A Comparative Study of Concert Formations for the Malone University Chorale in the Worship Center

Zachary C. Rearick

Honors Program, Malone University

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Advisor: Jon C. Peterson, DMA

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Author Note

Zachary C. Rearick https://orcid.org/0000-0001-7179-6374

Please, address correspondence to: Zachary C. Rearick. Phone: 717.601.9336. Email: rearickzacc@gmail.com

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Abstract

This study assesses the effects that varied formations and locations of the Malone University Chorale have on aspects of choral sound for homophonic and polyphonic selections. Four formations were studied: balanced sections, balanced mixed, bright voices on the outsides, and dark voices on the outsides. The University Chorale also performed a homophonic and polyphonic excerpt in two locations in the Worship Center: on the stage and on the floor. The Worship Center is located within the Johnson Center for Worship and the Fine Arts one the Malone University campus in Canton, Ohio. This study evaluates the effectiveness of each singing formation and location through considerations of blend, balance between sections, tone color, rhythmic precision, and intensity, and offers insights into ideal concert formations in the Worship Center.

Keywords: choir, formations, locations, voicing, acoustics, tone color, Malone University Chorale

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Purpose of the Study

What concert formation, with regard to ensemble location within the Worship Center and arrangement of voices within the choir, results in the best overall choral sound through consideration of blend, balance between sections, tone color, rhythmic precision, and intensity?

The aforementioned research question addresses an acoustical phenomenon in choral ensembles that has been researched and tested by several scholars, though none of the current literature is definitive due to the significant variables involved and the subjective, human element inherent in the assessment of sound quality. This phenomenon is best described by the fact that, though a choir may comprise the same singers, the resulting sound can be profoundly impacted by where the singers are positioned in a performance space and relative to one another within the ensemble. Each voice is unique, and the way that each singer's voice interacts with another's is equally unique. This means that by simply changing where singers are positioned, a director can change the choir's overall sound (e.g. tone color, blend, etc.) without the need for the singers to change anything about their individual technique. This study also has a second purpose of testing the effect that the Malone University Worship Center has on choral concerts. In 2006, Malone University purchased the building formally used by the First Christian Church and restructured it into what is now the Johnson Center for Worship and the Fine Arts (Malone, n.d.). The implications of this are that the Worship Center, which resides in the Johnson Center, was not intentionally designed with acoustics for choral

concerts in mind. It was designed to be a space for worship. Because of this, there is particular interest in assessing how the acoustics of this unique space influence aspects of choral performances.

Through the pursuit of this honors program thesis, I seek to understand this concept more fully so that I can use it for the career path to which I aspire. I would like to work with high school choirs in the public-school setting. Choirs of this type do not exclusively perform in their own auditoriums, but many other venues as well. Such venues would include Solo and Ensemble performance spaces, Music in the Parks, local churches, local colleges, etc. It is important that, as their director, I always give my students the best chances to succeed. Arranging my singers in the ideal formation for the music that is being performed should be a priority for every concert. In this way, I will have done my part as the director, as they continue to sing the repertoire to the best of their abilities.

Need for the Study

This research and experimentation will have implications for the future of the University Chorale's performances in the Worship Center. This study could suggest the existence of a single concert formation that is most effective. This would inform any choir director, whose choir is performing in the Worship Center, of the best formation(s) that will provide the optimal sound for any given style of piece.

Though much research and testing have been done in this field of study, there are still gaps in our knowledge of the subject. Little is understood of how formations or locations within a performance space can impact perceptions of rhythmic precision and/or rhythmic vitality. There are also two specific formations that I opted to test that,

to my knowledge, had not been directly tested and studied in the past. These formations are "bright voices on the outsides" and "dark voices on the outsides." I was particularly interested to see how these two formations would impact the overall tone color of the ensemble.

This study could also have an impact through expansion of this foundational research in publications of the National Association for Music Education (NAfME), Ohio Music Education Association (OMEA), Ohio Choral Directors Association (OCDA), and other statewide and national research journals.

Definitions

The definitions and concepts outlined below reflect the ways in which these terms are used for the purposes of this study.

Balance Between Sections: A criterion for auditor evaluation which assesses the congruency between larger sections within a choir (e.g. soprano, alto, tenor, bass) based on a variety of factors, with particular weight on relative dynamics between sections.

Balanced Mixed Formation: Standing formation in which all singers are placed in an acoustically optimal arrangement with regard to tone color, size of voice, vibrato, and other relevant factors. No two singers of the same voice part are placed next to one another.

Balanced Sections Formation: Standing formation in which all singers are placed next to other singers of their respective voice part. Within each section, the sound is balanced by spreading apart singers with like tone colors, voice size, vibrato, etc.

Blend: A criterion for auditor evaluation which assesses the level of uniformity that was achieved by the choir in a particular formation. For the purpose of this study, this refers to assessing whether or not there were audible, individual voices heard through the ensemble.

Homophonic Texture: A musical texture characterized by unified rhythms (i.e. homorhythmic) across all voice parts with melody primarily in one voice.

Intensity: A criterion for auditor evaluation which assesses the presence or lack of dynamic contrast throughout each excerpt.

Polyphonic Texture: A musical texture characterized by two or more melodic lines of interest across two or more voice parts.

Rhythmic Precision: A criterion for auditor evaluation which assesses the accuracy of rhythms in each excerpt. Both the arrangement of singers in the choir and ensemble location, resulting in acoustical changes, may influence this variable.

Tone Color: A criterion for auditor evaluation which assesses the Chorale's overall timbre for each excerpt. Options for tone color included bright, moderately bright, balanced tone color, moderately dark, and dark.

Limitations of the Study

Though every effort was made in this study to create an environment that mimicked that of a live performance, we were unable to fully replicate such an environment. Such limitations are outlined below.

There were no unnecessary people in the audience of the Worship Center during the testing session. If the room had been filled with audience members, the acoustics of

the space would have been impacted significantly. Future studies may supplement the current study through testing how the acoustics of the Worship Center change during choral performances while an audience is present.

Furthermore, the physical and emotional impact of having an audience for whom to perform has an important effect on any choir's overall sound. Performance anxiety, or stage fright, can result from the presence of an audience, and have noticeable impacts on each singer. It is an exaggerated fear of performing in public in which the body's emergency systems start to supply more adrenaline to the bloodstream. Since it is not appropriate for the performer's fight of flight response to be used, the increased heart pumping "is felt as distressing palpitations" and "the increased activity of the lungs and widening of airways produces a feeling of breathlessness" (Parncutt, 2002, p. 42). It is equally true that an ensemble's performance can be heightened due to the presence of an audience and the positive, nonverbal feedback that they can give. Due to the lack of audience members while recording for this study, neither of these positive or negative effects could have an impact. This hinders the authenticity of the performance environment.

Due to the lack of auditor availability during the scheduled testing session, we had audio recordings produced and exported to Google Drive folders that allowed the auditors to submit their evaluations remotely. As with all studies that rely on captured audio, we were limited by the quality of the recordings because of their inherent inability to record and fully recreate the sonic experience of a live performance space. Despite impressive efforts, it does not fully compare to being present in the room at the moment of testing.

The Honors Program minor allows for two semesters for the completion of the honors thesis. The bulk of the testing and analysis for this thesis was done during the second of the two semesters, as per the requirements of the course. Many more factors could have been considered and tested if there was more time allotted for the thesis. This study could, however, become the foundation for future research at the graduate level.

Because of the nature of human evaluation, there is a subjective element to the responses we receive. There are also limitations to each individual's personal sound equipment that they have to listen to the recordings. There is every possibility that each auditor hears the examples slightly differently because of the limitations of their personal equipment.

This study was conducted during the Spring 2020 semester. The Chorale was able to record the excerpts for this study during the first half of the semester, but auditor response rates diminished heavily due to the impact of the COVID-19 pandemic. The response deadline for auditor feedback fell during the first week of mandatory social distancing and the beginning of online instruction for public schools. Most of the choral directors invited to participate in the study were public school music educators.

Review of Literature

This literature review presents a summation of the current scholarly research and testing that assists in addressing my research question.

Blend

"Choral blend can be described as an ensemble sound in which individual voices are not separately discernible to a listener" (Goodwin, 1980, p. 119). It has also been described "as a way to homogenize a chorus sound" (Chorus Voice Matching, 2017).

This is a foundational element to a choir's sound and performance. Multiple studies have been conducted to review the optimal arrangements of singers that will produce the best blend of voices. Goodwin (1980) describes that when a tone is created from the voice, there are many frequencies, or partials, that ring at the same time. Around two or three frequencies will ring most prevalently, creating the foundation of the tone. These frequency ranges where the partials are the strongest are called formants (p. 120).

Focusing on analyzing blend, thirty sopranos from North Texas State University were asked to sing twice, once on their own using their solo singing voice, and another time while intentionally attempting to blend with a pre-recorded track (p. 121). Patterns emerged which indicated that compared to solo singing, "blended vocal tones tended to have fewer and weaker partials on frequencies above the first formant" (p. 124). This gives evidence that singers who intentionally blend with those around them will naturally reduce the frequency of partials above the fundamental tone through darkening their sound and decreasing the intensity of their singing (p. 125).

Daugherty (n.d.) also found this to be true and considers this to be a leading factor in the chorus effect. He says that the "chorus 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 effect, dissociates sound from its sources and endows it with an 'independent' existence" (p. 2). In short, when blend occurs as a result of weakening partials above the formant, individual voices start to become indistinguishable from one another.

Current research supports the claim that an acoustical placement of singers creates the best blend throughout the ensemble while reducing intonation issues (Adams, 2019).

When placed in two contrasting formations, acoustically placed and randomly placed, collegiate music majors and nonmajors were both able to hear a distinguishable difference between the formations, with regard to blend. There was a consistent preference for the acoustically placed formation (Killian, 2007).

Balance Between Sections

With choral singing specifically, Aspaas (2004) and Ternstrom (1994) found that there is a wide acceptance among singers for imbalance in sound. What they mean is that, unlike instrumental groups, voices are more subdued and thus blend together more easily. It is far less likely for voices to stick out when compared with instrumental ensembles.

From a band director's standpoint, evaluating the acoustics of performance spaces is essential for the sake of the balance of the musicians. Abdoo (1981) states that there are two things that affect the acoustics of performance spaces: reverberation, and standing waves and resonance phenomena. The second of the two factors, standing waves and resonance phenomena, can greatly affect the balance of instruments and registers within an ensemble. "Standing waves occur when surfaces of a room are exactly the same size. Their resonances cause certain musical instruments and voices to sound louder or softer than they normally would" (p. 36). He describes in detail a way that the director can detect whether a performance venue has standing waves and resonance phenomena. This is done through having two students playing fundamental tones while the director walks around the room and determines if the room is amplifying one sound over the other in certain areas of the room. In this way, the acoustical

construction of the room can cause issues in balance that will need to be addressed before a balanced overall sound is to be expected (p. 37).

In the choral setting, though it is not often explicitly tested, balance between sections can be influenced heavily by the number of singers in each voice part. In a 2004 study, Aspass compared singers' perceptions and preferences for three formations when singing homophonic and polyphonic music. Though balance between sections was not directly a part of the study, Aspass stated the following: "Other limitations that may have impacted these findings were only one choir was included, the relative small size of that choir, and the unequal balance of members in each vocal section [sic.]" (p. 24).

Beyond the audience's perception of balance between sections, there is evidence for an optimal level of balance between voice parts. Fauls (2008) quotes a study done by Killian in 1985 in which students and conductors gave preference to balance between sections based on modified recordings. Recordings were produced of a choir singing several four-part chorales, and each voice part was recorded on a separate track. From this, the researchers created new recordings with individual voice parts increased ~11db in comparison to the other voice parts. The students and conductors listened to each of the new recordings and responded to them by answering whether it was a balanced or an unbalanced recording, meaning that there was a section that was modified to be louder than the others. When asked to fix the recording to be balanced, the modified section consistently remained louder. It was found that preference was given for less bass comparatively through all conditions. The only other conclusion found was that male evaluators preferred louder levels of female singers than male singers (Faults, 2008, p. 56).

Tone Color

It is commonly accepted that there are many factors that influence tone color. Among them are vowel uniformity, vibrato, choral formation, strategic placement of singers, and the spacing between singers (Atkinson, 2010, p. 28). A study was conducted by Atkinson in which one singer of each voice part was individually recorded while they sang with the choral ensemble. Questions were asked of all singers as well as the four randomly selected ones as to the differences that they heard between solo singing and choral singing. What was found was that there are different techniques that are needed in solo singing versus singing within a choir setting. It was also noted that singers are sometimes hesitant to modify their singing in order to blend with those around them because they are unaware that they are allowed to experiment with their singing (Atkinson, 2010, p. 32). Making specific comments to one's choir would, therefore, help to unify the tone color of the ensemble as a whole.

Similarly identified by Atkinson and Ekholm (2000), vocal production used in solo singing is significantly different from vocal production when blending with a choral ensemble. From an article based off of her dissertation, Elizabeth Ekholm states:

> Research has shown that in trying to blend with an ensemble, singers produce relatively less energy in the "singer's formant" region (around 3 kHz) … The singer's formant is the region of the frequency spectrum associated with projection of the voice. Energy in the singer's formant is the principal acoustic factor that determines a singer's timbre (p. 124).

Using this logic, she goes on to say that attention to the singer's formant region would heighten choral blend "by obscuring differences in vocal timbre among singers" (p. 124).

In a study on the spacing between choristers within the choir, Daugherty (2003) came to a similar conclusion. He found that various formations at a close distance may achieve what a spread spacing can always achieve, regardless of the placement of singers, and that is the "distancing of shared vocal frequencies and/or incompatible vocal characteristics" (p. 57). In this way, the physical distance between the singers, regardless of the arrangement of singers in the choir, can blend formant frequencies to achieve a more unified tone color.

A conductor's gestures and patterns also have a noticeable impact on the quality of the tone of an ensemble. With a panel of expert auditors, Grady (2014) tested three different conducting patterns on the overall tone quality of the ensemble. The conducting patterns were the traditional pattern, vertical-only gestures, and lateral-only gestures. It was found that despite blindly switching the order of the pattern used by the conductor, the expert panel continually preferred the vertical-only pattern above the other two. When comparing the traditional pattern against the lateral-only pattern, more favor was shown towards the traditional pattern (p. 50). In this study, Dr. Peterson conducted every excerpt that was recorded, and he made every effort not to change his conducting between takes.

Rhythmic Precision

As defined by Tocheff (1990) in his doctoral dissertation, rhythmic precision is "exactness in the treatment of various aspects of choral music as it proceeds in time" (p. 11). In simpler terms, rhythmic precision speaks to the exactness and clarity of the rhythms in a passage of music as the choir is singing. He cites that rhythmic precision is viewed in different lights, both as a "factor in achieving good choral blend" and a

"requirement for good ensemble performance". However it is viewed, all agree that it is "an essential factor affecting expressive choral singing" (p. 3), and thus needs to be considered.

When Tocheff (1990) analyzed rhythmic precision, diction and text were also factors. In testing how voice part placement, both mixed and sectional formations, affects perceptions of rhythmic clarity and diction, it was found that the formation has no effect, regardless of whether homophonic or polyphonic music is being sung (p. 141).

This conclusion is supported through a study done by Hom in 2013. She compared the effects that performance spaces can have on the choir's overall sound. She specifically compared a Performance Hall (PH) with a Rehearsal Room (RR). Because of the more confined nature of the RR, the overall amplitude of the choir's sound was heightened compared to the PH. Listeners' preferences favored the performance in the RR because of this, and the rhythmic precision and vitality of the ensemble followed suit. Listeners stated that there was more "rhythmic accuracy and unity throughout the whole choir" because it was evident that they could hear each other better. Others said that the sound was more energized, compared to the PH which "seemed thinner and almost a bit lethargic" (p. 116).

Intensity

Intensity refers to the strength of the vocal tone. Commonly referred to as volume or dynamic level, intensity has many attributing factors. In his doctoral dissertation study, Tocheff (1990) noted that contrary to previous literature, various formations based on voice parts had no significant effect on intensity. It is also significant that the musical texture, both homophonic music and polyphonic music, had no main effect on the judges'

preferences. It is understood from this study that preferences of expressiveness and intensity were a result of individual judge preference (p. 142).

This is contrary to a study which tested various mixed and sectional formations on auditor preference. In it, Aspaas (2004) concluded that "the polyphonic selection was more intense than the homophonic selection for frequencies above 650 Hz. This difference was particularly noticeable at the singer's formant, where a difference of nearly 6 dB is shown between the selections" (p. 22).

The Lombard Effect (Meaningful Gestures, 2017) and Self-to-Other Ratio (Lambson, 1961) both influence the perceptions of the singer's intensity compared to others. According to the Barbershop Harmony Society, circumambient and lateral spacings produced "a 2-3 decibel change in the aggregate energy in overtones over Close spacing". Since human ears can detect changes of as little as 1 decibel, this is significant (2017). Similarly, Ternstrom (1994) notates how the decibels of each singer in the choir is much higher when singing all together compared to by themselves (p. 299). This strongly follows the Lombard Effect, which states that one's own sound will increase due to an increase in the ambient sound in the room (Meaningful Gestures, 2017).

When testing the effects of conducting patterns on the intensity of an ensemble, it was found that there were clear differences between the traditional, vertical-only, and lateral-only patterns. Across all frequencies, the traditional conducting pattern produced the strongest singing. Second below was the vertical-only pattern which consistently produced sound one to two decibels softer. The lateral-only conducting pattern consistently produced sound one to two decibels below the vertical-only pattern (Grady, 2014, p. 47).

Method

Design of the Study

Selection of Choir

The Malone University Chorale was selected to be the participating choir for this study through factors of ease of availability and relevance to the purpose of the study. The University Chorale will be the choir most heavily impacted by this study since they perform in the Johnson Center's Worship Center most frequently.

The University Chorale is an auditioned, mixed chorus of over 40 students enrolled at Malone. The choir has approximately a 1:1 ratio of music majors and non-music majors. At the time of testing, there were six basses, six tenors, thirteen altos, and seventeen sopranos in the choir. Two students, a tenor and a soprano, were unable to participate due to a scheduling conflict and an illness, respectively.

Selection of Choral Pieces

The choral pieces used in this study were taken from the repertoire that the choir was already rehearsing for performances during the concurrent spring semester. The most notable compositional textures of music that are performed and researched, with respect to their impact on a choir's sound, include homophonic and polyphonic textures. For this study, a two- to three-minute passage from both "A Mighty Fortress is Our God" by Dan Forrest and "1. Cattle, Horses, Sky, and Grass" from *Considering Matthew Shepherd* by Craig Hella Johnson were used for the homophonic and polyphonic selections, respectively. They represent literature at a collegiate level, which is consistent with the difficulty of repertoire most consistently performed by the University Chorale in the Worship Center.

Criteria and Selection of Auditors

Fifty-four auditors were contacted to participate in evaluating the performances of each excerpt. The criteria for being an auditor in the study was to (1) be an active choral director, and (2) have at least a Bachelor's degree in a relevant field of study (i.e. music or music education). A convenience sample of auditors (N=12) participated in evaluating the choir's performances. Auditors' current professions include church choir director, high school music director, collegiate choral director, and private voice instructor.

Recording Equipment and Audio Mixing

In the center of the front pew, two C1000 microphones were placed in a X-Y stereo configuration to capture the sound that audience members would hear. An Audio-Technica AT4081 Bidirectional Active Ribbon Microphone was placed in the center of the eighth pew from the front to capture some of the natural reverb that would be heard throughout the room during the testing.

The microphones were connected with XLR cables to a Tascam US-16x8 USB 2.0 Audio Interface, which then went to a MacBook Pro which used Logic Pro X software as a recording platform. Each microphone was recorded on a separate digital track with no artificial modifiers during the recording process. Once levels were set at the beginning of the testing session, they were left untouched for the rest of the night until all excerpts were recorded.

During the mixing and mastering process, little was done to change the raw sound captured during the testing session. The two usable microphone locations were evenly mixed together. To cut out unneeded HVAC and non-choir noises, a high pass filter

above 75 Hertz was put on every audio channel. With the lowest choir note being a C2 at 110 Hertz, no choir notes or sounds were cut out.

All of the digital tracks were "normalized" when exporting to make every mp3 have the same peak amplitude while maintaining the ratio of the softest to loudest dynamics. We did not want the auditors to give preference to one performance over another on the account of the overall volume of the excerpt. Normalizing all of the tracks allowed the dependent variable of intensity to remain unaffected, as the dynamic contrast of the selections would remain intact.

Experiment Location

The Johnson Center Worship Center was selected as the location for this study for its relevance and application with the Malone University Chorale. A wide variety of productions are done in the Worship Center with the Chorale, including Christmas at Malone, which makes it the most apt location for this study.

Pre-Experiment Preparation

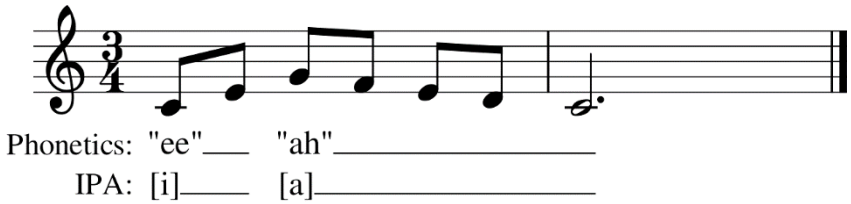
Ordering Singers Based on Tone Color

This study specifically focused on how the arrangement of singers, with respect to their individual vocal tone colors, affects the overall tone color and performance of the choir. In order to organize the singers by tone color, each section sang separately, and the individuals of those sections were ranked from brightest to darkest. In order to do this, the selected section was asked to line up shoulder to shoulder and start by singing in

pairs from left to right. They sang a simple warm-up passage in a comfortable tessitura for all singers based on their voice part, as seen in Figure 1.

Figure 1

Warm-up Used to Determine Relative Tone Color of Singers



Note. Singers sang the warm-up by ear. Notation, phonetics and IPA added afterward as an illustration.

After determining a rough order from bright to dark tone color for each section, the section-specific orders were used as a foundation for ordering the entire choir from brightest to darkest voices. During one rehearsal, the room was prepared with four circles with about 11 chairs each. In the middle was a piece of paper on a music stand with four tone color descriptors on them: Bright, Moderately Bright, Dark, and Moderately Dark. The entire choir was instructed to sit in the circle that they believe best describes their voice. During the warm-ups for that rehearsal, both their self-analysis and the previously determined orders were used to fine tune and determine the final order. This strategy allowed us to listen to each voice side-by-side and swap singers between circles until we were satisfied with the congruence of each singer's tone color within their circle. Pictures were taken of each circle for reference, and, with the assistance of Dr. Peterson, the order of every singer in the Chorale from brightest to darkest tone color was finalized.

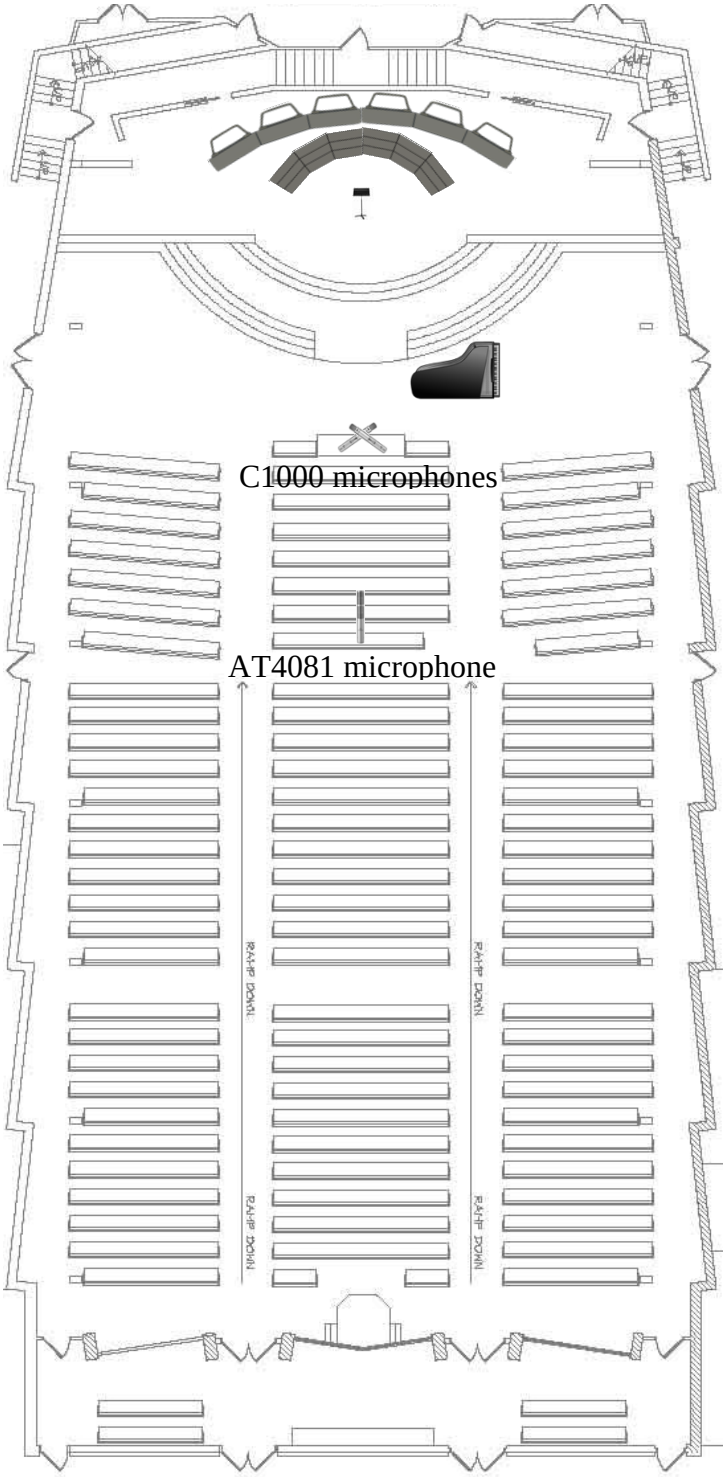
Worship Center Preparation

Risers and sound shells were needed as a part of this study in order to most closely mimic a performance environment. They were pre-installed prior to the start of testing through the help of the singers in the choir. Six risers and six sound shells were placed against the back wall on the stage, set for the first eight excerpts on the stage. This location mimics their typical location for performances during Christmas at Malone. After the eight excerpts were recorded on the stage, the risers and sound shells were relocated to the main floor of the Worship Center and pushed back against the stage. This mimics their typical location for choir-only performances.

As mentioned above, microphones were set up to mimic the locations of audience members for performances during Christmas at Malone and choir-only concerts. See Figures 2 and 3.

Figure 2

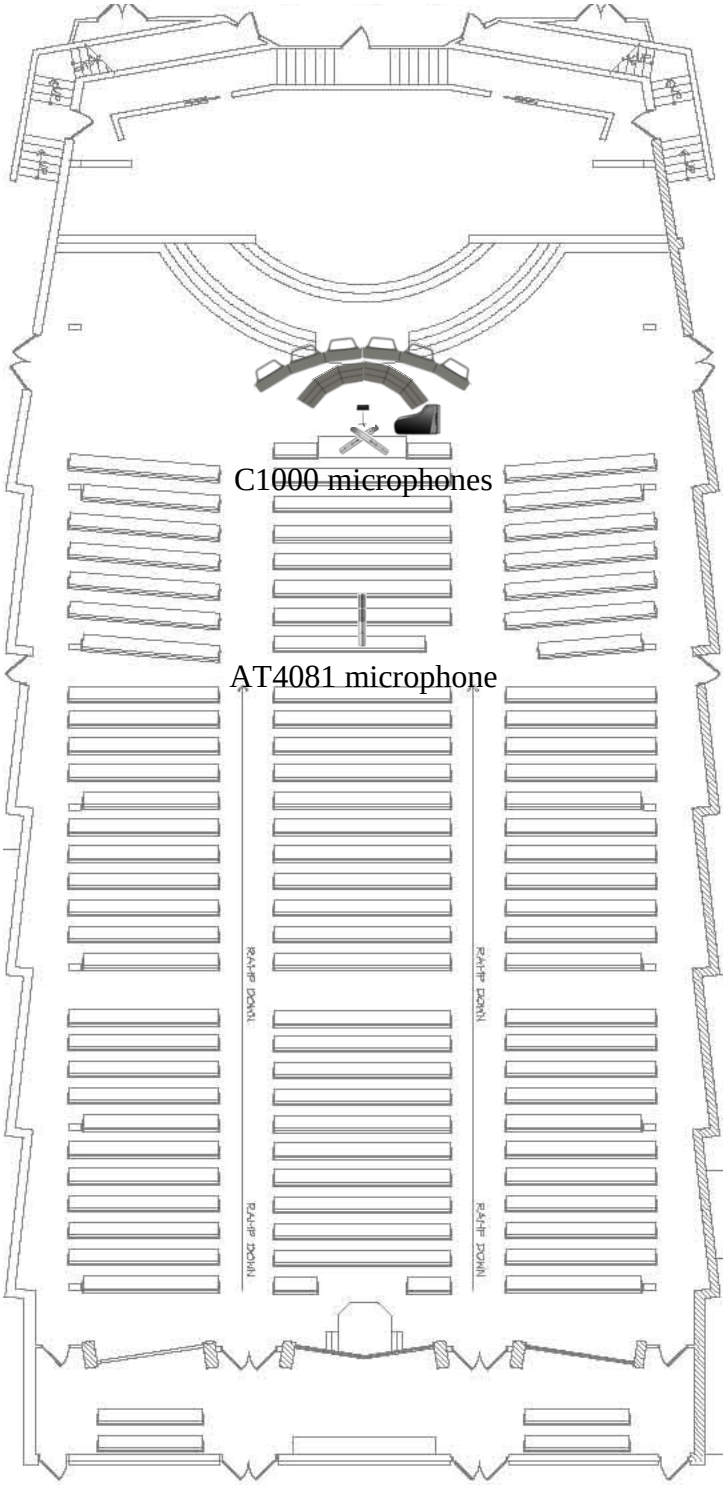
Stage Formation Location in the Worship Center



Note. This image is not to scale. This performing space has a 60-foot ceiling.

Figure 3

Floor Formation Location in the Worship Center



Note. This image is not to scale. This performing space has a 60-foot ceiling.

Additional Preparation

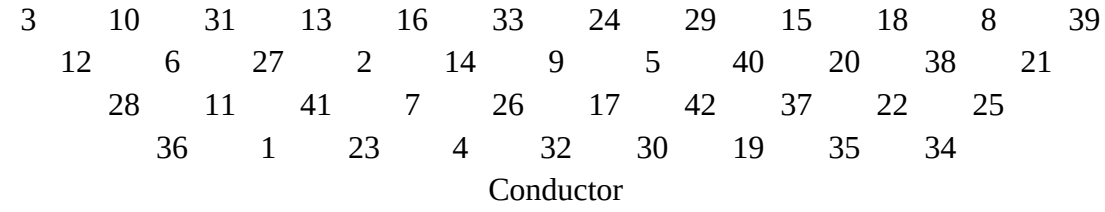
"Recording in Progress" signs were created and placed on the doors of the Worship Center prior to the start of testing to ensure that no extraneous noises would be created and appear in the final results of the recordings.

Choir Formations

Four formations were studied and used for this research: balanced sections, balanced mixed, bright voices on the outsides, and dark voices on the outsides. The first two formations are most widely studied in research and used in choral practice. They were used as constants because their impact on the choir's sound is consistent and predictable. The second two formations were chosen because manipulating a choir's overall tone color was the initial aim of this study. From Dr. Peterson's experience as a director of choral music, he has speculated that a choir's overall tone color is most impacted by the tone color of the singers positioned on the outsides of the ensemble. For this reason, we chose to include the latter two formations as a way of testing this speculation. Diagrams of the formations that were used are listed below in Figures 4-7. Due to vocal limitations as a result of illness, singer 11 was present, but did not sing during the testing session.

Figure 4

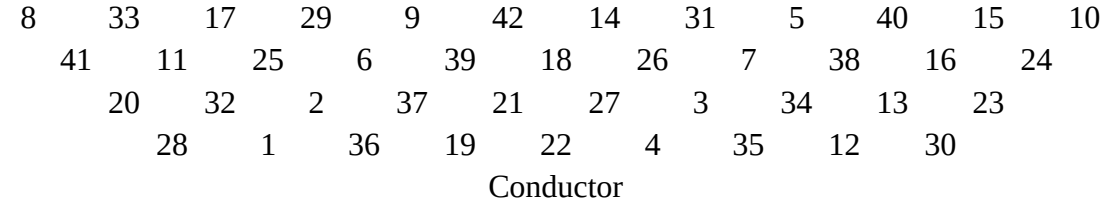
Formation A – Balanced Sections



Note. This formation reflects an STBA formation of singers.

Figure 5

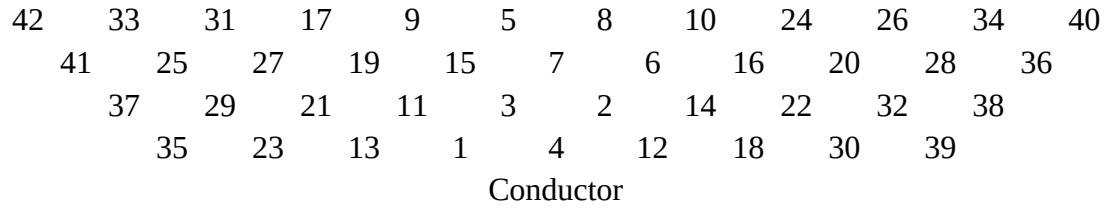
Formation B – Balanced Mixed



Note. Singers were placed so that no two singers of the same voice part stood next to each other. The final placement for this formation was up to the director's knowledge of each singers' individual voices and how they would work together.

Figure 6

Formation C – Dark Voices on the Outside



Note. Singers were primarily placed with dark voices (higher numbers) on the outsides with brighter voices (lower numbers) on the insides. Small adjustments were made due to height differences so that every singer could see the conductor.

Figure 7

Formation D – Bright Voices on the Outside

5 9 17 31 33 42 40 34 26 24 10 8
7 15 19 27 25 41 36 28 20 16 6
3 11 21 29 37 38 32 22 14 2
1 13 23 35 39 30 18 12 4
Conductor

Note. Singers were primarily placed with brighter voices (lower numbers) on the outsides with dark voices (higher numbers) on the insides. Small adjustments were made due to height differences so that every singer could see the conductor.

Method of Evaluation

Due to a lack of ample auditor availability at the time of the performance, the data from the testing was collected solely through the audio recordings that were made. The recordings were exported and uploaded into Google Drive as mp3 files. A separate, shared folder was created for each auditor which contained instructions, a consent form to sign, the auditor evaluation spreadsheet, scores of the recorded excerpts, and all sixteen audio recordings. The auditors were instructed to download the recordings and use the auditor evaluation spreadsheet (See Appendix A) to record their analysis and ratings for each excerpt.

Analysis of Data

Method of Analysis

Based on the data collected from the completed evaluation forms (See Appendix A), qualitative data was utilized as the primary enforcer of the following analysis. With the assistance of Dr. Peterson and Dr. Ballard, thematic analysis was done to determine themes that best described each dependent variable for all excerpts. To support the

thematic analysis, quantitative analysis through calculations of means was done. In order to perform quantitative analysis for tone color, the ratings were changed according to the following scale: Bright = 1, Moderately Bright = 2, Balanced Tone Color = 3, Moderately Dark = 4, Dark = 5. From there, calculations of the mean were compared against each other to find the excerpts that had the highest rating for each of the dependent variables, as well as the best overall score. Tone color was not included in the overall score rating. Rather, the "highest rating" for tone color was determined based on which excerpt's mean score was closest to three, or "balanced tone color". If two excerpts tied for the highest score in any area, they will both be mentioned.

Due to a lack of auditor responses, Chi-Square analysis could not be done because there would not be enough power in the test to show significant results.

The sixteen excerpts represent performances in permutations created from two performance locations within the Worship Center, two repertoire excerpts and four formations (See Figures 4-7). Table 1 outlines the order in which the combinations were tested in the testing session.

Table 1

Order of Performance during Testing Session

Formation	Texture	Order of Performance	Excerpt
		Stage	
A	Homophonic	1	O
A	Polyphonic	2	F
C	Homophonic	3	K
C	Polyphonic	4	H
D	Homophonic	5	M
D	Polyphonic	6	B
B	Homophonic	7	C
B	Polyphonic	8	I
		Floor	
A	Homophonic	9	N
A	Polyphonic	10	D
C	Homophonic	11	E
C	Polyphonic	12	G
D	Homophonic	13	A
D	Polyphonic	14	P
B	Homophonic	15	L
B	Polyphonic	16	J

Note. The homophonic selection was *A Mighty Fortress is Our God* by Dan Forrest, and the polyphonic selection was "Cattle, Horses, Sky & Grass" from *Considering Matthew Shepard* by Craig Hella Johnson. The numbers 1-16 were randomly sequenced by random.org (Timestamp: 2020-02-19 19:02:49 UTC) and assigned letters A-P based on the new, generated sequence. Excerpts were presented to the auditors in the order of this latter, randomized (A-P) sequence.

The following sections analyze both the dependent variables and independent variables for this study. Table 2 serves as a master table that contains all mean scores for every variable. Tables 3-11 contain specific information from Table 2, as it is relevant for its respective variable.

Table 2

Mean Scores for All Excerpts and Variables

Formation	Dependent Variables				
	Blend	Balance	Tone Color	Rhythmic Precision	Intensity
			Homophonic on the Stage		
A	4.17	3.50	3.17	3.67	3.83
B	4.08	3.92	3.00	3.92	4.00
C	3.75	3.92	3.33	3.75	3.92
D	3.92	3.83	3.50	3.75	3.75
			Polyphonic on the Stage		
A	4.00	3.67	2.58	3.83	3.83
B	3.42	3.36	2.50	3.67	3.92
C	3.92	3.75	3.25	3.25	3.83
D	2.90	3.40	2.70	3.50	3.30
			Homophonic on the Floor		
A	2.50	3.17	1.75	3.83	3.33
B	2.92	3.08	1.67	4.17	3.58
C	2.67	2.75	1.83	3.67	3.42
D	2.67	2.33	2.33	3.75	3.17
			Polyphonic on the Floor		
A	2.75	3.08	2.25	3.83	3.67
B	2.83	3.17	2.08	3.67	3.58
C	3.58	3.50	2.58	3.92	3.92
D	3.58	3.75	2.75	4.08	3.75

Note. All excerpts are n=12 except for Excerpt B (n=10) which is shaded in gray.

Analysis of Dependent Variables

Blend

Thematic analysis indicated that stage performances were preferred because the acoustics of the space helped the ensemble's sound to blend more before it reaches the audience's ear. As seen in Appendix B, one auditor stated this about Excerpt O (homophonic performance on the stage in formation A): "One of the most blended excerpts. This sounds like it has been recorded in such a large cathedral that all voices

blend together in a beautiful, almost magical, way." Comments about floor performances consistently noted that various sopranos cut through the ensemble's sound and caused the blend to be of lower quality than stage performances. One auditor was "not convinced the singers can hear each other easily," which led to certain voices sticking out with nasal tones because of an inability to hear and blend with the voices around them.

When looking at the mean scores for blend across all excerpts (See Table 3), the three highest scores, which are all above an average of 4 out of 5, are of stage performances. Furthermore, the averages displayed at the bottom of Table 3 indicate that, for both homophonic and polyphonic textures, stage performances are optimal for blend. When directly comparing all homophonic and polyphonic textures separately, Formation A on the stage had the highest for both homophonic and polyphonic textures.

Table 3

Mean Scores for Blend

Formation	Stage Performance		Floor Performance	
	Homophonic	Polyphonic	Homophonic	Polyphonic
A	O - 4.17	F - 4.00	N - 2.50	D - 2.75
B	C - 4.08	I - 3.42	L - 2.92	J - 2.83
C	K - 3.75	H - 3.92	E - 2.67	G - 3.58
D	M - 3.92	B - 2.90	A - 2.67	P - 3.58
Average	3.98	3.56	2.69	3.19

Note. All excerpts are (n=12) except for Excerpt B (n=10).

When considering the variable of blend, it is apparent through both qualitative and quantitative analysis that the space of the room and the positioning of the microphones in relation to the ensemble had a significant impact on the auditors' perceived sense of ensemble blend. Since the C1000 microphones were comparably close to the ensemble on the floor, as seen in Figure 3, individual voices were much more

likely to be heard compared to that of the stage performances. However, when the choir performs on the floor, they are equally close to some, though not all, members of the audience.

Balance Between Sections

Auditors heard and noted that the balance between sections was better overall for stage performances compared to floor performances. Because of the prominent number of women compared to men in the ensemble, a difference in ratings for this variable was most noticeable whenever the tenor and bass sections were more clearly heard.

Throughout most excerpts, the soprano section is clearly heard and sticks out. However, Excerpts N, D, and L (all three floor performances) were most notable for comments reflecting a heightened ability to hear the men, particularly the bass section. This is not to say that their ability to hear the men was preferred, as one auditor said that the "men's voices [were] sticking out as a section, especially Basses [sic.]," and another auditor described both the alto and bass sections' sound as "heavier" (See Appendix C). When looking at Table 4, it is interesting to note that Excerpts N and D are both performances on the floor in a sectional formation (Formation A). The auditors' comments suggest that the floor performances were less preferable for balance because of the distance between the sopranos and the audience. The space between the ensemble and microphones in the stage formations helped to dampen the relative strength of the women, leading to higher ratings overall.

Quantitative analysis supports the assessment that stage performances are optimal for balance between sections. When comparing scores between stage and floor performances, all other variables remaining constant, stage ratings were higher in almost

every case. The only exception is for polyphonic texture in Formation D, in which the floor performance rated .35 higher than the stage performance. The biggest difference heard, however, happens between stage and floor performances for homophonic music. In this study, the stage performances averaged almost an entire point higher (on a five-point scale) overall compared to the floor performances.

Excerpts C and K tied for the highest rating of all homophonic excerpts at 3.92. Excerpt H also averaged the highest rating among all polyphonic excerpts at 3.92. Not only does this indicate that stage performances are optimal for the best balance between sections, but Formation C on the stage, specifically, is ideal regardless of the piece's harmonic texture.

Table 4

Mean Scores for Balance Between Sections

Formation	Stage Performance		Floor Performance	
	Homophonic	Polyphonic	Homophonic	Polyphonic
A	O - 3.50	F - 3.67	N - 3.17	D - 3.08
B	C - 3.92	I - 3.42	L - 3.08	J - 2.83
C	K - 3.92	H - 3.92	E - 2.75	G - 3.50
D	M - 3.83	B - 3.40	A - 2.33	P - 3.75
Average	3.79	3.60	2.83	3.29

Note. All excerpts are (n=12) except for Excerpt B (n=10).

Tone Color

The auditors rated each performance's tone color without a number included (See Appendix A) so that results would not be numerically biased. The following scale was applied afterward for the ease of numerical analysis: bright = 1, moderately bright = 2, balanced tone color = 3, moderately dark = 4, dark = 5. Results considered to be stronger are those with average ratings closest to three (3), or a "balanced tone color".

Quantitative analysis suggests that for homophonic pieces, the Chorale should perform on the stage (See Table 5). All stage formations resulted in average ratings at or above 3, indicating that the overall bright tone of the choir was heavily improved by simply placing the ensemble on the stage. It is mostly inconclusive as to whether the location of the choir has a significant impact on ensemble tone color for polyphonic pieces, though a slightly more balanced tone color for polyphonic pieces can be noted on the stage.

Thematic analysis of comments affirms the conclusions from numerical analysis. Among homophonic excerpts, auditors showed significant preference for the spacious and tall vowels that the stage formations helped to produce. Regarding Excerpt C (homophonic performance on the stage in Formation B), one auditor said, “I don't think the color itself from the choir changed, however the warmth of the choir because of including the room” (See Appendix D). For Excerpt M (homophonic performance on the stage in Formation D), auditors commented that it sounded as if the singers could hear each other better, and the warmer voices balanced out the bright voices much more. These comments are starkly contrasted with Excerpt L (homophonic performance on the floor in Formation B) which was “a little tinny sounding” due to bright and spread vowels.

Table 5

Mean Scores for Tone Color

Formation	Stage Performance		Floor Performance		Average
	Homophonic	Polyphonic	Homophonic	Polyphonic	
A	O - 3.17	F - 2.58	N - 1.75	D - 2.25	2.44
B	C - 3.00	I - 2.50	L - 1.67	J - 2.08	2.31
C	K - 3.33	H - 3.25	E - 1.83	G - 2.58	2.75
D	M - 3.50	B - 2.70	A - 2.33	P - 2.75	2.82
Average	3.25	2.76	1.90	2.42	

Note. All excerpts are (n=12) except for Excerpt B (n=10).

One aim of this study was to analyze the effect that specific formations have on tone color. The two formations of interest were Formations C (dark voices on the outside) and D (bright voices on the outside) (See Figures 6 & 7). Prior to the study, it was conjectured that by putting the singers with the desired vocal color on the outsides of the ensemble, the entire ensemble will naturally sound more like those voices. The analysis found in Table 5 points to this concept being untrue. For stage performances of homophonic music and floor performances of polyphonic music, the results are fairly close between Formations C and D. However, in both of these circumstances, Formation D resulted in a slightly darker overall choral tone color. Formation C helped polyphonic music on the stage to be darker by a margin of .5, as seen between Excerpts H and B. The opposite was true for homophonic music on the floor, as Formation D was darker by a margin of .5, as seen between Excerpts E and A.

This may be a result of the acoustics of the Worship Center having an effect on tone color. The space between the ensemble allowed the stage performance of polyphonic excerpts to be darker, while the auditors heard a more bright overall sound for the homophonic excerpts on the floor because the performance space didn't have a

chance to naturally darken the sound before it reached the auditors' ears. Though, this conclusion cannot be fully supported because if it was true, it would have to be true for all combinations. Since tone color ratings were fairly close and consistent for homophonic excerpts on the stage and polyphonic excerpts on the floor, it is unlikely that this conclusion is fully supported by the quantitative analysis seen in Table 5.

Rhythmic Precision

Scores were fairly consistent regardless of musical texture or location in the Worship Center. Comments, however, did give slight preference toward floor performances. This could be because the rhythms and diction was more clearly captured because the choir was closer to the microphones. Auditors commented saying that the rhythms of stage performances seemed very delayed, muddy, and "needed to punch more" (See Appendix E). Some auditors made mention that compared to stage performances, the rhythmic feel, energy and overall precision of floor performances was better.

The highest overall ratings for both textures, Excerpts L and P, are of floor performances (See Table 6). Regardless of musical texture, the average ratings of floor performances scored higher, although by a limited margin. Based on numerical data, it is inconclusive as to whether the formation has a noticeable impact on rhythmic precision.

Table 6

Mean Scores for Rhythmic Precision

Formation	Stage Performance		Floor Performance		Average
	Homophonic	Polyphonic	Homophonic	Polyphonic	
A	O - 3.67	F - 3.83	N - 3.83	D - 3.83	3.79
B	C - 3.92	I - 3.67	L - 4.17	J - 3.67	3.86
C	K - 3.75	H - 3.25	E - 3.67	G - 3.92	3.65
D	M - 3.75	B - 3.50	A - 3.75	P - 4.08	3.77
Average	3.77	3.56	3.86	3.86	

Note. All excerpts are (n=12) except for Excerpt B (n=10).

Intensity

Auditor comments for this variable were inconsistent and inconclusive. It is believed that the auditors did not fully comprehend or agree upon the definition of "intensity" while evaluating (See Appendix F), though descriptors were given to the auditors beside each rating, describing what each rating should represent (See Appendix A).

When looking at the homophonic excerpt results alone, we find that Excerpt C (Formation B on the stage) had the highest average rating with 4 out of 5 (See Table 7). Solely comparing polyphonic excerpts, excerpts I (Formation B on the stage) and G (formation C on the floor) tied for the highest average rating with 3.92 out of 5. It is interesting to note that, despite the inconclusiveness of the written comments, quantitative evidence suggests that the auditors gave preference to Formation B on the stage, despite musical texture.

Table 7

Mean Scores for Intensity

Formation	Stage Performance		Floor Performance	
	Homophonic	Polyphonic	Homophonic	Polyphonic
A	O - 3.83	F - 3.83	N - 3.33	D - 3.67
B	C - 4.00	I - 3.92	L - 3.58	J - 3.58
C	K - 3.92	H - 3.83	E - 3.42	G - 3.92
D	M - 3.75	B - 3.30	A - 3.17	P - 3.75
Average	3.86	3.72	3.38	3.73

Note. All excerpts are (n=12) except for Excerpt B (n=10).

Analysis of Independent Variables

For choir-only concerts, the performing choir will need to remain in the same location within the worship center (floor or stage) for all pieces of music due to logistical limitations (e.g. the inability to move risers and shells in between pieces of music), though formations may change between pieces. Therefore, the following sections dedicated to optimal formations for homophonic and polyphonic pieces will analyze ideal formations and locations for large works with each respective musical texture, given that the choir will not be able to move locations.

Optimal Formations for Stage Performances

For homophonic excerpts on the stage, scores are fairly consistent, though Excerpt C still had the highest overall rating, as seen in Table 8. Comparing these results with the results for tone color, since they are not considered when calculating the average rating, we find that Excerpt C also has the best tone color rating of 3.00. For polyphonic excerpts on the stage, Formation C appears to be desired. Though its rating is .14 points (out of five) lower than Formation A, its rating for tone color is desired more since it is closer to three (3) and, on average, darker than Formation A.

Solely considering the averages of both excerpts in each formation, Formation A appears to be the optimal formation for stage performances. It has the highest average rating and the closest tone color average with a score .12 points brighter than a balanced score of 3. With regard to tone color, Formation D is close behind Formation A with an average tone color rating .13 darker than a balanced score, but its average rating of both excerpts is the lowest of all four formations. Despite Excerpt C (homophonic music in Formation B) having the most favorable score of all recorded excerpts, Excerpt I brought down Formation B's effectiveness overall due to having the second lowest average rating and furthest score from 3 of all polyphonic excerpts.

Table 8

Mean Scores for Excerpts of Stage Performances

Excerpt	Musical Texture	Average Rating	Tone Color
	Formation A		
O	Homophonic	3.79	3.17
F	Polyphonic	3.83	2.58
Average		3.81	2.88
	Formation B		
C	Homophonic	3.98	3.00
I	Polyphonic	3.59	2.50
Average		3.79	2.75
	Formation C		
K	Homophonic	3.83	3.33
H	Polyphonic	3.69	3.25
Average		3.76	3.29
	Formation D		
M	Homophonic	3.81	3.50
B	Polyphonic	3.28	2.76
Average		3.41	3.13

Note. All excerpts are (n=12) except for Excerpt B (n=10).

Optimal Formations for Floor Performances

Among the homophonic excerpts, auditor preference is inconclusive since Excerpt L was the highest for average rating, and Excerpt A had a tone color rating closest to three (See Table 9). However, among polyphonic excerpts, Excerpt P had both the highest average rating and the best score for tone color. These results suggest that Formation D is optimal for floor performances since both excerpts A and P were in Formation D.

Table 9

Mean Scores for Excerpts of Floor Performances

Excerpt	Musical Texture	Average Rating	Tone Color
	Formation A		
N	Homophonic	3.21	1.75
D	Polyphonic	3.33	2.25
Average		3.27	2.00
	Formation B		
L	Homophonic	3.44	1.67
J	Polyphonic	3.31	2.08
Average		3.38	1.88
	Formation C		
E	Homophonic	3.13	1.83
G	Polyphonic	3.73	2.58
Average		3.43	2.21
	Formation D		
A	Homophonic	2.98	2.33
P	Polyphonic	3.79	2.75
Average		3.39	2.54

Note. All excerpts are n=12.

Optimal Formations for Homophonic Pieces

The analysis in this section is most applicable for performances of large works with a dominant, homophonic, musical texture in which the choir will not be able to switch formations. Such works would include oratorios, masses, extended compositions and other multi-movement works.

When comparing each excerpt separately, quantitative analysis highly suggests that Formation B on the stage (Excerpt C) is ideal across both the average rating and tone color. This is consistent with current scholarly research, since Formation B was a mixed formation that blended all voices evenly. Performances on the stage also positively impact tone color, as seen when comparing Tables 8 and 9.

Excerpt O (Formation A) is also notable for having the highest average rating for blend with a score of 4.17 (See Table 3). Blend is of high importance for most choral directors, and it should be noted that excerpt O had a higher score for blend compared to excerpt C. This is important because among all homophonic excerpts, excerpt O had a comparatively high average rating of all homophonic excerpts. Its score for tone color is also ideal since a score of 3.17 indicates that the formation and location of the choir helped to darken the naturally bright tone color of the ensemble. Regardless, both Excerpts O and C are of performances on the stage, clearly suggesting that, for homophonic pieces, the choir should perform on the stage in the Worship Center in either Formation A or B.

Table 10

Mean Scores for Excerpts of Homophonic Pieces

Excerpt	Performance Location	Average Rating	Tone Color
	Formation A		
O	Stage	3.79	3.17
N	Floor	3.21	1.75
Average		3.50	2.46
	Formation B		
C	Stage	3.98	3.00
L	Floor	3.44	1.67
Average		3.71	2.34
	Formation C		
K	Stage	3.83	3.33
E	Floor	3.13	1.83
Average		3.48	2.58
	Formation D		
M	Stage	3.81	3.50
A	Floor	2.98	2.33
Average		3.40	2.92

Note. All excerpts are n=12.

Optimal Formations for Polyphonic Pieces

The analysis in this section is most applicable for performances of large works with a predominantly polyphonic musical texture in which the choir will not be able to switch formations. Such works would include oratorios, antiphonal works, masses, choruses in staged works such as operas, and other multi-movement compositions.

The optimal formation and location in the Worship Center for polyphonic works is less clear than it was when considering homophonic pieces. Excerpts F and P are the most notable of these performances because of their high average ratings of 3.83 and 3.79, respectively (See Table 11). Among all excerpts where scores for tone color range from 1.67 to 3.5 (See Table 2), a score of 2.58 for excerpt F and 2.75 for excerpt P are

very similar and almost indistinguishable to the audience's ear. With this in mind, quantitative analysis suggests that the two ideal formations for polyphonic pieces are Formation A on the stage or Formation D on the floor.

Table 11

Mean Scores for Excerpts of Polyphonic Pieces

Excerpt	Performance Location	Average Rating	Tone Color
	Formation A		
F	Stage	3.83	2.58
D	Floor	3.33	2.25
Average		3.58	2.42
	Formation B		
I	Stage	3.59	2.50
J	Floor	3.31	2.08
Average		3.45	2.29
	Formation C		
H	Stage	3.69	3.25
G	Floor	3.73	2.58
Average		3.71	2.92
	Formation D		
B	Stage	3.28	2.70
P	Floor	3.79	2.75
Average		3.54	2.73

Note. All excerpts are n=12 except excerpt B (N=10).

The one deciding factor between excerpts F and P, however, is their scores for blend. Since overall choral blend is a strong focus for choral directors when determining how to arrange their choirs, it will be considered in this circumstance. As seen in Table 3, scores for Formation A on the stage are 4.17 and 4.00 compared to 2.67 and 3.58 for Formation D on the floor for polyphonic textures. 4.00 and 3.58 represent the average ratings for the polyphonic texture specifically. However, this analysis is most applicable for large works primarily of the polyphonic texture. A large work will not explicitly have

a polyphonic texture, and thus, scores for the homophonic texture can still be considered. With this in mind, Formation A on the stage, as seen with excerpt F appears to be preferred over Formation D on the floor, as seen with excerpt P.

Singer Formation Preference

An informal survey was conducted with the singers in the choir. After performing on the stage and, again, after performing on the floor, the singers were asked the following questions: In what formation did you most enjoy singing? A? C? D? B? A-C-D-B was the order of formations in which the excerpts were sung (See Table 1). The singers raised their hands and their responses are recorded in Table 12.

Table 12

Totals of Singer Preference of Singing Formations

Location	Stage				Floor			
	A	B	C	D	A	B	C	D
Floor					5	14	4	17
Stage	8	8	12	13				
All	1	4	2	6	4	9	3	12

Note. One singer did not vote for their preference of floor formations.

What was found is that the singers in the choir had a strong preference for Formations B and D. Among all formations on the stage and floor, Formation D on the floor was most preferred. Preference for Formation B was expected since it was a mixed formation, which is most commonly used for all choral performances with the Chorale in the Worship Center. Formation D, which was bright voices on the outside, was more surprising. Among all floor performances, these findings are consistent with the auditors' responses since Formation D has the best tone color rating and second highest average rating. Though, stage performances were consistently rated higher across every variable.

Therefore, preference among the singers for Formation D on the floor could be a result of the singers' ability to hear themselves and each other more when positioned on the floor.

Results

Thematic and quantitative analysis from this study leads to the following conclusions:

The best overall choral sound is produced by performing homophonic music in a mixed formation (Formation B) on the stage (Excerpt C). It received scores of 4.08 for blend, 3.92 for balance between sections, 3.00 for tone color, 3.92 for rhythmic precision, and 4.00 for intensity. Of those scores, it had the highest ratings of all excerpts in balance between sections, tone color, and intensity.

This is likely because of the Malone University Worship Center's unique acoustics. The space between the choir and the audience had a strong impact, but the performing space also has 60-foot ceilings with limited acoustic panels to absorb the natural reverberation of the choir's sound. All of these factors aided the choir's performances on the stage more than the choir's performances on the floor.

For dependent variables of blend, balance between sections, and tone color, stage performances consistently rated higher because the space between the choir and audience allowed the space in the Worship Center to positively impact and mix the choir's sound. For the dependent variable of rhythmic precision, however, the opposite was true. Because the choir was closer to where the audience would be, the auditors heard more clarity and accuracy of rhythms in performances on the floor compared to performances on the stage. The effects of the acoustics on the dependent variable of intensity was inconclusive according to both qualitative and quantitative analysis.

In many circumstances, a choir will have the ability to alter their formation depending on a variety of factors, including the texture of the work. The data in Table 8 indicates that the ideal formation for homophonic music on the stage is Formation B and suggests that the ideal formation for polyphonic music is Formation A.

In specific circumstances, a choir may not choose to alter their formation many times. If the choir is singing on the stage and is unable to change formations for different musical textures, the best overall stage formation is Formation A, or a sectional formation (See Figure). Its average of both the homophonic and polyphonic excerpts (3.81 out of 5) was the highest of all four formations on the stage, though closely followed by Formation B which had an average rating of 3.79 out of 5. Formation A's average score for tone color also was the closest to three, with a score only .12 brighter than "balanced". By a narrow margin, this study's data suggests that Formation A is preferred among auditors for stage performances if the performing choir is unable to alter their formation during a performance.

If the performing choir is singing on the floor and can alter their formation depending on the work that is being sung, the data in Table 9 suggests that the ideal formation for polyphonic works is Formation D. Its average rating was the highest of all excerpts at 3.79 out of 5, and its rating for tone color was the closest to three with a rating of 2.75. Results for an ideal formation for homophonic works is inconclusive since the highest average rating was in Formation B, but the highest rating for tone color was in Formation D.

Based upon the preceding conclusions, if the choir is singing on the floor, quantitative analysis suggests that the ideal formation for both homophonic and

polyphonic music is Formation D. While results were inconclusive for homophonic music on the floor, the highest average rating and best tone color scores for polyphonic music on the floor were for Formation D. Of the homophonic results, the excerpt resulting in the best tone color also was of Formation D. This suggests that the preferred formation for floor performances, regardless of musical texture, is Formation D, or bright voices on the outside of the ensemble (See Figure 7).

Placing the singers with the desired vocal tone color on the outsides of the ensemble does not appear to result in an overall choral tone color representative of those singers. Though, no definite conclusions can be made. Almost consistently, Formation D, which was conjectured to produce an overall choral sound that was brighter than the other three formations, produced a choral sound that was darker than Formation C. The exception of this conclusion was for polyphonic excerpts on the stage. Regardless, Formations C and D consistently resulted in an overall choral tone color that is darker than Formations A and B, regardless of choir location or musical texture.

It is likely that the positioning of the microphones for this study may have affected this conclusion, as they were aligned with the center of the ensemble. Therefore, the tone color from the singers in the center of the ensemble may have been disproportionately captured in the recordings, especially for performances on the floor in which the ensemble's sound did not have a chance to be influenced by the acoustics of the performance space. These results do not suggest that this conclusion is true of all elements of vocal sound, such as voice size, speed of vibrato, etc., but only with respect to tone color.

Overall ratings for stage performances were more positive and rated higher than floor performances because the acoustics of the performance space were able to blend and balance more evenly before reaching the audience's ear. Though not explicitly tested, it is believed that performing on the stage in the Worship Center, however, makes it harder for singers in a choir to hear themselves because of the nature of the performance space (See Figures 2 & 3). On the stage, the singers' sound has more room to fill, which in turn decreases their ability to hear themselves and one another while improving the resulting sound for the audience. On the floor, especially with an audience present to absorb some of the sound, the singers are able to hear each other more because their sound does not have to fill as much space, and the reverberation of their sound is less than on the stage.

Shared preference for certain formations between the singers and auditors is inconclusive. Although the auditors preferred the blend and balance of performances on the stage, the singers preferred performing on the floor. Formation D, specifically performed on the floor, was highly preferred among the singers and also highly scored by the auditors. However, it still did not score higher when compared to stage performances. Singers also had a secondary preference for Formation B, which was a mixed formation. Auditors also had preference for this formation, specifically on the stage while performing the homophonic excerpt.

This research has implications for impact on my future vocation as a choir director. From this study, I have personally concluded that performing in locations that allow the choir's sound to reverberate throughout the room before it reaches the audience's ear is preferred. It gives the choir's sound the best opportunity to use the

acoustics of the room to naturally blend the ensemble's sound, thus producing a more balanced and pleasing performance overall.

It is important to keep in mind that this study was completed with applications for the Malone University Chorale in mind. All of the results found in this study are particularly relevant for one ensemble in one performance space, the University Chorale in the Worship Center. When working with choirs in the future, I will recall and use elements of this study to inform my directorial decisions to position my singers in optimal formations and locations for every performance.

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Appendix A

Auditor Feedback Form

Excerpt A	Rating	Comments:
Blend	1 - Multiple individual voices consistently audible. 2 - Individual voices frequently audible. 3 - Individual voices occasionally audible. 4 - Individual voice(s) rarely audible. 5 - No individual voices detected.	
Balance Between Sections	1 - Multiple sections consistently unbalanced. 2 - Individual sections frequently unbalanced. 3 - Individual sections occasionally unbalanced. 4 - Individual sections rarely unbalanced. 5 - All sections consistently balanced.	
Tone Color	Bright Moderately Bright Balanced Tone Color Moderately Dark Dark	
Rhythmic Precision	1 - Poor rhythmic precision. 2 - Fair rhythmic precision. 3 - Average rhythmic precision. 4 - Good rhythmic precision. 5 - Excellent rhythmic precision.	
Intensity	1 - There is a general lack of intensity in the performance. 2 - There are significant inconsistencies in intensity/dynamic contrast. 3 - Dynamic contrast/intensity is somewhat inconsistent. 4 - Dynamic contrast/intensity is fairly consistent throughout with few exceptions. 5 - Dynamic contrast/intensity is maintained throughout the excerpt.	

Appendix B

Auditor Comments for Blend

Excerpt A:

"Upper voices very prominent"

"In this recording, singers seem a bit unable to hear the whole ensemble effect."

"Blend inside the section was fair, this could have been for lack of additional singers"

"There is a soprano voice that is frequently audible at the beginning, and then a tenor voice that seems to stick out during the TB feature"

"The women are particularly present in this recording, to the point where one hast to listen carefully to hear the men in the SATB sections. I do hear some individual voices, but mostly a lot of soprano."

"Individual soprano & tenor voices present"

Excerpt B:

"The blend felt attributed more to the accoustics [sic.] than choral precision"

"S1 at beginning"

"Tenor and soprano"

"One tenor voice continues to stick out"

"Here and there, but especially the tenors"

Excerpt C:

"Sounds far away"

"Sections can hear their own voices"

"Overall blend was more uniform and cohesive"

"Tenor."

"Well-blended within parts with the exception of a soprano or two"

"The "blend" is much better than Excerpt A, however they sound far away. While they sound far away in some places, I think it is much better because I can hear the choir in the space rather than on-top of them."

Excerpt D:

"I like this sound so far of the examples I listened to."

"This position seems to really expose voices, especially in women's sections."

"If not under control, a few times high passages had poorer blend lower passages"

"Every section had individuals that stood out."

"I think it is an alto"

"It sounds much more clean, like I can hear each part clearly, while still being clear. There's one soprano that comes out of texture in the passaggio. There are also some tuning things, but I am calling that a mulligan. :)"

"Some voices with excessive vibrato"

Excerpt E:

"Sounds distant"

"Not a very successful blended effect"

"Diction was improved and blend was more consistent"

"Soprano"

"Soprano section has one or two voices that are distinctive"

"It's not as tight of a sound. It sounds as if the microphones are down their throats. You can also hear individual vocal faults clearly, like vibrato."

"Some soprano voices heard"

"Soprano"

Excerpt F:

"I like this version of A Mighty Fortress so far"

"When individuals show, it is sometimes quite glaring."

"If not careful, higher passages in the ladies parts tend not to blend"

"Soprano 1"

"There are some tuning things from the women, but I am not considering that an issue with the "blend" category you are talking about."

Excerpt G:

"Can hear lower voices better"

"Only in soprano - seems excellent except in highest voices"

"Only noticable [sic.] when the ladies sing high uncontroled [sic.]"

"Soprano 1"

"Much cleaner sounding recording."

Excerpt H:

"Sounds very distant"

"Very nice blend here seemingly in a larger space, which plays a role"

"Overall a nice blend"

"S2 and Tenor"

"In tenor and bass mostly"

"One bass sticks out during the TB section"

"I don't hear much of a different [sic.] between this and F."

Excerpt I:

"Sounds far away"

"The acoustic environment here seems to be again playing a part in assisting singers"

"S1"

"Expecially [sic.] in the women"

"Closer sound, easier to hear words"

"This recording seems the most unbalanced to my ears"

"Nice blend"

"Alto and Tenor"

"Way, way too close! Definetly [sic.] a lot of individuals."

Excerpt K:

"Way to far away"

"Just a few places the blend seperated [sic.]"

"Tenor"

"It sounds like you are singing into a fishbowl. I can hear some individuals mostly when there is a crescendo and in unison before the B section."

Excerpt L:

"Closer sound words clearer"

"This recording shows excellent listening, and significcant [sic.] adjustments made by singers"

"Nice overall blend"

"Soprano"

"A Soprano"

"Sopranos tend to stick out, especially in the upper register."

"Nope. Don't do it."

Excerpt M:

"Way to far away"

"To my ears the most successful excerpt for blend."

"Good blend overall"

"Tenor, soprano"

"I hear more of the alto and bass voices in this excerpt, which mask the soprano voices that tend to stick out in other recordings."

"It sounds far away, but not as bad as K. The balance is good though. I can hear the men a lot more. This is the first time I have heard that interesting alto line in the B section."

"This was the best overall example in all areas in my opinion"

Excerpt N:

"Words clear"

"Nice blend"

"This recording sounds like there are some female soloists in the choir"

"Nope. I can barely hear the men in parts. It sounds as if the women aren't listening to each other. Also, spreadable vowels are quite prevalent."

"Some dark voices/some very bright"

Excerpt O:

"Far away sound lacks diction"

"The hall sounds different - much more influence of the space here"

"Ladies stand out on the high places"

"One of the most blended excerpts. This sounds like it has been recorded in such a large cathedral that all voices blend together in a beautiful, almost magical, way."

"I hear problems in the high parts for the women. You sound far away still."

"A few sopranos have a little too much color"

Excerpt P:

"nice sound"

"Not convninced [sic.] the singers can hear each other easily."

"Good blend"

"Alto"

"One soprano, most likely the same one as previous excerpts, keeps sticking out. She is incredibly nasal compared to the other performers, and some vowel unity would go a long way."

"Altos, especially I can hear."

"Some treble voices are louder/brighter than others"

Appendix C

Auditor Comments for Balance Between Sections

Excerpt A:

"Difficult to assess whether this stems from ensemble traits (strong individuals) or not"

"Blend between sections could have been tighter"

"Soprano section dominant throughout entire excerpt. Cannot hear inner parts, especially when altos had melody."

"Soprano much louder than others"

"This recording lends to the treble side"

"I really loose the men in the SATB sections. It does sound like in the men only sections, they have to work harder in order to balance themselves."

"Ladies voices in both sections sticking out. Not individually though"

"Soprano very predominant"

"Heard mostly soprano"

Excerpt B:

"When things got rhythmic the total sounded unbalanced"

"Hard to hear altos in certain sections"

"Higher voices tend to stick out"

"Need more T/B in SATB; more A in S/A"

Excerpt C:

"Reasonable ability to listen between sections"

"Balance improved"

"Tenor and soprano are most dominant. Bass is very limited, as is alto."

"It sounds like there is less heaviness in the soprano section. Although they carry the melody, this lightness in the section makes for a more pleasurable sound, and I can hear all sections fairly equally."

"Good balance!"

"Soprano dominant at times"

Excerpt D:

"Sections sounded in tact overall"

"Sopranos"

"Alto and bass sections are heavier at the beginning than other sections"

"It sounds so much better!"

"Men's voices sticking out as a section, especially Basses"

Excerpt E:

"Upper voices seem prominent sometimes"

"Consistant [sic.] balance across the choir was improved"

"Soprano heavy."

"Soprano"

"Again, individual voices are prevalent, causing the balance to go"

"Heavy on ladies' vocal parts sometimes"

"Soprano"

Excerpt F:

"The blend seems to be better but ladies voice seem to stick out on a few high passages"

"Alto"

"Altos sound stronger at the beginning, but it lends to a more pleasurable balance later on, not having as much treble"

"Again, just those few tuning things."

"Ladies overwhelm the men's vocal line,especially in chordal sections with higher notes"

Excerpt G:

"A more homogenous sound"

"Soprano a problem"

"Noticeable when the ladies sing loud and high"

"Soprano and Alto"

"Much better!"

"Sopranos overwhelm men's vocal part in highter [sic.] chordal sections"

"Need more alto; treble/bass not always balanced"

Excerpt H:

"Hear mostly upper voices"

"Very good blend between sections, although there is some inconsistency"

"The rhymical [sic.] section seemed to occasionally lose balance"

"Basses hard to hear"

"Balanced performance, but sounds as if it is lacking in intensity from each section."

"I didn't hear the tenors well when they came in."

Excerpt I:

"Fuzzy sound"

"Tenors hard to hear; altos difficult to hear later on"

"Bass section sounds quiet and timid in this recording, especially when isolated in the music"

"I felt like the men could be more."

"Sopranos overwhelm men's parts sometimes, altos and sopranos seem far away"

"Better men & alto!"

Excerpt J:

"Nothing consistent, but lots of exposure"

"Men sounded stronger to offset the uncovered ladies high voices"

"Soprano and Alto"

"Tenors seemed softer and were hard to distinguish when singing SATB"

"Balance between sections is good because they are so close"

"More bass needed"

Excerpt K:

"Men's sections most predominant here"

"Overall blend was much better"

"Can hear the tenor part in this one, but not the bass (except the TB soli). Soprano is toned down."

"Soprano"

"Again, fishbowl."

"Soprano section less dominant in this excerpt"

Excerpt L:

"Men's sections well balanced comparatively"

"Men have a better balance them and the ladies"

"More alto can be heard. Hard to hear the bass."

"Soprano; TB are well-balanced"

"Hear a lot of Soprano and not much men"

"Ladies' vocal line overwhelming men's vocal line"

Excerpt M:

"Hard to hear words"

"This sounded quite good across the choir"

"Soprano"

"Pretty good. Men, you had a "seek and ye shall find" moment :)."

"Sopranos overwhelm again, not as much as example N"

Excerpt N:

"Men sound fuller"

"Hello basses."

"Soprano"

""We tremble.." - men are too loud individually. I can hear the basses but not tenors really"

"Ladies' vocal lines overwhelm men's vocal lines"

Excerpt O:

"Ladies stand out over the men"

"Hard to hear the altos."

"Not often, but every once and a while."

"Sopranos stick out on higher notes"

"Soprano dominant"

"Too much soprano occasionally"

Excerpt P:

"Unbalanced only when the ladies sang uncontrolled"

"I lose the men with the women. I can hear them but I think they are too soft compared to the women."

"Need more tenor"

Appendix D

Auditor Comments for Tone Color

Excerpt A:

"Not knowing the group, hard to assess effect of placement"

"Overall the performance lacked passion and color"

"Again seems to stem from soprano"

"Very lovely sound! Sound [sic.] full and healthy."

Excerpt B:

"The text was lost"

"Soprano section tends to be brighter than other sections"

"It's here and there because of the individual voices."

Excerpt C:

"Ladies upper register could have been a bit more controlled"

"I don't think the color itself from the choir changed, however the warmth of the choir because of including the room."

Excerpt D:

"Tone very bright here - perhaps struggling to listen?"

"Some parts were balanced more than others"

"A few voices are creating a brighter, sometimes strident sound"

"Sopranos sound incredibly bright in this excerpt, and even nasal at times. "Never die" is shrill compared to the lower register in previous measures."

"Wonderful!"

Excerpt E:

"Here the tone does indeed seem affected by trouble hearing each other."

"This arrangement helped the lower parts sound brighter"

"Soprano"

"TB warm sound; SA brighter and unbalanced, esp sopranos"

"Sopranos tend sharp, especially on vowels in "it is" and "age""

"Individual voices being hear [sic.] causes the tone color to go."

Excerpt F:

"Overall it was ok...not great, but ok"

"Most balanced excerpt to my ears thus far (listening in alphabetical order)"

Excerpt G:

"Again soprano seems exposed"

"Starts darker but brightens as the song progresses"

"Sopranos very bright at their entrance, sounds "ping"-y in upper register"

Excerpt H:

"Singers seem comfortable here and listening"

"Color was good"

Excerpt I:

"The singers are listening very actively."

"Sopranos nasal on entrance, all sections sound bright on "sing" and "and""

Excerpt J:

"Singers seem to be struggling a bit"

"Ladies need to match the men's color better"

“"Sky" and "dance" were a bit too forward-sounding for my taste”

“Treble too bright”

Excerpt K:

“The choir seems consistently bright to my ears, but here more rounded and warmer”

“Ladies parts could have been covered more in the higher register at times”

“Beautiful tone color in this excerpt - sounded like one choir with many choristers, not like a choir of soloists!”

Excerpt L:

“Sopranoes [sic.] a little tinny sounding”

“Nice overall choral sound”

“Soprano”

“It seems to be one or two voices causing this”

“There's a bright soprano with spread vowels that one hears all the time.”

“Ladies' vocal line very bright”

Excerpt M:

“Sounded like each part could hear and feel the other parts”

“Though I can hear individual bright voices, the warmer voices balance them out as a whole”

“A darker sound than I have heard thus far from the group. Vowels sound taller and more towards the middle/back of the mouth. Vowels in words like "God" and "us" are uniform and blend well together.”

Excerpt N:

"Ladies continue to stand out in their higher register"

"Sounds pushed on the "from age to age" section"

Excerpt O:

"Nice lyrical sound throughout"

Excerpt P:

"Good color overall"

"Overall very balanced, save for the one soprano (See above)"

Appendix E

Auditor Comments for Rhythmic Precision

Excerpt A:

"This is most glaring problem in this recording"

"Overall rhythms were together, but could have been more accented"

"I didn't hear any problems."

Excerpt B:

"Very difficult to hear actual rhythmic lines"

"Some entrances are "fuzzy" or seemingly unsure. When starting on a vowel, attacks are inconsistent."

"Slightly delayed"

"Could be cleaner"

Excerpt C:

"Considerable difference here compared to A"

"Rhythm needed to punch more"

"Very good."

"Delayed"

Excerpt D:

"Although blend is less successful here, precision maintains well."

"It was there, but not very colorful"

"Sounds like there are some "leaders" and some "followers," especially in the TB sections"

Excerpt E:

"Some real problems with precision during homphonic [sic.] sections!"

"Rhythms felt tighter inside the section"

"Still fine. That's because you have an AMAZING director there!!"

Excerpt F:

"Rhythms don't seem to be very pronounced"

"A bit muddy throughout"

Excerpt G:

"Moves ok even without it being pronounced"

Excerpt H:

"As much as I hear slight precision isseus [sic.] - it is in a pleasant way (soft beginnings)"

"Good although it could have been more percussive sounding"

"A bit muddy"

"There was a part where the men were a bit off.""Some delay"

Excerpt I:

"Again here there are some inconsistencies, but in a very alive and spontaneous pleasant manner"

"Men are having some issues in the ending section."

Excerpt J:

"Still maintaining an [sic.] decent precision."

"Men maintained a good rhythmic foundation"

"Soprano entrance was messy, and two distinctive voices can be heard"

Excerpt K:

"Singers seem to be self-policing on consonants here."

"Normal. Nothing real exciting"

"Sound is somewhat delayed"

Excerpt L:

"Singers hear each other - excellent precision in exposed moving lines"

"Good rhythmic feel"

Excerpt M:

"Precision is a problem compared to blend This positioning requires less listening, more eyes."

"Average - not real exciting"

Excerpt N:

"Could have had a more rhythmic feel for contrast"

"Not all unified"

Excerpt O:

"Singers seem both able to hear and adjus [sic.]"

"Men exicuted [sic.] this well"

"TB section not as crisp as other iterations"

"There was a spot in the B section."

Excerpt P:

"Bigger homophony good; but individual sectional moving parts not as good"

"Men kept it moving"

Appendix F

Auditor Comments for Intensity

Excerpt A:

"Performance lacked passion"

"It was full and with presence, but I didn't hear much difference in intensity in the sound."

"Loud"

Excerpt B:

"The score seems to lend itself to dynamic interpretation more than "A Mighty Fortress" did."

"Beginning more intense than ending section"

"Contrast could be greater"

Excerpt C:

"Slightly better intensity than in Excerpt A"

"I can hear the choir phrase more!"

"Best contrast so far"

Excerpt D:

"Loud shouldn't be mistaken for intensity."

Excerpt E:

"Intensity seemed a little stronger"

"When one person crescendos, then the section doesn't follow."

Excerpt F:

"There are some of the best moments here, but also some of the worst - interesting."

"Better"

"Since the microphones are farther away, I think, the dynamics didn't come through well."

Excerpt G:

"Could have been a little more percussive"

"It is almost all loud"

"I can hear the phrasing much better."

Excerpt H:

"Good throughout"

"Long notes can have more intensity."

Excerpt I:

"Full choral sound is wonderful here; and singers seem very inspired"

"I think you could do more with the intensity."

Excerpt J:

"Good"

"Long notes are better, but I think that's because of the closeness of the mics."

"Too loud throughout; pianissimo was much better, however"

Excerpt K:

"Contrast seemed better executed"

"Interesting to listen to and made me want to listen to more!"

"I don't really know how to answer this question because there is intensity but its individualistic rather than section."

Excerpt L:

"Intensity seem better"

"TB by themselves are great, when with SA lose their strength"

"Individualistic rather than sectional"

"Sometimes abrupt"

Excerpt M:

"Consistant [sic.] but lacks passion"

"The long unison notes suffer. Rather than intensitying [sic.], they sound like you put the car in park and rev the engine. Keep the voice free and open."

Excerpt N:

"Cosistant [sic.], but needs more passion"

"TB by themselves are great, when with SA lose their strength"

"Softer sections are more pleasurable, as they sound a bit more intense and thoughtful rather than pushed. Forte sections are too much."

"Same as my above comments."

"Some abrupt changes in dynamic levels (other than those that are marked)"

Excerpt O:

"Very dynamic, expressive performance, without pushing"

"DUDE. The men sounded like they rocked in this."

"Contrast could be even greater"

Excerpt P:

"Good moments but then also sections seem to be trying to hear"