inches from the ceiling. Reverberation times were measured at 2.7 seconds for higher frequencies and 2.9 seconds for mid-range

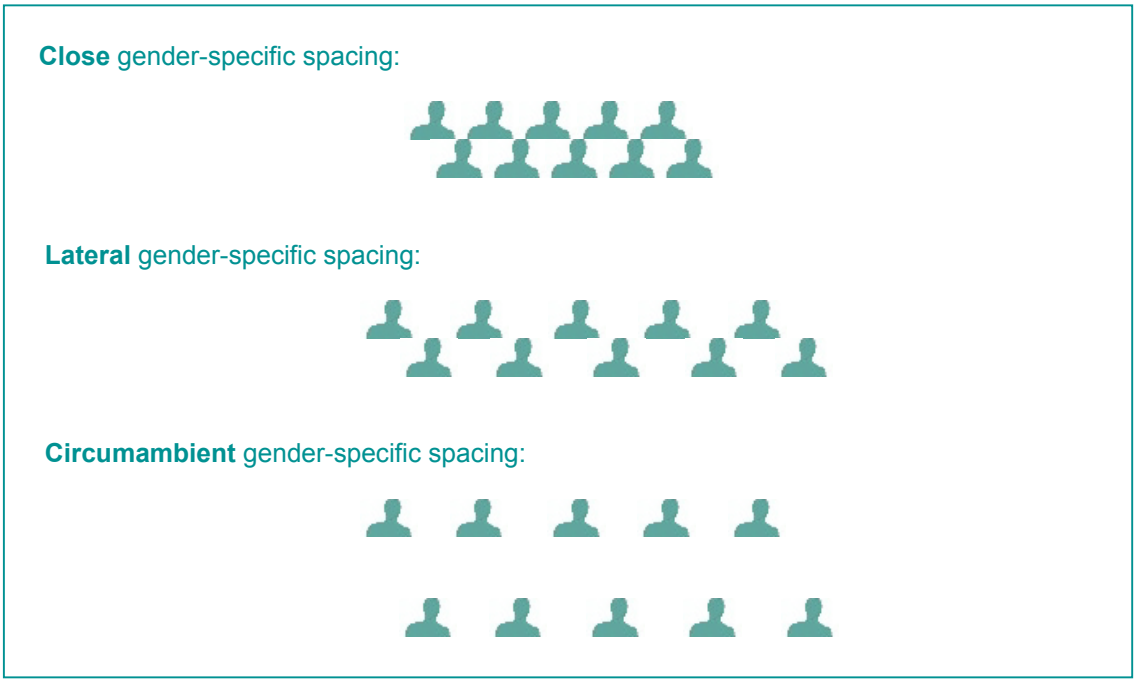

Figure 3. Gender specific chamber choir spacings in a random block choir formation

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frequencies. Verbal descriptors of the hall from those performers who used it frequently most often included adjectives such as “live” and “reverberant.”

Recording equipment and procedures. Two identical AKG C 414 B-ULS omni condenser microphones were placed in a spaced pair configuration with a distance of 6 feet between them. Microphones were situated 15 feet from the line formed between the ends of the semi-circular riser configuration at a height of 11 feet from the stage floor. They were angled slightly upward. In all details, this arrangement followed expert recommendations for recording choral ensembles as described in Miller (1992). A professional recording engineer monitored the entire process. Once microphones were placed and the recording level set, nothing was touched during the recording process; only the positions of the choristers on the risers were changed.

Excerpts were recorded on a BASF DATmaster (R-64) Digital Audio Tape (DAT). Signals from the microphones were brought directly into a Tascam DA-P1 DAT Recorder. No EQ (frequency equalization) was added. The recording engineer monitored the entire process with AKG 240 headphones, the same headphones later used by auditors.

Survey instruments and auditor DAT. Immediately upon conclusion of the recording session, two survey instruments, the Singer Evaluation Form (SEF) and the Ensemble Director's Evaluation Form, were completed. The SEF was adapted from Daugherty (1996, 1999).

Research questions formulated for this study addressed spacing variables in three contexts: full choir, female ensemble, and male ensemble. Twelve presentation pairs compared these variables, including two comparisons of synergistic and random formations and a randomly selected identical pair of excerpts. Following the first two pairs of excerpts, presentation order varied so that no two pairs featuring the same ensemble context were heard in succession. Within that framework, excerpts for the auditor DAT were selected randomly, both with respect to the order in which specific research pairs would be heard and with respect to which excerpt would be heard first in each pair.

Excerpts were transferred directly from the master tape to the auditor DAT using two identical Tascam DA-P1 DAT recorders, the same machine used for the recording session. No mixing or compression of the electronic signal occurred.

The auditor DAT included auditor instructions and announcements of pair numbers for administrative consistency. Five seconds of silence separated excerpts in each pair. Twenty seconds of silence between each pair of excerpts allowed time for marking responses.

The same Tascam DA-P1 DAT machine used to record the study played the auditor DAT. Up to four auditors at a time completed the listening task, using four identical professional AKG K-240 headphone sets. Three choral music professionals piloted the listening process, and determined the volume level set for the study. Auditors completed the listening task in an acoustically isolated university research laboratory.

For each of the 12 pairs of excerpts heard, auditors responded as follows:

1. Comparing the overall sound of the choir in these two performances, I heard: a) No difference; (b) A Little difference; (c) Much difference; (d) Very Much difference; (e) Not sure.
2. I preferred the overall choral sound of the: (a) First Performance; (b) Second Performance; (c) Both sounded the same.

Auditors devoted approximately 17 minutes each to this study.

RESULTS

Chorister Results

Among choristers overall, 100% (*N*=20) thought spacing exercised some degree of influence on choral sound, with 60% (*n*=12) characterizing such influence as "much effect" and 40% (*n*=8) describing such influence as "very much effect." No respondents chose “some effect," "no effect," or "not sure." Among female singers, 80% (*n*=18) characterized the contribution of spacing to choir sound as "much effect," while 20% (*n*=2) described it as "very much effect." Among male singers, 30% (*n*=3) responded that spacing had "much effect" and 70% (*n*=7) said that spacing had "very much effect." Most choristers (75%) thought that circumambient spacing had more influence upon the sound of the choir than lateral spacing.

To what extent do you think spacing between singers influences your own vocal technique and production? “Much” (n=8) or “very much” (*n*=7) effect was the response of 75% of choristers. Among male singers, 70% (*n*=7) attributed “much” influence to spacing on individual vocal technique, while 70% of female singers thought there was “very much” effect.

In which spacing were you generally able to hear/monitor your own voice best? Ninety-five per cent (*n*=19) of choristers thought spread spacing best enabled hearing one’s one voice. Lateral spacing was preferred by 35% (*n*=7) of the singers, while 60% (*n*=12) preferred circumambient spacing. Sopranos (75%) and tenors (100%), those voices singing at higher frequencies, thought circumambient spacing was preferable for hearing one’s own voice.

In which spacing were you generally able to hear/monitor best the sound of the choir as a whole? Fifty-five per cent (*n* =11) of choristers preferred spread spacing, almost evenly divided in their preference for lateral or circumambient dimensions. Forty-five per cent (*n*=9) of singers thought they could hear the choir as a whole best in close spacing.

Specific Formation Questions. In the full choir random formation, 85% (*n*=17) of choristers thought they produced their best tone in spread spacing (lateral: 35% (*n*=7); circumambient: 50% (*n*=10)), while 75% of these singers thought the choir as a whole had the best sound with spread spacing (lateral: 35% (*n*=7); circumambient: 40% (*n*=8)). In synergistic formation, the choir’s accustomed placement, 95% (*n*=19) of choristers preferred their usual spacing over closer spacing. In the gender specific random formations, 80% (*n*=8) of women and 90% (*n*=9) of men thought they produced their best tone in spread spacing. Women preferred circumambient spacing (50%, *n*=5) over lateral spacing (30%, *n*=3), as did men (60% circumambient, 30% lateral). Similarly, 90% (*n*=9) of men and 70% (*n*=7) of women thought the ensemble as a whole had its best sound in spread spacing. Interestingly, 50% of women thought their ensemble sounded best in circumambient spacing, while 60% of men thought their ensemble sounded best in lateral spacing. Respondents were evenly divided in their estimation of the comparative contribution of spacing to gender specific and mixed choir placements, with 50% (*n*=10) saying spacing had the same effect and 50% (*n*=10) stating that they thought spacing had more effect on the sound of the gender specific ensembles than the full choir.

Choristers were also asked in which formation they thought the full choir produced its best sound for the recording session. One-hundred per cent (*n*=20) of these singers thought the choir sounded best in its accustomed synergistic formation rather than the random formation.

Rehearsal room questions. Eighty per cent (*n*=16) of choristers thought they personally sang

best with spread spacing in the rehearsal room during the week prior to the recording. Preferences were evenly divided between lateral and circumambient spacing. Ninety-five per cent (*n*=19) of singers thought the choir as a whole had its best sound in the rehearsal room with spread spacing, 70% (*n*=14) favoring lateral space and 25% (*n*=5) favoring circumambient space.

Vocal tension questions. Four questions addressed tension in individual vocal production. (1) "I tended to experience more tension in my body and/or more tension in my voice in:" Close spacing was the response of 80% (*n*=16) of singers, including 100% (*n*=10) of female singers. (2) "I would characterize such tension as:" Forty-five per cent (*n*=9) of singers responded with "moderate" tension, while 35% (*n*=7) thought the tension was "minor" and 20% (*n*=4) described it as "negligible." No singer thought close spacing produced "severe" or "somewhat severe" tension. (3) "I tended to experience the least tension in my body and/or the least strain in my voice when in:" Spread spacing was the response of 90% (*n*=18) of choristers, with 55% attributing the least tension to lateral spacing and 35% attributing it to circumambient spacing. (4) "I tended to push or sing louder:" A majority (85%, *n*=17) of choristers responded "when other singers were close," including 100% of sopranos and tenors.

Other. Choristers (95%) reported success with following the conductor via a video monitor. Similarly, 95% of singers thought that the choir performed the choral excerpts recorded for the study in a consistent manner.

Director's responses. The choir's director indicated strong preference for spread spacing in all placements, and thought that spacing had "very much effect" on the sound of the ensemble. He strongly agreed that the choral excerpts were performed in a consistent manner throughout the recording session by attending to the videotaped conducting.

Auditor Results

Tables 1-5 present auditor results according to the variables considered. As data are at the nominal level, chi-square testing is used to determine significant relationships at a pre-determined *alpha* level of .05.

Full choir spacing. Three pairs of performances (Pairs 1, 2, and 9) presented a random sectional formation with contrasts in choir spacing. In each condition comparing close spacing with spread spacing (Pairs 1 and 2), auditors overall significantly favored that excerpt performed with more spread spacing, whether the spacing was lateral or circumambient (see Table 1).

Table 1

Responses to Paired Choral Excerpts Among Experienced Auditors Overall (N=60)

	Full Choir Spacing Comparisons		
Pair 1:	Random Close	Random Circum.	Same
Responses:	15	45	0
Percentage:	25.00	75.00	0.00
			χ^2 (2, *N* =60) = 32.50 *p* <.05
Pair 2:	Random Lateral	Random Close	Same
Responses:	41	12	7
Percentage:	68.33	20.00	11.67
			χ^2 (2, *N* =60) = 33.70, *p* <.05
Pair 9:	Random Lateral	Random Circum.	Same
Responses:	16	26	18
Percentage:	26.67	43.33	30.00
			χ^2 (2, *N* =60) = 2.80 *p* >.05

Note: Circum. = Circumambient, i.e., space on all sides provided by a vacant riser row between each row of singers in addition to lateral spaces between singers on each row.

However, distribution of auditor responses was not significant when the spread spacing dimensions, lateral and circumambient, were compared (Pair 9). Thirty per-cent (*n*=18) of auditors thought both excerpts in Pair 9 "sounded the same," the second highest percentage of such responses obtained with any pair of excerpts. Crosstabulations revealed no significant differences in auditor preferences by gender when comparing close spacing to spread spacing. A comparison of lateral and circumambient spacings, however, found that male auditor preferences were evenly divided while female auditors significantly preferred circumambient spacing.

Female ensemble spacing. Three pairs of performances (Pairs 3, 6, and 10) presented all female voices in a random sectional formation with contrasts in choir spacing. In all conditions (see Table 2), auditors significantly favored that excerpt sung with more spread spacing.

Table 2

Responses to Paired Choral Excerpts Among Experienced Auditors Overall (N=60)

	Female Ensemble Spacing Comparisons		
Pair 3:	Female Lateral	Female Circum.	Same
Responses:	7	43	10
Percentage:	11.67	71.67	16.66
			χ^2 (2, *N* =60) = 21.90, *p* <.05
Pair 6:	Female Close	Female Lateral	Same
Responses:	7	45	8
Percentage:	11.67	75.00	13.33
			χ^2 (2, *N* =60) = 26.90 *p* <.05
Pair 10:	Female Circum.	Female Close	Same
Responses:	41	14	5
Percentage:	68.33	23.33	8.33
			χ^2 (2, *N* =60) = 19.10, *p* <.05

Note: Circum. = Circumambient, i.e., space on all sides provided by a vacant riser row between each row of singers in addition to lateral spaces between singers on each row.

Male ensemble spacing. Three pairs of performances (Pairs 4, 8, and 11) presented all male voices in a random sectional formation with contrasts in choir spacing. In each condition comparing close spacing with spread spacing (Pairs 8 and 11), auditors overall significantly preferred that excerpt sung with more spread spacing. In a direct comparison between lateral and circumambient spacings with male voices (Pair 4), auditors significantly favored lateral spacing (see Table 3).

Full choir formation comparisons. Two pairs of performances (Pairs 5 and 11) presented contrasts between random sectional and synergistic formations. A direct comparison between these two formations at close spacing yielded a significant distribution of auditor responses, with slightly more auditors favoring the random formation. Significant differences also obtained in favor of the random formation at lateral spacing when compared to the synergistic formation at the choir's usual spacing. Auditors overall appeared to prefer the random formation over the synergistic formation in both trials (see Table 4).

Table 3

Responses to Paired Choral Excerpts Among Experienced Auditors Overall (N=60)

Male Ensemble Spacing Comparisons

Pair 4:	Male Circum.	Male Lateral	Same
Responses:	12	42	6
Percentage:	20.00	70.00	10.00
			χ^2 (2, *N* =60) = 37.20 *p* <.05
Pair 8:	Male Close	Male Lateral	Same
Responses:	8	41	11
Percentage:	13.33	68.33	18.33
			χ^2 (2, *N* =60) = 17.30, *p* <.05
Pair 11:	Male Close	Male Circum.	Same
Responses:	13	38	9
Percentage:	21.67	63.33	15.00
			χ^2 (2, *N* =60) = 24.70, *p* <.05

Note: Circum. = Circumambient, i.e., space on all sides provided by a vacant riser row between each row of singers in addition to lateral spaces between singers on each row.

Table 4

Responses to Paired Choral Excerpts Among Experienced Auditors Overall (N=60)

Full Choir Formation Comparisons

Pair 5	Synergistic Close	Random Close	Same
Responses:	23	26	11
Percentage:	38.33	43.33	18.33
			χ^2 (2, *N* =60) = 6.30 *p* <.05
Pair 12:	Synergistic Usual	Random Lateral	Same
Responses:	15	36	9
Percentage:	25.00	60.00	15.00
			χ^2 (2, *N* =60) = 20.10, *p* <.05

Synergistic Usual = This ensemble's customary formation of couples arranged according to a combination of strategies often mentioned by choral methods literature. While there is spread spacing between couples in this formation, there is not necessarily spread spacing between the members of each couple.

Identical pair. Results indicated that 63.33% (*n*=38) of all auditors correctly heard no difference between the identical pair of excerpts sung as Pair 7. This percentage was significantly greater than the frequency of "both sounded the same" responses obtained with any other pairing. Crosstabulations revealed no significant differences according to gender (see Table 5).

Table 5

Responses to Paired Choral Excerpts Among Experienced Auditors Overall (N=60)

	Identical Pair		
Pair 7:	Synergistic Close	Synergistic Close	Same
Responses:	14	8	38
Percentage:	23.33	13.33	63.33

$\chi^2(2, N=60) = 21.20, p < .05$

Characterizations of differences heard. Auditors overall reported hearing differences in all pairs presented, with the least frequency of perceived difference occurring in Pair 7 (Identical Pair) and the highest frequency of perceived differences in Pair 1 (Random Close vs Random Circumambient). The mean percentage of auditors reporting differences on all items, excepting Pair 7 (Identical Pair), was 85.36%. In those pairs soliciting full choir spacing comparisons the mean percentage of auditors perceiving differences was 86.11%. The mean percentage of reported differences for male ensemble spacing comparisons was 85.56%; for female spacing comparisons it was 86.67%. For pairs seeking formation comparisons, the mean percentage of auditor perceived differences was 83.13%.

Overall, most auditors characterized differences they heard as "A little difference." Approximately 20-25% of auditors reported hearing "Much" or "Very Much difference" in all performance pairs, excepting Pair 7 (Identical Pair). The highest percentages of "Much" or "Very Much" difference responses occurred in Pairs 4 (Male Circumambient vs Male Lateral; 36.67%) and 10 (Female Circumambient vs Female Close, 33.33%). The least occurrence of such reported differences was in Pair 9 (Random Lateral vs Random Circumambient, 19.5%).

DISCUSSION

A primary finding of this investigation is that spread spacing among choristers in this university choral ensemble yields significantly preferred nuances in choral sound for both singers and auditors. This result is in keeping with previous studies (Daugherty 1996, 1999) that found similar preferences for spread choir spacing among larger high school ensembles and their auditors. Such spacing preferences, moreover, tend to confirm Ternström's (1995, 1999) data with respect to self-to-other ratios among choir singers, notably with respect to auditor preferences in this study for different degrees of spread spacing among male and female singers.

Choir spacing is a phenomenon that warrants continued investigation. It may be conjectured, for instance, that spacing phenomena intuitively inform persistent beliefs among choral directors regarding presumed benefits of mixed formation and voice compatibility placement. At heart, both compatibility placement and mixed formation appear to aspire at close level to what spread spacing may accomplish even with random assignment of singers, i.e., a distancing of shared vocal frequencies and/or incompatible vocal characteristics.

A corollary conclusion of this study is that random assignment of singer position in block sectional formation at close spacing appears to be just as preferable as a synergistic formation based on recommendations from choral methods literature. Indeed, in more spread spacing, auditors express significant preference for the random assignment.

Results of this study are not necessarily transferable to other populations. Choirs differ, as do the acoustic venues in which they perform and rehearse. Moreover, as Coleman (1994) finds, individual singers within the same choir, subject to the same choral training, can vary greatly in their vocal output power. These very factors raise philosophic and empirical questions about acoustical claims commonly made for various choir formations. Researchers potentially may find sociological, behavior management, or other practical benefits to such formations. Yet, the assumption that certain formations per se, be they mixed, sectional, or

synergistic, tend universally to yield favorable or predictable changes in choral sound is problematic.

Suppositions regularly made about choir formations, moreover, often exhibit the logical fallacy of composition, i.e., the fallacious claim that the whole is inevitably a simple sum of its constituent parts. In this case, diagrams and discussions in choral methods material typically confuse the distributive and collective parameters of choral sound, assuming that each voice or voice section is an equal and universal unit of measurement (Daugherty, 2001).

Data from this investigation raise other questions of import for choral pedagogy. Primary among these is the finding that 80% of choristers in this investigation, including 100% of female singers, experienced moderate to minor body tension and strain of vocal production when in close spacing. Choral directors who customarily pack singers closely onto risers for performance or rehearsal may want to reconsider such a strategy. Related issues, such as the economics and design of choral risers and choral performance venues, also merit reflection.

Another result of this study of practical interest is that female singers in this ensemble likely require more spacing to achieve optimal vocal production and desirable choral sound than male singers. Future investigations may wish to examine whether choirs might benefit from more individualized spacing of singers, as opposed to a uniform dimension among all voices.

Though auditors clearly prefer spread spacing in this choir, no significant preference for the dimensions of such spacing, i.e., lateral or circumambient, raises unanswered questions. Perhaps such results are due, at least in part, to the reverberant nature of this performing venue and the vocal maturity of these choristers. Another possibility is that fewer singers in fewer rows, as was the case with the gender specific choral excerpts, yield more defined spacing preferences.

Finally, chorister formation preferences in this study mirror those of previous investigations (Daugherty, 1996, 1999) in that choir singers, though preferring spread spacing, also remain loyal to that formation into which their director places them. Given this factor, choral directors may want to experiment with differing placement assignments and spacing in both rehearsal and performance venues before consigning singers to rigid ensemble configurations that may not enable the choir to realize its best choral sound or healthiest vocal production.

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