UNIVERSITY OF CINCINNATI

Date: November 17, 2008

I, Gwendolyn Coleman Detwiler, hereby submit this work as part of the requirements for the degree of:

Doctor of Musical Arts

in:

the Performance Studies Division in the College-Conservatory of Music

It is entitled:

Solo Singing Technique & Choral Singing Technique

in Undergraduate Vocal Performance Majors:

A Pedagogical Discussion

This work and its defense approved by:

Chair: Barbara Honn, M.M.

Barbara Paver, M.M.

Brett Scott, D.M.A.
Solo Singing Technique & Choral Singing Technique in Undergraduate Vocal Performance Majors: A Pedagogical Discussion

A document submitted to the

Division of Graduate Studies and Research
of the University of Cincinnati

in partial fulfillment of the

requirements for the degree of

Doctor Of Musical Arts

in the Performance Studies Division
of the College-Conservatory of Music

16 September 2008

by

Gwen Coleman Detwiler
12 Westerly Dr.
Fredonia, NY 14063
gwen.detwiler@fredonia.edu

B.M. and B.A., Northwestern University, 1993

M.M., University of Cincinnati, 1995

Barbara Honn, M.M., Committee Chair
Abstract

Choral singing differs in important pedagogical ways from solo singing. For the undergraduate voice performance major with developed upper partials in his/her resonance signature, the goals of solo singing technique and those of choral singing technique may be in conflict. This document delineates clearly the interrelationship of these techniques and clarifies the extent to which these different modes of singing edify and/or impede the technical goals of the other. It is concerned primarily with the individual student as he or she alternates between the many solo and choral requirements of an undergraduate performance degree and illuminates the pedagogical conflict from an objective voice science perspective.

Research has shown that untrained singers (those with undeveloped upper partials) sing with greater phonatory efficiency in a choral environment versus a solo environment. For singers in this stage of development, the choral arena helps them to build phonatory efficiency. However, for the trained singer (those with developed upper partials), the choral environment requires that the singer diminish efficiency in order to blend with surrounding voices. Most students of vocal performance will experience both extremes during their undergraduate studies.
Whether trained or untrained, members of a chorus gain much in terms of musicianship, repertoire and artistry. Singers who are unable to negotiate the differences between choral mode and solo mode fail to benefit from the advantages that choral singing offers. However, it is clear that choral singing is not one-size-fits-all. While the difference in phonation for trained singers is modest, it is not non-existent, and some undergraduate singers may not be able to sing well in both modes. For most undergraduate students, however, choral singing mode and solo singing mode are similar enough to warrant the pursuit of both.

This document reviews pertinent research in the areas of vocal pedagogy, choral pedagogy and voice science. It outlines a clear methodology based upon this research for voice teachers, choral directors and, most importantly, for the student who endeavors to achieve excellence both as a soloist and as a choral singer.


**Table of Contents**

**Chapter 1: Introduction**

- Acoustic Considerations 4
- Pedagogical Conflict between Solo and Choral Techniques 6

**Chapter 2: Physical Properties of Sound**

- Frequency (Pitch) 12
- Amplitude (Intensity) 13
- Timbre 19

**Chapter 3: Voice Science Literature Review**

- Timbre Difference between Solo and Choral Singing 26
- Self to Others Ratio 38
- Choral Techniques and The Singer’s Formant 42
- Effect of Choral Formation and Spacing on the Individual 47
- Resonance Differences in Trained vs. Untrained Singers 50
- Vocal Fatigue 58

**Chapter 4: Discussion**

- Breath 82
- Posture 83
- Freedom of Jaw, Tongue, and Lips 84
<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening of Space in Mouth and Throat</td>
<td>85</td>
</tr>
<tr>
<td>Phonation</td>
<td>87</td>
</tr>
<tr>
<td>Resonance</td>
<td>87</td>
</tr>
<tr>
<td>Spacing and Placing of Singers</td>
<td>89</td>
</tr>
<tr>
<td>Conclusion</td>
<td>93</td>
</tr>
</tbody>
</table>

**Bibliography** 97
List of Tables

Equal Loudness Contour Graph 17
Sound Level Chart 19
Vowel Frequency Chart 23
Titze Glottogram Illustration 68
Flow Glottogram Illustration 69
Transglottal Air Flow Waveforms 70
Chapter 1

Introduction

The National Association of Schools of Music (NASM) is the American accrediting agency for schools, conservatories, colleges and universities offering degrees in the musical arts. According to NASM, accredited institutions are required “to develop and maintain basic, threshold standards for the granting of degrees and other credentials.”¹ Among those standards is the requirement that all undergraduate vocal performance majors study their art in both solo and ensemble contexts. In addition to learning about Western solo classical singing technique, accredited institutions also require voice performance majors to participate in a choral organization of some kind.²

Participation in choirs can be educationally and artistically rewarding. Improvement of musicianship skills, sight singing, aural skills and diction, as well as exposure to performance practice in various stylistic periods are a few of the many benefits. Choral singing affords the undergraduate singer the opportunity to explore diverse musical genres and to experience the master works of choral literature. Undergraduate voice majors may have the opportunity to sing the choral music of Mozart or Mendelssohn before he or she is ready to perform solo concert repertoire by the same composers. Exposure to the compositional genius of Palestrina, Bach, Mozart, Beethoven, Brahms, Verdi and many others serves to edify and enlighten the choral singer.

By its very nature, however, an undergraduate voice performance degree is primarily focused on solo singing. Private voice lessons are designed to improve technique in the solo arena, and a student is required to participate in these lessons so that the voice teacher may evaluate him/her as a soloist rather than as a member of a group. The student who pursues a voice performance degree is most often evaluated based on solo ability during the audition for admission as well as throughout the college experience. If a student has reached the academic standards of the institution and is also deemed sufficiently talented as a soloist, he or she will be admitted into the program. If throughout the student’s academic tenure, he or she shows an

inability to meet solo standards in a vocal jury or hearing by the faculty, that student is reprimanded or released from the degree program. Though ensemble participation is important to the education of a young soloist and required by NASM, it is the solo ability of a student that determines success for an undergraduate student who chooses a degree in voice performance.

It is important to point out that this pedagogical discussion is focused on those students who wish to pursue solo singing careers and have therefore chosen a voice performance degree. Singers in other curricular programs may also be enrolled in both private voice lessons and a choral ensemble. These singers may or may not have the same goals as the voice performance major. For this reason, this discussion will be limited to those students who have made a clear commitment to pursuing a future in solo singing – those who have chosen and been accepted to the voice performance curriculum.

For the voice performance major, participation in solo voice lessons can be educationally and artistically rewarding. In addition to learning about musical style, solo diction and exposure to performance practice in various musical periods, the student learns first and foremost to be the master of his or her vocal instrument. Over time, he or she strives to learn the art of controlling one’s voice with ease. Techniques learned include efficient breath management, a free and released body and vocal mechanism, and a resonant tone with consistent vibrato which may be heard over an orchestra.
**Acoustic Considerations**

Undergraduate students may encounter significant incongruity between the type of vocal timbre promoted by choral directors and the type of vocal timbre promoted by voice teachers. One issue at the heart of this incongruity is the proper use – or non-use – of the singer’s formant.\(^3\) The singer’s formant is an area of higher acoustical energy situated between 2300 and 3200 Hz in the resonance of a singer’s voice.\(^4\) Resonance is a term having different meanings in a variety of contexts. For the purpose of this paper, resonance is defined as the process by which small vibrations (as in those produced by the vocal folds) induce large vibrations (as in those that we hear when sound leaves the vocal tract). When a resonator (the vocal tract) acts upon a complex sound (a sound with more than one frequency such as the one coming from the vocal folds), the resonator will amplify certain frequencies, and attenuate or soften others. Resonance is this process of intensification and moderation of sound that occurs within the vocal tract.

The singer’s formant, a resonance peak, is an essential characteristic of classically trained solo voices. It allows the solo voice to be heard over a full orchestra. Resonance peaks also help to identify a singer’s unique timbral signature. A primary goal of most teachers of Western classical singing is to

\(^3\) Ibid.

instruct their students in how to produce this type of resonance without straining or pushing the voice. In this way, classical singers can sustain their ability to be heard over an orchestra for several hours at a time in an opera or concert performance.

Conversely, a primary goal of many choral conductors is to instruct their students to produce an ideal choral sound. The term “blend” is most often used to describe this sound. It is characterized by a seamless and unified choral texture. If a choral director wishes to achieve blend in his or her ensemble, then the singer must modify resonance to reduce the amplitude of the singer’s formant and match his/her personal volume to the rest of the ensemble. The use of this technique helps to create the acoustical effect known as the choral effect. This effect is produced when many individual sounds (in this case, voices) with approximately the same timbre converge and are perceived as one. The amalgam of sounds has a rich, shimmering quality which would be absent if the sound came from a single source. This effect is what provides the unique quality of choral sound—many voices coming together to sound as one.

---

6 Carter, ibid.  
Pedagogical Conflict between Solo and Choral Techniques

Choral singing and solo singing place different technical demands on the singer. A pedagogical conflict occurs when an undergraduate who is learning techniques from the vocal instructor to enhance his/her singer’s formant is simultaneously being discouraged from using those techniques by the choral instructor. The difference in approach can be confusing for young singers. Renowned voice scientist, Johan Sundberg asserts:

...voice use in choral and solo singing differs in certain respects that are probably important for success of a solo singer... the same type of voice timbre is not sought in choral and solo singing... choral singers strive to tune their voice timbre in order to mesh with the timbre of the rest of the choir, while a solo singer would try to develop his or her own individual timbre.  

Solo singing technique differs in important pedagogical ways from choral singing technique. For the purpose of this document, solo singing technique will refer to Western classical vocal technique. The singer’s formant with its emphasized upper partials is of central importance for this type of solo singing. In addition, there is a general agreement in the singing community that vibrato is a feature of the voice of trained singers that occurs naturally when the voice is produced with freedom and a foundation of buoyant breath support.  

---

9 Ibid.
**Choral singing technique** will refer to a unified choral approach. The choral effect is of central importance for this type of choral singing in which blending is considered a key element of choral tone.

There are many typical techniques that are common to both *classical solo singing* and *blended-tone choral singing*. In situations where care is taken to serve the vocal health of the individual, the vocal instructor and the choral instructor will espouse many similar concepts with regard to breath, posture, range, opening of space in the mouth and throat, and flexibility\(^\text{12}\). Conversely, there are many techniques that are unique to *classical solo singing* and unique to *blended-tone choral singing*. Examples of techniques that may be different in a solo context than in a choral context include: diction, resonance, vowel modification and articulation.\(^\text{13}\)

This discussion will explore the undergraduate singer as an *individual* – an individual in the vocal studio as well as an individual in the choral rehearsal (as part of the whole). The focus is not how the choral sound might be affected by the individual, but rather how the individual might be affected by participating in the choral sound. There are two important questions to be explored: To what extent can the central acoustical property of solo technique (use of upper partials and/or singer’s formant), be maintained while upholding the central acoustical property of blended-choral technique


(the choral effect)? What pedagogical and physiological techniques accompany these acoustic effects for the individual?

This discussion identifies and explains the techniques that define *Western classical solo singing* and *blended choral singing* from the perspective of the individual student in each context. It explains the interrelation of these techniques and explores the extent to which these different modes of singing edify and/or impede the technical goals of the other.
Chapter 2

Physical Properties of Sound

In this chapter, the physical properties of sound will be investigated inasmuch as they apply to solo singing and choral singing. Four elements are essential to the existence of sound: a vibrating object, a power source which makes the object vibrate, a medium through which the vibrations are transmitted and an apparatus to receive the vibrations.\textsuperscript{14} According to this definition, one must hear a sound for it to occur. If a tree falls in the forest and no one hears it, does it make a sound? No. The falling tree has the first three qualities of sound, but not the fourth. The existence of sound is dependent on this relationship between the sound source and the sound receptor. This is an important point for the purposes of our investigation.

\textsuperscript{14} James C. McKinney, \textit{The Diagnosis and Correction of Vocal Faults} (Nashville, TN: Genevox Music Group, 1994).
In some cases, the sound receptor itself (the ear) influences how the vibrations are received from the sound source (voices). The choral or ensemble effect, for example, occurs in the ear of the listener not in the actual sound waves being produced. We hear this effect each time a tuned piano key is played. Several strings are struck, but we do not hear several sounds. We hear one sound. We do not hear the vibrations made by each individual string. According to acousticians, this shimmering unison does not exist in the individual vibrations of each string. Likewise, in a choir where voices are similar in timbre but not exactly alike, we hear one voice - not many.

We are unable to hear the individual singers in a choir, and that is precisely the point. The sonic character of a sum of sounds that are similar, yet not phase coherent, is quite different from the sound of a single source. This special character is usually called the ensemble effect or chorus effect; it arises when many voices... combine and create a quasi-random sound of such complexity that the normal mechanisms of auditory localization and fusion are disrupted. In a cognitive sense, the choral effect can magically dissociate the sound from its sources and endow it with an independent, almost ethereal existence of its own. The sensation of this extraordinary phenomenon, strongly perceived inside the choir, is one of the attractions of choir singing.15

This is a fascinating point considering that there is a broad range of opinion as to if and when this blended effect is produced by an vocal ensemble. Perhaps each ear produces this effect in a slightly different way. Aural perception of the ensemble or choral effect, it seems, is like a dance with two partners. Each partner, the choir on the one hand, and the listener on the other, contributes necessary elements to create the effect.

Let us now examine how the basic four elements of sound correlate with the vocal instrument. In singing, the vibrating objects are the vocal folds, the power source which sets the vocal folds in motion is the breath, the medium through which the vibrations are transmitted is air and the receiving apparatus, as mentioned above, is the ear of the listener.

Sound vibrations travel through air at a velocity of approximately 1,100 feet per second. The velocity varies with the density of the air. At high altitudes when the air is thin, the voice will travel farther faster. It is not air itself which moves at 1,100 feet per second, it is the vibrations which move through the air. William Vennard describes the quality of air which allows for it to serve as a conductor of vocal sound vibrations in his book, *Singing – the Mechanism and the Technic*:

The air about us is made up of submicroscopic units of mater, called molecules. They move about independently but tend to stay a certain distance apart, other conditions remaining the same. If they are forced closer together, they fly apart again, and if they are forced apart, they fly back together again. This property of matter is called *elasticity*.\(^1\)

Sound waves are alternations in pressure which move through an elastic medium. Sound waves moving through air is similar to the ripples of water which expand when a stone is tossed in a pond. Because air, like water, is elastic, these alternations in pressure move in a similar pattern. Each air molecule passes energy on to the neighboring air molecule without any perceptible motion of the air mass as a whole. It is similar to the effect of

---

a stone tossed into the water. It creates ripples in otherwise stationary water. Sound waves function in a similar way.

Musical tone is one type of sound. It has a variety of characteristics, but experts disagree as to which elements are salient. An exhaustive list might include frequency (pitch), amplitude (intensity), growth, duration, decay, timbre, and deviation through time.¹⁷ For our purposes, however, we will examine three primary properties of sound waves in vocal tone: frequency (pitch), amplitude (intensity), and formant signature (timbre).

**Frequency (Pitch)**

Frequency refers to the number of compression and decompression cycles that occur in one second. One compression and one decompression together are equal to one vibratory cycle or period. We refer to frequency in cycles per second (cps) or Hertz (Hz). One vibratory cycle is called the period of a sound wave. This period remains constant given a constant frequency. For example, the pitch A₄₄₀ has a frequency of 440 cps or 440 Hz. As long as the pitch remains the same, the period of the sound wave is also the same. A₄₄₀ travels 1,100 feet in one second. In one second, the period appears 440 times. Therefore, the period of that sound wave is approximately 2.5 feet long. A₈₈₀, an octave higher, would have a period which appears 880 times in 1,100 feet. The period of this sound wave is, of course, half as long. It is

---

approximately 1.25 feet long. The higher the frequency, the shorter the period of the sound wave.

One interesting characteristic of sound waves is that longer sound waves bend more easily. Shorter sound waves (higher pitches) do not bend as easily. Where lower tones will radiate like that stone in the pond, higher tones are more likely to travel in a straight line forward from the sound source because they do not bend as easily.\(^\text{18}\)

**Amplitude (Intensity)**

Intensity is sometimes used interchangeably with the term loudness, but they are not exactly the same. Intensity refers to the amplitude of a sound wave. Amplitude is measured based upon the extent to which molecules have been displaced by a vibration. The greater the displacement, the greater the intensity of the sound wave. Intensity and amplitude are synonymous. Both terms relate to the amount of energy in a sound vibration.

Loudness, on the other hand, is a more subjective measure of sound. What might be considered loud to one person may be soft to another. Like the ensemble effect, loudness is perception based. The concept of loudness is one which occurs not only in vibrations from the sound source (voice), but also in the sound receptor (ear). Intensity or amplitude is a measure of the vibrations produced by the sound source. Loudness, however, takes into

---

account the amplitude of the vibrations as well as how those vibrations are received and interpreted. When one increases intensity, then one will increase loudness, but not necessarily at the same rate. Doubling the intensity does not equal double the loudness. Twice as many singers in a choir will make the choir louder, but not twice as loud.

Frequency or pitch also affects loudness. Vennard notes that “a high tone sounds louder than a low one of the same intensity; the ear is more sensitive to high pitches.”¹⁹ For example, in many choruses, the sopranos’ forte may be perceived louder than the basses’ forte. Because the ear is more sensitive to higher pitches, this discrepancy of dynamic is not necessarily an issue of the sopranos not attempting to match dynamic or the students’ inability to do so (though it may also be those things). Even when two pitches have the exact same intensity, the higher one will seem to be louder. Perceived volume can be an asset in Western classical singing. It helps high voices, whose vocal tracts are shorter than those in other fachs, to be heard over an orchestra. However, it is a common problem in choral singing – the sopranos permeating the choral blend. Because loudness occurs in the ear of the listener as well as in the amplitude of the sound wave, our ears and minds perceive that higher pitches are more intense, even when they are not. In addition, some eardrums are more sensitive to the pressure variations of a sound wave. Pressure variations actually indent the eardrum, and surely we

¹⁹ Vennard, ibid.
can imagine that not every eardrum is exactly the same. Loudness is subjective. Amplitude or intensity is an objective measure.

From 50 Hz to 4,000 Hz the ear is most sensitive to changes in frequency (pitch) and amplitude (intensity). As the frequency descends below 1000 Hz, however, the ability to perceive changes in frequency and amplitude diminishes greatly. Perception of pitch and intensity are less accurate in this range. As a pitch rises, the ears sensitivity to intonation becomes more acute. The higher the pitch, the more accurate intonation must be. Sopranos must be more accurate than altos, altos will have to be more acutely in tune than tenors, tenors more so than basses. An examination of the actual length of one period of a sound wave at various pitch levels helps to illuminate the point.

A common pitch in soprano range is A5. If A4 is equal to 440 Hz in equal temperament, then A5 is equal to 880 Hz. As was mentioned before, the period of this sound wave is 1.25 feet. When the pitch ascends a whole step to B5, the period of the sound wave shrinks to 1.11 feet, a difference of under two inches. In contrast, a pitch common to bass repertoire, low A2 has a pitch frequency of 110 Hz. The period of this sound wave is ten feet long. When the pitch ascends a whole step to B2, the period of the sound wave shrinks to 8.87 feet, and the difference is a whole foot and two inches. At high frequency, very small changes in the length of the period make large changes in perceived pitch. Conversely, at lower frequency, small changes in
the length of the period make little or no difference in perceived pitch. In real world situations, this evidence translates into a higher bar for pitch accuracy in high voices than in low voices. The lower the pitch, the more difficult it is to distinguish inaccuracy.\textsuperscript{20}

Like frequency, the timbre of a tone affects our perception of loudness. The more complex the tone, the louder it appears to be to the human ear. A student with a very complex solo-quality vocal timbre will sound louder and may more easily protrude from a choral texture, even when his or her physical amplitude is the same as other singers in the chorus. Research by Benade showed that a tone with more partials will be perceived as louder by the ear than a tone with fewer partials, even when the physical amplitude of the two tones is the same.

In research on vocal use in choral and solo contexts, experimenters measure loudness, in addition to a variety of other characteristics of tone. Our ears, however, do not perceive changes in volume in a linear fashion, so measures of simple amplitude do not reflect actual perception. The perceived loudness of a sound correlates roughly logarithmically to its sound pressure.

The human ear is a sound pressure sensitive detector. But the sensitivity of the ear is not the same for all frequencies, so sound pressure is often A-frequency weighted so that the measured level will match the perceived level. When weighted in this way, the measurement is referred to

as a sound pressure level (SPL) and it is measured in decibels (dB). An A-frequency weighting filter is based on historical equal-loudness contours that show the subjective auditive perception or sensitivity of the human ear at about 40 – 60 dB. See the graph below.  

Equal-Loudness Contour

An equal-loudness contour is a measure of sound pressure (dB SPL) over the frequency spectrum, for which a listener perceives a constant

---

loudness when presented with pure steady tones. The unit of measurement for loudness levels is the phon. By definition, two pure tones of differing frequencies are said to have equal-loudness level measured in phons if they appear equally loud to the average young person without significant hearing impairment. For example, if a pure tone A220 (in bass range) is sounded at 50 dB (without A-frequency weighting filter), that tone is 40 phon. In order for a pure tone A880 (in soprano range) to be perceived at the same 40 phon level, it must be sounded at literally half the volume (40 dB) in order to be perceived as the same level of loudness. Since we know that ten decibels is a doubling of volume, 40 dB is half the intensity of 50 dB.

Equal-loudness contours are sometimes referred to as "Fletcher-Munson" curves, after the earliest experimenters. However, the definitive curves being used today are those defined by the International Organization for Standardization or ISO 226:2003. They are based on a review of several modern determinations of equal loudness made in various countries.

Sound pressure levels are based upon an algorithmic decibel scale using an A-frequency weighted filter. Using this scale, the difference of 1 decibel is the minimum perceptible change in volume, 3 dB is a moderate change and 10 decibels is doubling of volume. 0 db is the threshold of hearing. A general background of sound levels will help us to better analyze sound pressure levels of the voice when used in both choral and solo circumstances. Examples include:
Sound Level Chart

<table>
<thead>
<tr>
<th>Sound Level</th>
<th>dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whisper</td>
<td>15-25</td>
</tr>
<tr>
<td>Background noise</td>
<td>@ 35</td>
</tr>
<tr>
<td>Normal home or office background</td>
<td>40-60</td>
</tr>
<tr>
<td>Normal speaking voice</td>
<td>65-70</td>
</tr>
<tr>
<td>Orchestral climax</td>
<td>105</td>
</tr>
<tr>
<td>Live Rock music</td>
<td>120+</td>
</tr>
<tr>
<td>Pain Threshold</td>
<td>130</td>
</tr>
<tr>
<td>Jet aircraft</td>
<td>140-180</td>
</tr>
</tbody>
</table>

Timbre

Timbre describes those features of sound which allow the ear to differentiate between sounds of the same pitch and intensity. It is a general term for the distinguishable characteristics of a tone. Timbre is determined by the harmonic content of a sound (overtones and partials) as well as the dynamic characteristics of the sound, such as vibrato and the attack-decay envelope of the sound.

The harmonic content of the sound is derived from the initial vibration of the vocal cords. This vibration carries with it an “entire family of
simultaneously sounding tones.”\textsuperscript{22} There is the fundamental tone or the tone that one perceives as the main pitch, as well as partials and overtones which go along with that fundamental tone. The sound that we hear has been amplified by the vocal tract. This amplifier increases the intensity of the fundamental frequency and shapes the whole spectrum of overtones and partials, magnifying some and attenuating others. The resulting magnified partials and overtones are the very thing that gives each voice its unique timbre.

The sound envelope surrounds the tone with additional elements of sound or noise as well as patterns of decay. If, for instance, one eliminates the attack sounds of a piano key being struck, the piano tone that follows is difficult to distinguish. That initial sound of the hammer striking the strings is absolutely necessary to our recognition of a piano tone. It forms the initial part of the sound envelope of the piano tone. The way the tone decays over time forms the latter portion of the sound envelope. The same is true for vocal sound. The initial and latter portions of vocal tone form an envelope of sound that helps us to recognize vocal tone.

Certain partials and overtones are magnified by the vocal tract and others are attenuated. The frequencies which “are most successful in traveling through the vocal tract are called resonance or formant

Formant frequencies help us to quantify specific elements of vocal timbre such as vowel sound and use of the singer’s formant. Analysis of formant frequencies is an important tool that help to objectively assess how solo vocal timbre is different from choral vocal timbre. Research has established that the vocal timbre required in a blending choral environment is different than the vocal timbre required in a Western classical solo environment. How they are different can be quantified by looking at format frequency data.

Physiological mechanisms govern changes in formant frequencies. Adjustments of the lips, tongue, soft palette, jaw opening and larynx directly influence the resulting formant frequencies. Any change in articulation or resonance produces a corresponding change in formant frequency. To a much greater degree than other musical instruments, the size and shape of a singer’s vocal mechanism is constantly changing. Articulators shape vowels and consonants, and the muscles of the larynx move in complex ways to close the vocal folds, stretch the folds, and alter the length of the vocal tract itself. Change is constant in the vocal mechanism of a singer. If a singer changes his or her physiological mechanism when alternating between solo singing and choral singing, then we see that change reflected in the formant frequencies. The question, of course, is whether changes in formant frequencies of solo versus choral singing have corresponding physiological changes which impede the artistic goals of the undergraduate singer.

---

23 Sundberg, “The Voice as a Sound Generator,” 7.
There are five resonance peaks or formant frequencies which one may identify in a sung tone. The two lowest formant frequencies are most important to vowel quality. The upper three are more significant to voice color than the bottom two. In general, movement in any of the articulators affects the frequencies of all formants. Length of the vocal tract has an uncomplicated effect on all frequencies: the longer the vocal tract the lower the frequencies. The vocal tract may be lengthened by lowering the larynx or narrowing the lip opening or both.

The first formant is particularly sensitive to changes in jaw opening. An increase in jaw opening tends to raise the first formant frequency. The shape of the tongue has a great influence on the second formant frequency. When the front of the tongue constricts (as in the [i] vowel) the second formant frequency is raised. If the back of the tongue constricts (as in the dark [a] vowel), the second formant frequency is lowered. The second formant is lowest when the back of the tongue is constricted and the lips are rounded (as in the [u] vowel). In most vowels, the third formant frequency is altered by the movement of the tongue tip. If the space behind the incisors is large, the third formant frequency tends to be low. Moving the articulators can have a great effect on lower formant frequencies in particular.

Since certain tongue, lip and jaw positions produce certain vowel sounds, and those tongue, lip and jaw positions also correspond to certain formant frequencies, we know that specific vowel sounds have specific areas
of formant frequency. Each mouth position “corresponds to a combination of formant frequencies characteristic to that vowel.” Each vowel sound is associated with a specific articulatory profile as well as a specific formant frequency profile. These are shown in the vowel frequency chart below.

Vowel Frequency Chart

The higher formants, the fourth and the fifth, are less responsive to the movements of the lips, tongue, jaw and larynx. They are more dependent on the vocal tract length than on the positioning of certain articulators. The

24 Sundberg, Singing Voice, 23.
fourth formant is very dependent on the shape of the larynx tube. The fifth formant, or the singer’s formant, is that resonance peak which characterizes Western classical singing. Sometimes referred to as “ring,” this formant frequency can enable one soloist to be heard over a full orchestral accompaniment. It is usually between 2300 Hz and 3200 Hz in low female and male voices. The effect of the singer’s formant in higher fachs is still being studied.

Studying the physical nature of sound helps us to understand and quantify the specific differences between choral and solo singing. Studio-isms which describe tone are helpful when each person in the situation defines those terms in the same way. However, terms like heavy, round, light, and even loud or soft are subjective and may be viewed differently by different pedagogues. Most of all, the idea of “good vocal technique” or even “vocal technique” gives rise to a whole host of differing ideas. Use of these terms to define specific vocal differences in a choral and solo contexts leads to confusion. The objective measures of science, on the other hand, though initially complex, can lead to clarity. Voice scientists use these measures of fundamental frequency, sound pressure levels, overtone and partial amplitudes, and formant frequencies to explore and define similarities and differences in solo vocal and choral vocal techniques.
Chapter 3

Voice Science Literature Review

Voice scientists have compiled a significant canon of research which illuminates how the vocal mechanism functions. Almost all research on the singing voice concerns operatic singing. Voice scientists, however, are beginning to address and test the effect of choral singing. Important voice science studies compare trained and untrained voice use in solo and choral contexts to illustrate facts about vocal efficiency, stamina, and overall health. We will review these studies and investigate how this scholarship adds to our understanding of how the singing voice works in various environments.

26 Ternström, 128-143.
Timbre Differences between Solo and Choral Singing


This early study found a distinction between solo and choral singing. Its purpose was to ascertain if there was a difference in vowel formants between speech and classical singing and to compile comparative data on choral and solo classical singing. A group of subjects was asked to speak the texts of solo and choral music, and then asked to sing that same text. The vowels [i], [a] and [u] were isolated and examined to determine their formant frequencies. Not surprisingly, the study showed there were consistent differentiations between spoken and sung vowels.

In choral mode versus solo mode, the vowel formants, F1 and F2, were not significantly different. However, it was found that the formants related to timbre, F3, F4 and F5, showed significant differences between choral mode versus solo mode. The vowels [a] and [u] showed the most consistent difference between the two modes. In other words, when comparing these vowels in solo and choral singing, the first two formants, F1 and F2, did not change. However the upper formants, F3, F4, and F5, did change, thereby
changing the timbre of the voice. Vocal timbre was found to differ in solo versus choral singing modes.

Goodwin, Allen W., “An acoustical study of individual voices in choral blend.”

*Journal of Research in Music Education* 28 (1980a); 119 – 128.

More evidence to support this theory of timbral change between modes can be found in Goodwin 1980a. The purpose of this study was to determine what acoustical differences exist between blended choral singing and solo singing. Thirty experienced choral sopranos were tested. First, each singer was asked to sing a sustained vowel while hearing themselves in headphones. Next, each singer was to sing a sustained vowel while the same vowel, sung by many singers, was played into their headphones. During this second phase, they were asked to try and blend with the chorus of other voices. The sung tones they made in each situation were recorded and the spectral analysis of each was examined.

The results showed that differences between the formant characteristics of the two modes of singing were significant. When spectral analysis of the two modes were compared, it was found that although the formant frequency peaks of the two modes were similar, peaks above the first formant in choral singing were both fewer and weaker. However, the spectral energy of the first formant frequency was comparatively stronger in
the choral mode. Subjects used less and more irregular vibrato when attempting to blend. The overall intensity of singing levels dropped in choral singing.

Goodwin explains these phenomena by stating that choral singers decrease upper spectrum energy in their sound in order to give the listener fewer aural cues to separately identify their particular voice. He notes that Benade, in an earlier study, had shown that a tone with more partials will be perceived as louder by the ear than a tone with fewer partials – even when the physical amplitude of the two tones is the same. Therefore, reducing the number and strength of upper partials is effective for blending because it reduces the voice’s perceived loudness as well as the distinguishing characteristics of timbre. Goodwin goes on to theorize that a stronger first formant clarifies pitch and vowel in the choral context.


Two landmark studies on the differences of vocal usage in choral and solo modes are those performed by Rossing, Sundberg and Ternström in 1986 and 1987. In these two studies, the authors compare not only differences in solo and choral singing, but also differences between well-
trained/professional singing and untrained/amateur singing. This is of particular interest because the subjects of this pedagogical discussion, undergraduate performance majors, find themselves growing from untrained to trained while simultaneously being challenged to alternate between choral and solo.

As stated by NASM, the undergraduate voice performance major is required to sing in both solo and choral contexts. In addition, as private vocal study continues, he or she may vacillate between well-trained and untrained or amateur level singing. The student strives to perfect his/her art as a soloist and to increase those skills which are necessary for the professional classical singer. This type of student does not attain a professional level of performance all at once. The process is slow, with moments of professional level singing mixed in with much amateur singing. As study continues, one hopes that the professional level singing increases and the amateur level decreases. Let us examine how Rossing et al. research and define the acoustical differences between solo and choral modes as found in professional and amateur singers.

In Rossing et al. 1986, a pool of eight bass-baritones were identified as subjects. Three were professional soloists, and five were amateurs with varying levels of solo and choral experience. Each singer was asked to sing in both choral and solo mode wearing headphones that simulated the choral or solo experience respectively. The headphone material was played at a variety
of sound pressure levels (levels of intensity measured in decibels) for each mode. For the choral mode, singers heard the Poulenc *Gloria* as recorded within a choral bass section at various sound pressure levels (SPL). Subjects were instructed to sing as they would in a choral context. For the solo section, a short song was composed with many of the same vowels used in the *Gloria*. Piano accompaniment for the song was piped into the headphones at various SPLs. Subjects were instructed to sing as they would in a solo context.

Recordings of the singers were analyzed using several procedures: a long term average spectrogram (LTAS) for each mode, sound pressure levels for the singer’s formant and the fundamental in each mode, formant frequency analysis of paired vowels one selected from each mode, and voice source spectrum of paired vowels.

An LTAS is a line graph showing the average intensity of all the frequency bands of a complex sound over the course of the sample.\textsuperscript{30} Using this tool, the sound pressure levels (SPL) for the singer’s formant as well as the SPL for the fundamental were determined for both the choral and solo modes. After this analysis was completed, pairs of vowels, one sung chorally and one sung solo, were selected based upon similarity of vowel sound and SPL. These paired vowels were compared to determine the formant frequency of each vowel as well as the voice source spectrum of each vowel.

A voice source spectrum is a spectrogram of the voice source vibration (from the vocal folds) before it has gone through the filter (the vocal tract). Here, it refers to a spectrogram derived by a computer of the sound coming from the vocal folds \textit{without} the additional filtering and resonance added by the vocal tract.\textsuperscript{31}

In the results of this study, the authors identify several important differences between choral and solo singing:

1) In the choral mode, SPLs of the singer closely matched the SPLs of earphone sound. In the solo mode, however, the singer consistently sang at a higher SPL than the sound piped into his earphones. In other words, singers in the choral mode more closely matched their own dynamic level to the level they were hearing. In the solo mode, they sang with more intensity than the level they were hearing.

2) Comparisons of LTAS of choral vs. solo singing showed that the singer's formant was strong in solo singing at all dynamic levels and in choral singing at a forte dynamic, but weak in choral singing which fell below a forte dynamic. LTAS also showed that choral singing displayed higher intensity levels for the fundamental and F1 than solo singing.

3) Matched vowel pairs (one from choral, one from solo, each with equal SPLs)) showed that the larynx itself contributes more to the fundamental frequency when singing in the choral mode, and in some cases, more power to the singer's formant when singing in the solo mode.

\textsuperscript{31} Ibid.
The third result shows that the differences between solo and choral singing reflect differences not only in articulation of the vocal tract, but also a difference in glottal adjustment. Choral singers use more “flow phonation,” a less efficient glottal closure, in order to achieve better vocal blend. They reduce the degree of glottal adduction and lower subglottal pressure to achieve this higher peak amplitude of transglottal airflow wave form. When flow phonation is used, the fundamental frequency has greater amplitude, and this happens at a glottal level where phonation occurs. The authors of this study write that this glottal level change is support for voice teachers who do not want their solo singers to participate in choir if those singers have trouble adjusting between the two different techniques.

The higher level of singer’s formant in solo singers, on the other hand, is a phenomenon primarily of articulation. In describing what constitutes the singer’s formant, Rossing et al. take great pains to differentiate between the band of energy in the range of the singer’s formant (2300 –3200 Hz) which occurs naturally with an increase in vocal volume and the true singer’s formant which occurs when F3, F4, and F5 are clustered in the range of 3 kHz. They point out that a true singer’s formant would require years of training to achieve. Vocal changes which emphasize the singer’s formant (solo) or the fundamental frequency (choral) occur in both articulatory and phonation processes. It is not only the shape and size of the vocal tract which
changes to accommodate these differing techniques, but also the larynx and vocal folds themselves.


Rossing, Sundberg and Ternström 1987 is similar to the previous study. However, for this set of experiments, the authors used a test group of sopranos instead of basses. Five sopranos were asked to sing in both solo and choral modes. All subjects were highly trained in both modes. In addition, two internationally acclaimed sopranos were asked to sing the solo portion. Subjects wore earphones as they did in the previous study and heard excerpts of the Poulenc *Gloria*. Selections were sung in both choral and solo modes. Peaks of energy were found in the range of the singer’s formant, though the authors found that the frequency of the singer’s formant was much more varied in sopranos than it had been in baritones. Not surprisingly, the internationally acclaimed soloists showed the highest frequency levels in the singer’s formant range. Because the fundamental frequency for sopranos is so high, and space between partials in this range increases dramatically, it is much more difficult to locate the formant frequencies of vowels in the upper ranges of soprano voices. The extent of vibratos (how far it varies from the
fundamental pitch) was found to be slightly greater in solo versus choir singing.


Ternström and Sundberg constructed an experiment attempting to discover how vowels are pronounced differently in choral singing, solo singing and speech. In addition, they sought to determine whether choir singers adjust to the vowel articulation of the ensemble momentarily, vowel for vowel, while they are singing together; or gradually, as a result of long-term training with the group or both. The singers in this experiment sang alone, therefore, they noted, it reflected only long-term training.

The subject pool was comprised of amateur choral singers. These subjects were not trained as soloists, and the LTAS of their singing reflected this. Even though they were singing alone, they maintained a choral style of vocalism and did not display singer’s formant frequencies. This implies that the singers retained their choral “dialect” even when singing alone.

Results also showed that vowel formant patterns were different and more unified in singing than in speech. Vowels in speech tended to modify toward the sound of schwa. Subjects were Swedish, all with a typical Stockholm dialect. One may conclude that this result is consistent across all
nationalities, though it seems unlikely that every language and dialect is modified to the same extent. Common sense implies that some languages require a more diverse spectrum of vowel color than others. One might even suspect that some spoken languages and/or dialects are better suited to sung tone than others. All things considered, it seems likely that many singers modify vowels toward the sound of schwa in speech and unify them more in singing.

Sundberg, in his 1986 study, showed a much higher rate of singer’s formant use in forte choral singing. The present study showed none. The authors postulate that this is because the subjects of the earlier study were trained as both soloist and choral singers and that the choirs they participated in were of a high professional standing. The subjects of this study, on the other hand, were amateur choral singers with little or no solo training. According to the authors, they represent the average amateur choral singer.

Of significant interest to this study is the authors’ concluding discussion. In it, they related that the use of singer’s formant is determined not only by the experience and training of the individual singer, but also by the quality of the vocal ensemble to which that singer is trying to blend. Some types of blended choral singing may be more similar to solo singing than others, though they still require different techniques. The authors write that use of the singer’s formant would be inappropriate in an amateur choir
because it would be an impediment to choral blend. Conversely, if all singers of the ensemble have a singer’s formant frequency present in their singing, then blending would not be affected. They suggest that an opera choir, consisting of more singers trained as soloists, might fit this description. According to their comments, it is not the requirement of blend which automatically excludes the use of the singer’s formant, it is the timbre of the ensemble to which a trained singer is trying to blend that determines whether the singer’s formant may be used. Similarity of individual vocal timbre is the key to a successful blend which respects the individual singer’s solo technique. The authors’ conclusion is pivotal. They write, “the degree to which a singer’s formant is present in a choral sound must be relevant to the timbre of the choral sound.”


Reid et al. recorded members of a professional opera chorus, Opera Australia, while singing in both choral and solo modes. They analyzed the relative strength of singer’s formant in both modes using long-term average spectra (LTAS), singing power ratio (SPR) and energy ratio (ER). Vibrato
rate and extent were determined for each mode. Acoustic differences between opera chorus members in choral versus solo mode were investigated.

The subjects were opera chorus members, but regularly cover or perform solo roles for the opera as well. They were trained solo singers who auditioned for their choral roles as solo singers. Reid et al. noted that published research suggests that the singer’s formant is not used by choir singers. The authors differentiate between liturgical choral singers and opera chorus singers, citing that the previous studies were carried out on liturgical singers, and that the requirements for opera choral singers are different. Use of singer’s formant by an opera chorus, they postulate, may result in a richer sound quality and a larger dynamic range appropriate to this art form.

The results showed that there was similar or more relative energy in the acoustic range of the singer’s formant for choral singing when compared with solo singing. The authors contradict the finding of the Letowski et al. study wherein untrained singers tended to use a brighter voice quality and trained singers tended to dampen their voice when singing in a blended choral context. The singers in this study did not dampen their tone in a choral context. Reid et al. write:

In contrast, in the context of this study, all singers were highly trained and it seems it did not “dampen” their voices to achieve choral blend in the same way as singers in a liturgical choir. . . Choral blend was still achieved but perhaps through the common use of an energy boost in the singer’s formant region. Singing teachers’ advice to their solo singing student not to perform in choral music due to difficulties with combining two conflicting
vocal techniques does not seem to hold for singing as a member of an opera chorus.”

To trained singers and teachers, this result is not surprising. The only point that seems worthy of challenge is the concept of blend. The authors assert that blend was not disturbed, however no measure of blend was presented. Their determination seems to be based upon opinion rather than upon empirical evidence. It is possible that the Opera Australia chorus achieved blend, but since we have no evidence to confirm it, it is also possible that they did not.

Vibrato rate and extent did not vary between choral and solo modes. In a previous studies, Rossing et al. found vibrato extent was slightly greater in solo mode than in choral mode, and Goodwin found that singers reduce vibrato extent when attempting to blend. The researchers of this study concluded that the difference in the findings of their study was evidence that the timbral requirement of operatic choristers is different than that of “liturgical” choruses.

**Self to Others Ratio in Choral Singing**

**Ternstrom, Sten.** “Physical and Acoustic Factors that Interact with the Singer to Produce Choral Sound.” *Journal of Voice* 5, 2 (1991); 128 – 143.
Ternström created a study which explores several acoustic elements of choral tone. He found that performance of a choral singer is based upon two acoustical signals: his or her own individual loudness when singing in an ensemble situation (feedback) and the rest of choir (reference). Ternström writes that if the singer is too soft, then he/she will not be able to hear his or her own signal. Conversely, if the singer is too loud, the individual sound will protrude through the choral texture. The upper limit of sound is determined by the singer’s desire to blend. The lower limit is determined by a singer’s need to receive feedback from his or her own voice. The author established an ideal “self to others ratio” for choral singing and found that choristers performed best if they heard the reference (the rest of the choir) and the feedback (his or her own voice) in roughly equal amounts. When reference became 5 or more decibels louder than the feedback, intonation errors became greater then 20 cents. When the feedback became more pronounced than the reference, intonation errors also occurred, but more gradually.

Vowel transitions were also found to effect intonation. When a large tongue and jaw movement such as [i] to [a] or [i] to [ɛ] were required, the fundamental frequency dropped with more open vowels, [a] and [ɛ], and rose with more closed vowels, [i] and [y]. The worst offender was the [i] to [ɛ] transition as in the text “Kyrie Eleison.” Ternström found that these pitch/vowel transitions were consistent with the theory of intrinsic pitch of vowels. The intrinsic vowel theory states that vowels themselves have pitch
which is separate from the pitch of the fundamental or formant frequencies of a tone. The vowels [i] and [y] are pitched higher than the vowels [a] and [ɛ].

In order to match vowels among singers and create homogeneity of resonance, Ternström found that choral singers used a more neutral pronunciation of vowels than that used in solo singing. Matching of formant frequencies among singers is advanced as a method of increasing vowel intelligibility and improving vocal blend. In experiments, it was found that F1 and F2 were closer together, and the relative strength of these frequencies was greater in choral singing. The author wrote that this difference between formant frequencies in choral singing versus solo singing probably allowed singers to blend more effectively. Ternström attests to the fact that he has rarely seen evidence of a singer’s formant in the voices of choral singers in a choral context and that solo and choral singing seem to require different training.

Room acoustics were found to affect the self to others ratio, and thus, the intonation of the ensemble. Choir members sang louder in absorbent rooms to compensate for a lack of feedback. They also tended to raise the frequencies of F1, F2, and F3 in order to better balance the self to others ratio.

---

33 Ibid.
Ternstöm refers to the *chorus effect*, the summing of many slightly asynchronous vocal signals coming together to produce a blended ensemble sound. According to Ternstöm, this acoustical phenomenon occurs when a cluster of phase incoherencies of pitch, vowel, and vibrato (coming from multiple sources – the choristers) combined with the sound qualities of the room to “magically dissociate the sound from its sources and endow it with an independent, almost ethereal existence of its own.” He found that the beating of partials caused by the flutter of individual voices was primarily responsible for the degree of choral effect displayed by an ensemble.

After studying the effects of vowel, room reverberation and self to other ratio on the intonation of individuals within the ensemble, Ternström turns to the subject of group intonation. Not all choristers need to be singing in tune for the ensemble to be perceived as in tune. It is the averaged sound of the choir which determines our perception of group intonation. Scatter levels (individual deviations from pitch, including vibrato) of 10 – 20 cents were typical of choirs deemed to have good intonation. It was determined that an acceptable amount of scatter may occur without intonation being adversely affected.

---

34 Ternström, “Choral Sound,” p 141.
Choral Techniques and The Singer’s Formant


In this study, Eckholm recorded a 22-voice mixed choir in both random and predetermined seating arrangements with greater and lesser use of the singer’s formant. The recordings were played for various groups of choir directors, voice teachers, and non-vocal musicians and their preferences were analyzed. Eight members of the choir were also recorded individually, and those recordings were evaluated by the group of voice teachers based upon excellence of vocal usage.

The results of this study support conventional wisdom. The group of choir directors preferred a choral sound sung in choral mode over one sung in solo mode. The voice teachers and non-vocal musicians did not show a preference for either mode. The voice teachers did, however, showed a preference for individual singers who sang in solo mode to those who sang in a choral blended mode. Voice teachers noted that the blended tone lacked “freedom of production.” Eckholm noted that singers may have to
significantly modify their normal solo vocal production to attain a blended choral tone. However, she noted that placement of singers so that their voices are acoustically matched may lead to better blend, phrasing and overall tone quality, in addition to benefiting vocal production, vocal comfort and the aesthetic satisfaction of the singers.


Ford’s article is similar in scope and intent to the Ekholm study referred to previously. Ford inquires whether there are differing expectations for use of the singer’s formant in choral situations. Ford made recordings of a chorus using first, a resonant sound and then, on the same repertoire, a less resonant sound. He assessed the preference of three subgroups of undergraduates: choral or vocal majors with choral training, music majors with instrumental training but not choral training, and those with no music training.

The chorus was a small ensemble with two singers on a part. The resonant solo-like technique was to have good glottal closure and singer’s formant. The less resonant technique had reduced glottal intensity. Singers used a hand-held Singer’s Formant Analyzer to help them visually monitor
and manipulate the level of singer’s formant they were showing in their singing. The results showed that the choral examples which lacked resonance and ring (singer’s formant) were preferred by all undergraduate subgroups. Notable is the result that a greater majority of those with vocal training preferred the less resonant example.


In his award-winning dissertation, Fagnan fervently disputes the results of the Ford study. Referring to the original dissertation on which the Ford’s article was based, Fagnan quoted errors in calculation and analysis, questioned the authority of Ford’s professional panel, and pointed to a possible lack of competence of choral members and student subjects. Fagnan’s own dissertation makes clear his preference for a resonant and balanced choral tone which makes use of the basic tenets of bel canto singing.

Though bel canto style was originally intended for solo singers, Fagnan explores the merit of bel canto principles in a choral context as revealed in experiments with five different types of choirs: a community children’s choir, a mixed youth choir, a university mixed choir, a men’s choir, a mixed seniors’ choir.

---

35 Fagnan won both the Julius Herford Award from the American Choral Directors Association and a National Choral Award for Outstanding Thesis or Dissertation from the Association of Canadian Choral Directors.
First, Fagnan addressed *il respiro* (breath). He taught breath inhalation as a passive gesture with breath “falling into the body’ rather being ‘sucked into the body’ through the half-closed throat.” Effects of this principle were not separately analyzed, but success in this area was deemed to be foundational for all other concepts. He then made use of Manuel Garcia’s concept of *le coup de glotte* with choirs and found that use of this concept significantly improved the level of upper spectrum energy in choral singing while also lowering levels of energy near the fundamental frequency. Fagnan wrote of how *le coup de glotte* supports a resonant tone.

Just as a diffuse source of light will not excite a full colour spectrum when it passes through a prism, a relaxed phonation caused by a superfluous quantity of breath flowing though the glottis will not excite the full resonance possibilities of breath that pure vibration can be fed rather than spread. Just as a beam of concentrated light excites a full colour spectrum when shone through a prism, a concentrated ore of focused vocal vibration is able to excite all of the colouristic capabilities of the vocal tract and provide a more complete harmonic spectrum.

He concluded that emphasized upper spectrum energy and lowered energy near the fundamental is a more efficient use of spectral energy in the singing process. One might ask, however, how this rise in upper spectral energy (singer’s formant) affects a choir’s blend. Based on previously sighted studies, a blended choral tone has less spectral energy in the upper frequencies. However, Ternström and Sundberg did postulate that the level of upper spectral energy disturbs blend only if it is dissimilar to surrounding

---

36 Fagnan, ibid.
frequencies. In other words, if everyone in the choir is using this same technique, then it is possible that blend could co-exist with the use of upper spectral energy.

The effect of *chiaroscuro* (bright-warm) resonance was studied. It was found to equalize timbre and intonation when applied to two issues known to negatively effect choral intonation and consistency: the intrinsic pitch of vowels and major tongue/jaw adjustments common in non-professional singers (as in, [i] to [E]). Choral groups were found to have a more homogenous sound as well as more consistent intonation.

Soft singing was explored through the use of the bel canto technique, *messa di voce*. Using chiaroscuro and coup de glotte techniques, choristers were better able to maintain upper spectral energy in their soft singing as well as in their forte singing. Bel canto techniques were found to be effective tools in balancing resonance among vowels and creating a more colorful resonance.

Fagnan’s experiments are broadly tested and supported by scientific method. One cannot refute that upper spectral energy was increased or that a more consistent timbral signature was produced using these techniques. One may only question whether this rise in energy is desirable in choral singing. Certainly there are those who prefer a full and resonant sound, but clearly there are others who do not (see Ford above). Sound evidence shows

---

37 Ternström and Sundberg, 517–522.
that use of upper partials is the most efficient way to promote vocal power. Soloists have known this for generations. Fagnan writes that use of solo bel canto techniques in a choral situation “appears to have little or no pejorative effect on that all-important component of choral singing: ensemble blend.” As in the Reid et al. study above, there is no empirical evidence to support that ensemble blend was maintained. There is no scientific data to support its existence. Here, as before, it seems to be a matter of opinion as to whether or not blend was achieved.

The Effect of Choral Formation and Spacing on the Individual


Neil Woodruff constructed a study of male singers in which the attributes of acoustical placement and lateral spacing were evaluated by auditors as well as by the singers themselves. The singers were recorded in solo, duet and trio formations, and those recordings were evaluated by a panel of auditors.

Acoustic placement refers to a technique whereby singers are matched with voices with whom they blend. Blending voices are placed next to one another. This technique was developed by Weston Noble. Noble described
his technique of voice matching in an interview with R. Paul Crabb in 2002.\textsuperscript{38} The first step is to find two natural blending voices. Gradually, singers are added one by one until all singers are placed. Blend must be present on both sides of each singer.

Lateral spacing refers to a technique wherein singers are placed with a length of space between each one (usually 12 to 30 inches).

Woodruff found that combining acoustical placement of voices with spacing was preferred by auditors and singers over acoustic placement alone. In addition, Woodruff proposes that voice matching reduces the vocal changes singers must make to achieve blend. Giardiniere made a similar conclusion in 1991. He concluded that voice matching allows singers to have individual vocal timbres and freedom in vocal production while singing in a choral ensemble.\textsuperscript{39} In his study, Woodruff found that lateral spacing and attention to acoustic placement reduced the amount of vocal change experienced by the singer. This set up was also preferred by the panel of auditors over acoustic placement alone. Lateral spacing was viewed positively by singers and auditors even when acoustic placement was not used.


James Daugherty is one of the pioneers in choral acoustics. He has written several academic papers on lateral and circumambient spacing of singers in the choral ensemble and the effect of that spacing on the individual chorister as well as the perceived blend of a choir. The study above was built upon two previous articles.\(^4\)\(^0\)\(^4\)\(^1\) In his 1999 study, Daugherty tested preferences of auditors for singers in sectional or mixed formation as well as close, lateral or circumambient spacing. The focus of this article was primarily that of auditor preference, not singer preference. Close-spacing was defined as a formation in which singers stood no more than one inch apart. In lateral spacing, a twenty-four inch space was measured between singers. Finally, circumambient spacing used the same twenty-four inch space between them, and also a row of space in front and back. Auditors were able to distinguish between mixed and sectional formation, but the greatest positive difference in blend quality was attributed to spacing, not formation.


According to Daugherty’s 2001 article, empirical studies suggest that mixed formation does not produce a noticeably better sound for the listener, though the experienced singer may prefer it. He does suggest, however, that acoustic placement or voice matching could be beneficial for choral ensembles because it encourages sensitivity to ensemble blend and allows singers to consider their own vocal sound. He points out that perhaps this technique would be most effective if singers are allowed to participate in the process of placement.

In the 2003 study, Daugherty included analysis of singers’ individual perception in addition to auditors’ perceived blend. Like the previous study, auditors perceived greater blend with a spaced formation than random, synergistic, or gender-specific placements. In addition, choristers showed a preference for spread spacing with little difference in preference between section or mixed arrangements. Singers stated that the spacing improved vocal production as well as their individual ability to hear themselves and others. Daugherty’s findings suggest that spacing positively influences choral sound preferences for auditors and individual singers more so than choral formation.

**Resonance Differences between Trained and Untrained Singers**

Voice performance majors at the undergraduate level are in the process of changing from relatively untrained soloists into trained soloists.
During the undergraduate years, voice performance majors are neither fully “trained” nor fully “untrained.” They are on the cusp -- growing in their understanding of vocal use and endeavoring to apply newly acquired vocal technique in both solo and choral environments. When they emerge from this four-year metamorphosis, one hopes that they have learned and integrated the basic tenets of excellent solo vocal technique.

Elements of vocal excellence which differentiate a “trained” singer from an “untrained” singer are: 1) A buoyant foundation of breath support which is managed effectively by the singer  2) A resonant and free tone  3) Ease of production  4) Flexibility  5) Ability to sing in a solo context (recital and concert) and to be heard easily over an orchestra without straining or exhibiting unnecessary bodily tension  6) There is a general agreement in the singing community that vibrato is a feature of the voice of trained singers that occurs naturally when the voice is produced with freedom and good technique.\textsuperscript{42}


Efforts to address the elements of a well-trained voice using acoustical data appear in the literature as early as 1934 when Bartholomew attempted

to define “good voice quality”. Recordings were made of 46 men singing individually. The men were of varying vocal abilities – some were considered to be trained, while others were considered to be untrained. The recordings were then ranked by a panel of experts based upon the relative quality of each. Since laryngeal function, which neither singer nor listener can see, can be observed indirectly only, Bartholomew utilized the acoustical output of the singers to make comparisons. He identified those singers ranked highest by the panel, and determined what acoustical elements differentiated these singers from the others. The author set forth four key criteria for “good voice quality” singing: total intensity, a strong low formant, a strong high formant and vibrato.

Total intensity was identified as a superior vocal quality. It referred to the ability of a singer to produce consistent tone over a broad range of dynamic. Since sound pressure level readings were not included in this study, it is not clear whether dynamic change was a result of change in the SPL, or whether it was a result of a change in the strength of upperpartials. A tone with more partials is perceived as louder than a tone with few partials. Therefore, if dynamic change was a result of an increase in strength of upper partials, then this is a change of total resonance. If it is due to only an increase in sound pressure level, then it is not. Sundberg’s 1972b study implies that it may be a combination of the two.

---

The strong lower formant refers to F1 (approximately 500 Hz), the first of the two formants which determine the vowel being sung. Interestingly, subsequent studies imply that a strong F1 and/or F2 are typical of a choral tone, while a strong upper formant energy is typical of solo singing. Bartholomew identifies both strengths as identifying features of a trained tone.

The presence of a strong high formant was found to be definitive of a superior trained tone. The high formant peak appeared between 2300 Hz and 3200 Hz. This has since been identified as the singer’s formant. Bartholomew noted that this is the range most sensitive in human hearing. He also made hypotheses that the strong high formant was determined by the physical structure of the larynx. He mentions that it should be fairly constant in all voices, “although its prominence usually varies with the excellence of the voice.” The better a voice was perceived to be, the stronger the high formant was in that voice.  

Finally, Bartholomew found vibrato to be an element of excellence in the trained voice. He identified three qualities which oscillate in the vibrato of a subject with good voice quality. “Good voice-quality is inseparably connected with a smooth and fairly even variation occurring around a central mean about 6 or 7 times a second in usually all three of the variables: pitch,

---

intensity and timbre. In a good voice, this variation is more marked the louder the tone.”

Pitch, intensity and timbre all contribute to a well-functioning vibrato. When one or more of the three elements are not balanced in time or intensity, a tremolo may result. Bartholomew wrote that this is caused by uncoordinated muscular tension and often results in variation which is faster than 6 or 7 per second.

In the vibrato analysis, eleven recordings of individual voices were ranked on the basis of excellence by “teachers with experienced musical taste.” Later, single tones from the same recordings were ranked based upon “amount and evenness” of vibrato. The ranking of the vibrato analysis very closely approached the ranking of excellence. Bartholomew concluded, “the importance of an even vibrato to the satisfying quality of a voice appears to be considerably greater than formerly realized. “ Vibrato was found to add richness which listeners perceive to be part of the overall timbre of a tone. Good voice quality was determined to be inseparably connected to even vibrato in the well-trained singer.

This study sought to determine whether the singer’s formant is more evident in trained voices than it is in untrained voices. Subjects were of varying levels of training and were drawn from various voice fachs. The singer’s formant was found to correlate with singing experience. The more singing experience a subject had, the greater the intensity of the singer’s formant produced in that voice. Teie wrote that the placement of the singer’s formant within a singer’s spectral analysis was similar among all subjects. It was the intensity of the singer’s formant, relative to vocal experience, which varied among skill levels. This result was corroborated by Magill and Jacobson in their study, “A comparison of the singing formant in the voices of professional and student singers.”


In this study, Letowski, Zimak and Ciolkosz-Lupinowa compared choral and solo singing of vocally trained and vocally untrained individuals. As shown in previous studies, the subjects overall were found to use more singer’s formant frequency in solo singing than in choral singing.

Of additional significance to this investigation is their finding regarding trained and untrained singers. When comparing the solo versus choral modes of trained and untrained singers, the authors showed an interesting result. Untrained singers were found to sing with a richer, brighter sound in choral mode than in solo mode. However, vocally trained singers were found to sing with a richer, more powerful sound in solo mode than in choral mode. They found that the singer's formant is often totally missing for trained singers when they sing in choral mode. Nonetheless, they conclude that trained singers are “often an essential factor mobilizing the other performers.”

When comparing individuals to themselves, untrained singers sang with a richer tone in choir. Trained singers sang with a weaker tone in choir. This investigation leads to the following questions: At what point does a singer change from untrained into trained? At what point does he or she begin to diminish vocal tone to blend in a choral situation?


Carter’s experiment concerns the acoustic signatures of trained and untrained basses and baritones in both choral and solo situations. His
subject group is made up of undergraduate and graduate vocal students who are participating in choir. His primary concern was the relative strength of the singer’s formant. His results showed that as a singer became more experienced, the difference in the strength of the fundamental became greater when comparing solo and choral modes. Conversely, the difference in the strength of the singer’s formant between solo and choral modes decreased as the age and experience level of the singer increased.

He noted that “a primary difference between choral and solo singing is the strength of the SF [singer’s formant], which is also the primary resonance difference between trained and untrained singers.” He pointed out that choral singing has been shown to have more energy in vowel formants, F1 and F2, and posed the question, “Are inexperienced singers naturally predisposed to choral singing, and as they are trained move away from singing patterns that are beneficial to choral blend?” Carter’s study shows that control of the singer’s formant usually occurs in the junior and senior years as an undergraduate. Graduate students, he finds, make use of the singer’s formant without fail in both choral and solo situations. If the singer’s formant is the defining mark of a trained singer, then, according to Carter, it is during the second half of the undergraduate career that undergraduate voice majors change from “untrained” into “trained” singers.
Vocal Fatigue


In this experiment, ten tenors trained as choral singers performed a series of vocal tasks before and after a choral performance (Mahler Symphony, No. 2). Acoustic considerations were measured, such as perturbation, harmonic-to-noise ratio, pitch range, and amplitude range. Perceptual analyses were also performed, including auditory and proprioceptive/kinesthetic analysis. The majority of the subjects showed vocal deterioration after the performance. The voice tasks which showed the greatest change were: comfortably pitched notes, high soft notes, and bottom notes in scale singing. Acoustic measures revealed the greatest change in harmonic-to-noise ratio. In contrast, however, no significant differences in perceptual ratings were found after the performance. Perceptual ratings contradicted the acoustic analysis results.

This is one of only a few studies which examine the effect of performance on vocal fatigue. An early study by E. Foeschels confirms the Kitch results. Foeschels viewed subjects larynxes after vocal performance.46

He found that incomplete glottal closure was a common effect after performance. This is particularly interesting considering Sundberg’s later finding concerning flow phonation in choral mode singing. Sundberg states that singers in the choral mode use an incomplete closure of the glottis when attempting to blend in an ensemble (see above). Foeschels found that the incomplete glottal closure was found mainly in singers who he considered used poor vocal technique.

More recently, Novak et al. studied vocal change in actors after a spoken theater performance\textsuperscript{47}. Although many of the subjects, particularly those with less vocal training, reported vocal fatigue, no objective deterioration was detected. Other studies have confirmed that trained subjects are less susceptible to vocal damage, although few statistically significant changes have been reported.\textsuperscript{48}


Sundberg asserts that there are two types of phonatory voice disorders: organic and functional. Organic disorders emanate from the tissues themselves, such as swelling, polyps and/or nodules. Functional disorders, on


the other hand, emanate from inappropriate use of voice. Functional
disorders may or may not be associated with the organic disorders listed
above. There is no clear boundary between organic and functional disorders
because one may lead to the other and vice versa. For the purposes of this
discussion, those functional disorders which have their origin in
inappropriate voice use are of primary concern.

In his text, Sundberg writes about vocal health for the undergraduate
singer.

Typically the young singer who spends his or her first semester
in the conservatory comes to see the phoniatrician [laryngologist] for
an unexpected voice disorder that began when the patient started to
sing after a cold that was almost completely cured. The singer’s pre-
conservatory experience is that such use of the voice is harmless: it
never caused any voice problem before. It is important to realize that
the more one uses one’s voice, the more careful one needs to be. 49

The singer entering undergraduate voice study most likely uses his or
her voice more than ever before. Solo practice and voice lessons, choral
rehearsal and performance, aural skills classes and even music theory or
music history classes may require that students sing. Because of this volume
of use, behaviors which were considered appropriate before are no longer
appropriate. Behaviors which did not cause voice disordered before do cause
voice disorder when carried out within the context of a large volume of
singing.

49 Sundberg, Singing Voice, italics mine.
Sundberg uses the term *phonastenia* to describe tiredness of the voice or phonatory fatigue. The patient, he writes, experiences a sense of tiredness in the throat, sometimes in combination with pain or burning as well as increased secretion which leads to throat clearing. Problems increase when the voice is used, and decreased when the voice is allowed to rest.

The physiological cause emanates from excessive stress on the vocal folds, either when the vibrations happen too forcefully or for overly long periods of time. Voice teachers and choral directors can be sensitive to the first of these causes – forceful vibrations. Certainly, in a one-on-one situation, that type of vocal behavior is immediately evident. Even in a choral situation, where one-on-one attention is rare, good modeling and listening on the part of the choral director can lead to healthy vocalism.

The second issue, length of use, may not be immediately known to the choral director or even to the private voice teacher. A student who has practiced a strenuous passage at length comes to rehearsal more sensitive to use than a student who has come from a period of relative quiet. The type of vocal use required in choral mode may be healthy when considered out of context, but when considered within the context of the vocally active student, it may contribute to phonastenia. The same holds true for private vocal study, however the individual nature of lessons allows the teacher to identify symptoms of overuse and before they are exacerbated. Voice performance majors may, in some cases, be more sensitive to the type of flow phonation
required in a blending choral situation. That flow phonation which does not cause vocal disorder in a student who is not performing extensively outside of chorus *may* lead to vocal disorder in the voice performance major. It all depends upon the context. One must consider the vocal context of each individual student when evaluating choral and solo techniques.

Closely related to the mechanical impact of vocal fold vibration is the failing lubrication of the phonatory apparatus. Sundberg points out that it is important for singers and actors to observe that the mucosa tends to dry in connection with and often immediately after a cold. In addition, etheric vapors in the exhaled air, which result from alcohol consumption, are thought to dry the cords. Smoking may also have this effect, though scientists believe that the disadvantage is mainly a chemical one which acts directly upon the vocal fold tissues. Finally, conditions in which the air is not sufficiently humidified may also cause vocal distress.

Endurance of the vocal mechanism apparatus varies greatly from individual to individual no matter how economically he or she uses the instrument. When in good shape, the voice may be used for several hours a day, but in combination with illness, excessive use, alcohol or other risk behaviors, almost any duration may be too much. An essential side of a singer’s career is to learn not only *how* to sing, but also *how much* to sing and under what conditions. Sundberg writes:

The more the voice is used, the more wisely and economically it must be used; the risk of developing a voice disorder using one’s
normal voice technique increases during and immediately after a cold. Alcohol consumption, tobacco smoking, and dry air generally put an increased strain on the phonatory apparatus and raise the demands on economical and appropriate voice use.

One way to increase wise and economic vocal use is to warm-up. Why warming-up is important is not well understood, but Sundberg presents some speculations. A major component of the vocal folds is muscle tissue. Like other muscles, the vocal folds depend on efficient blood circulation in order to function well and maintain viscosity. Sundberg writes that an appropriate warm-up may stimulate good circulation. Other professionals who rely on muscular function, like ballet dancers or athletes, warm-up muscles to increase performance. Gentle phonation during a warm-up can serve the same goal for singers.


In some cases, healthy singing may not be maintained by an undergraduate who has a developed singer’s formant and is attempting to curtail that singer’s formant in a blended choral context. Issues of size, weight, and color of instrument may contribute to problems with vocal technique. An undergraduate voice major’s primary responsibility is to become the master of his or her own instrument. This level of mastery takes
more time for some students than others. If “voice use in choral and solo
ingging differs in certain respects that are probably important for success of a
 solo singer,” then choral directors and voice teachers must observe the effect
 of choral rehearsal on the emergent soloist. A young singer who is not yet
 proficient at both types of singing may experience vocal fatigue or strain.
In the above survey of prominent choral directors, the causes of vocal fatigue
and strain that frequently occur during choral singing were explored. Their
responses included opinions about the general causes of these problems.
Causes included: inappropriate warm-up, too much rehearsal or rehearsal
techniques which are too strenuous. They emphasized the importance of
vocal warm-ups, the differences between choral and solo singing and proper
rehearsal planning. It seems fair to assume that students of solo singing who
have no major problems with their vocal technique could easily participate in
a choir and, in doing so, enrich their musical experience. If, on the other
hand, the student has problems in learning two differing types of voice use
simultaneously, it seems advantageous for them to know that the same type
of voice timbre is not sought in choral and in solo singing. Scientific
evidence and professional experience from both choral and solo vocal
disciplines must be applied to develop curricular requirements that serve the
vocal health and wellbeing of the undergraduate singer.

50 Sundberg, “Choral Voice,” 143.
51 Carol Ann Cook-Koenig “Vocal fatigue in choral singing: Causes and suggestions for
prevention voiced by prominent choral directors.” Ph.D. diss., Florida State University.
52 Ibid.
Chapter 4

Discussion

In most cases, teachers of western classical solo singing and conductors of blended choral singing have a common desire to encourage healthy vocal technique as a means to artistic expression. Certainly, no teacher or conductor intends to cause vocal distress. However, studies from the previous chapter confirm that not all methods are equally efficient and appropriate. Indeed, some methods seem “either impractical or detrimental or both.”

This pedagogical discussion concerns the individual—both in the vocal studio and in the choral rehearsal. Of course, no two individuals are the same. A vocal technique that suits one student may not suit another. But in general, it is clear that some techniques are much more effective in

---

53 Sundberg, Singing Voice, p. 194
promoting vocal efficiency and excellence than others.\textsuperscript{54} Not all solo vocal techniques are created equal, and likewise for choral vocal techniques. Even with the best intent and methodology, no non-operatic blended choral environment can fully serve the technical goals of the advanced solo singer. It may serve the student in dozens of academic and musical ways, but technically, it requires the well-trained singer to function in a less efficient manner.\textsuperscript{55} Some choral environments, however, promote a vocal approach which is more consistent with the technical goals of voice performance majors than others. For the student who is pursuing excellence in solo singing, a choral environment which supports this goal is more likely to promote excellence in both arenas.

In Letowski et al., it was found that trained singers perform in a less efficient manner in choral mode as compared with solo mode, while untrained singers function in a more efficient manner in choral mode as compared with solo mode. Voice performance majors are in the process of transforming from untrained to trained singers. An inexperienced singer will grow technically in a choral situation while an advanced singer will have to diminish themselves technically to fit into the texture. Often the same student will experience both extremes during his/her tenure. This can be very confusing for the undergraduate voice major. Initially, the student can use all of their vocal prowess in choir and still fit into the texture. Subsequently, however,

\textsuperscript{54} Sundberg, \textit{Singing Voice}, p. 194
\textsuperscript{55} Letowski et al., 55 – 65.
using all their vocal prowess no longer works. At this juncture, the student’s voice may no longer blend into the choral texture. The young singer has determined how to sing more efficiently, but the tone may be too loud, too complex, too unique for the choral environment. Benade’s studies on perceived loudness show that a vocal tone with more upper partials will be perceived as louder even when the amplitude remains the same. A main goal of solo vocal study is to learn how to emphasize those upper partials while maintaining vocal and bodily freedom. Just when a voice student really starts to let those upper partials ring and thus excel as a soloist, he or she may have to abort his/her technical best in choir in order to blend.

This was confirmed by the Sundberg and Ternström studies in the previous chapter. Results of their study showed that trained singers use a tone with fewer upper partials and a greater emphasis of the fundamental when trying to blend. This effect occurs at the glottal level. Glottal closure is less efficient in choral singing (flow phonation) than in solo singing. However, there is a range of glottal closure which may be considered healthy by doctors and scientists, and flow phonation may fall within that range if approached correctly.\footnote{Sundberg, \textit{Singing Voice}, p. 194} Unhealthy phonation includes such vocal faults as pressed phonation, breathy phonation, and whispered phonation.

In pressed phonation, the glottis is closed for a longer period than is normal within each cycle. This method is inefficient. The tone is hard,
subglottal pressure is abnormally high, and the sound pressure level is low. The singer using this approach is putting forth much effort, but not producing much sound. When subglottal pressure is lessened into a normal range, normal closure is achieved. The vocal folds close completely during each cycle and sound pressure levels rise. This is the most efficient use of breath and tone. It is the Bel Canto coup de glotte referred to in Fagnan’s study - complete glottal closure which is balanced with appropriate subglottal pressure. Various combinations of glottal pressure and ligament stress are shown below in a glottogram graph by Titze.  

Glottogram by Titze

---

On the other extreme, the whispering glottis does not close at all. A breathy tone shows the vocal folds coming closer together but not fully adducting. In their 1986 study, Sundberg and Ternström showed that singers in choral mode moved more toward the breathy extreme than singers in solo mode. In blended choral mode, a higher peak amplitude of transglottal air flow waveform was achieved by reducing the degree of glottal adduction and producing a subglottal pressure which is lower than the pressure used in solo mode. Sundberg and Ternström called this type of less complete glottal closure and lowered subglottal pressure *flow phonation*. Sundberg’s flow glottogram below shows the open phase and closed phase of the transglottal air flow waveform.  

Sundberg concluded that flow phonation is different than the solo approach (which has a more complete closure of the glottis and higher subglottal pressure) and that singers who have trouble learning two slightly

---

different techniques may benefit from knowing that the same phonation and timbre is not sought in both circumstances. However, he did agree that concern regarding glottal closure may be a valid consideration for voice teachers who do not want their students of solo singing to participate in choirs. In the graph below, Sundberg compares the open phase and closed phase of the transglottal air flow waveform in several different types of phonation.

If flow phonation does not lead to vocal disorder in and of itself, then students who are able to learn two slightly different techniques may grow personally, musically, and artistically when exposed to both choral and solo idioms. It seems reasonable to assume, however, that use of flow phonation may slow solo growth in some individuals. Alternating between the optimal glottal closure of solo singing and the flow phonation of choral singing may be confusing for the undergraduate voice major, and that confusion may stall solo progress.

For the trained singer, singing in choir while you are learning to be a soloist is like eating chocolate while you are on a diet. In the same way that chocolate slows weight loss goals, choral singing may slow solo singing goals. But surely, most people can agree that chocolate is worth it! It is the same with choral singing. Singing a well-tuned blended tone with others is a delicious experience and participating in an ensemble is certainly good for you as a musician. If flow phonation is not used too much, and optimal glottal closure is maintained the rest of the time, a healthy portion of blended choral music can be fine for body and soul.

However, one must be careful of overindulgence. Use flow phonation for overlong periods of time can impede solo progress. Choral conductors must be sensitive to the cues that young singers and their teachers give about vocal tiredness and fatigue. In his book, *Choral Director’s Complete Handbook*, Lewis Gordon explains the tension a choral conductor may feel
between upholding a reputation for choral excellence and attending to the individual. “Choral directors are judged to a large extent by their ability to produce quality ensembles. Sometimes it is possible to forget that organizations are molded from individuals whose efforts and abilities ultimately determine the group’s success.” Every aspect of the choral environment must first take into account the vocal goals of the individual student. To this end, we must be careful that voice performance majors do not overindulge in flow phonation singing. Special attention to the scheduling of extra rehearsals must be given so that rehearsals are neither too long nor too numerous.

Singing in blended choral mode is not optimal for the trained solo singer. In the proper context, it can be achieved while maintaining vocal health. However research indicates that voice use in a blended choral context is less efficient than voice use in a solo context for the trained singer. As voice teachers and choral conductors, we must make sure advanced students understand that there is a difference between what is being asked of them in the studio and what is being asked in a blended choir rehearsal. If it is not clear that there is a difference for advanced singers, then additional problems may ensue.

Students emerging as advanced solo singers do not always make good choices when trying to fit into the choral landscape, and choral directors may not be able to hear individual vocal problems within the choral texture.

---

60 Letowski et al., 55 – 65.
Student attempts to hold back an emerging solo timbre may lead to inappropriate bodily and vocal tension. To soften the tone, students may squeeze the throat, hold the tongue and jaw, or under-support with the breath mechanism. At times, when singers are not able to hear themselves in an equal proportion to those around them, they may use pressed phonation and sing out of tune. This tendency was revealed by Ternström in his research on the self-to-other ratio. Any of these issues can cause problems in the voice studio. If the student who is making solo progress reverts to poor habits in the choral rehearsal, he or she may very well be bringing those poor habits into the voice studio as well. Flow phonation, in and of itself, may be a part of a healthy vocal regime. However, when continued for too long or combined with inappropriate body and/or vocal tension, the student’s choral technique may be considered unhealthy. Use of an unhealthy technique in choral mode will surely affect solo progress. It is the opinion of this author, however, that most or all of these types of vocal faults may be remedied with good rehearsal planning and proper modeling by the choral director and voice teacher.

There are many similarities between singing in solo and choral mode. Emphasizing these similarities promotes excellence in both modes of singing. However, to understand what is similar, one must understand also what is dissimilar. Within blended choral mode, there are gradations of technique. Some of these choral techniques may utilize phonation which is more
efficient, and thus more similar to solo singing, at the glottal level. Others use a less efficient glottal closure, and are thus more dissimilar to solo mode. In order to clearly define efficient and appropriate methods, it is important first to evaluate how the term “healthy vocal technique” is commonly used. It is doubtful that there is only one method of healthy vocal technique that is most favorable from a physiological point of view, but it is clear that not all methods are equally efficient and appropriate.

Books on choral methodology often include information on “healthy vocal technique”, and the authors of these books advise choral conductors to be well versed in the pedagogy of Western classical singing. While vocal pedagogy texts include a more advanced view of how the voice works and should work, for the most part, this information describes only solo singing, not choral singing. Many choral conductors make use of “healthy vocal techniques” which are derived from books and study of choral

---

methodology. However, for the trained singer, there is a point at which producing a blended choral tone means modifying vocal freedom, loss of complete glottal closure, and lessening use of the singer’s formant (all important hallmarks of healthy vocal technique). Because of this, the “healthy vocal technique” of the choral situation is not wholly the same “healthy vocal technique” of the vocal studio. While the two techniques may share certain basic aspects, the ultimate means of expression of each is in opposition. In the choral environ, a homogenous resonance is sought, while in the solo vocal environ, a unique resonance is sought.

In the vocal studio, it may be more accurate to replace the term “healthy vocal technique” with “maximized vocal technique.” Like an athlete-in-training seeks not just a healthy diet, but an optimal one to support his/her athleticism, the soloist-in-training seeks not just healthy vocal technique, but the optimal technique. The voice student and teacher are ever striving to evoke the most efficient, ringing, easy, and uniquely beautiful tones possible for the student. Nothing less than the most efficient glottal closure and the most resonant use of upper partials possible is acceptable. What might be considered “maximized” performance for the undergraduate voice performance major is ever changing, of course. As the student improves, the bar for excellence rises.

In a choral situation, however, the term “healthy vocal technique” has a more general connotation. In chorus, there is a broad range in which
vocalism might be considered “healthy”. In 2000, Eckholm studied aural preference of choral conductors and voice teachers. Subjects listened to examples of choral and solo singing, both with and without use of emphasized upper partials. The voice teachers showed a preference for individual singers who sang in solo mode (with emphasized upper partials) to those who sang in a choral blended mode (without emphasized upper partials). Voice teachers noted that the blended tone lacked “freedom of production.” “Freedom” refers to functional efficiency in singing.⁶９ For voice teachers, maximized efficiency equals "healthy vocal technique." If the tone is not maximally efficient, then the tone may be considered unhealthy. For choral directors, a vocal tone which is in tune and does not cause distress might be considered healthy. Being in tune and not in distress is not always enough for voice teachers to consider a tone healthy. The solo tone must also have “freedom of production.” It must be maximally efficient. These varying definitions of “healthy vocal technique” reflect the basic goals of each area, which are at times in opposition. Where choral directors’ main goal may be to maximize the beauty of the blended choral tone, voice teachers’ main goal will be to maximize vocal freedom and resonance.

The two modes of performance are different, and the technique a student uses to achieve excellence in each mode is different as well. Similarities do exist, and it is advantageous for the undergraduate singer if

these similarities are explored and maximized. Undergraduate voice majors 
must develop new strategies and techniques to grow in success both in the 
studio and in choral rehearsal. The undergraduate voice major who believes 
these choral and solo techniques are the same “healthy vocal technique” will 
find it difficult to achieve excellence in either discipline.

Most undergraduate voice performance majors will experience being 
both untrained and trained during their tenure. If students follow the 
pattern revealed in the Letowski et al. study, then we might expect a scenario 
similar to the following: In the beginning, many students present themselves 
as untrained (undeveloped upperpartials/singer’s formant) and they may 
respond to the choral situation with increased vocal efficiency as compared 
with solo singing. After significant private vocal study at the college level, 
students may present themselves as trained (developed upper 
partials/singer’s formant) and respond to the choral situation with decreased 

goal efficiency as compared with solo singing. Carter, in his 2007 study, 
postulated that this change from untrained to trained occurs between the 
sophomore and the junior year. This, of course, would vary with the 
individual’s talent, drive and maturity. 

In describing specific similarities and dissimilarities of choral and solo 
mode, one must differentiate also between untrained and trained singers. 
The student’s level of solo ability has a significant effect on how that student 
responds to the blended choral environment. If a student is untrained, either
much will be the same both acoustically and physiologically between solo singing and choral singing\textsuperscript{70} or the student will actually sing with more vocal efficiency in choral mode.\textsuperscript{71} When a student is trained, more dissimilarities between choral and solo mode arise.\textsuperscript{72}

An undergraduate voice performance major has as his or her major goal to excel as a Western classical solo singer. It is possible for the blended choral environment to encourage that goal, both acoustically and physiologically. Many other studies have examined the positive effect of solo study on the choral tone. In this discussion, the effect of choral singing on solo progress is explored. After all, the ultimate goal of the voice performance major is to become a better solo singer. One must respect that personal goal and support it with curricular requirements which are in concordance with it. Proper choral vocal instruction, good rehearsal planning and appropriate spacing and placing of singers can all help to uphold the goals of the voice performance major while also maintaining the worthy goals of the choral environment. The aim is to create a choral environment that encourages singing which is as efficient as possible at the glottal level without sacrificing blend.

The term \textit{blend} is subjective. In attempting to define this allusive trait, Ternström refers to the \textit{chorus effect}, the summing of many slightly

\textsuperscript{70} Ternström and Sundberg, “Formant Frequencies of Choir Singers.”
\textsuperscript{71} Letowski et al.
\textsuperscript{72} Rossing et al., 1986 and 1987.
asynchronous vocal signals coming together to produce one blended ensemble sound. According to Ternstöm, this acoustical phenomenon occurs when a cluster of phase incoherencies of pitch, vowel, and vibrato (coming from multiple sources – the choristers) combined with the sound qualities of the room to “magically dissociate the sound from its sources and endow it with an independent, almost ethereal existence of its own. Voices may be slightly asynchronous, but not considerably so or oneness of sound is obliterated. Voices must be similar for the chorus effect to occur.

Of significant interest to this issue is Ternström and Sundberg’s article, “Formant Frequencies of Choir Singers.” In the authors’ concluding discussion, they concluded that some types of blended choral singing may be more similar to solo singing than others, though they still require different techniques. The authors write that use of the singer’s formant would be inappropriate in an amateur choir because it would be an impediment to choral blend. As stated above, voices must be similar for the chorus effect to occur. Conversely, if all singers of the ensemble have a singer’s formant and/or emphasized upper frequencies, then blending would not be affected. They suggest that an opera choir, consisting of singers trained as soloists, might fit this description. According to their comments, it is not the requirement of blend which automatically excludes the use of the singer’s formant or emphasized upper partials, it is the timbre of the ensemble to which a trained singer is trying to blend that determines whether the singer’s

73 Ternström, “Choral Sound,” p 141.
formant may be used. Similarity of individual vocal timbre is the key to a successful blend which respects the individual singer’s solo technique.

There is a range of physiological techniques even within blended choral mode, as well as a spectrum of how much air leaks through the glottis during flow phonation. That range is dependent not only on the singing technique of the individual, but also upon the dynamic relationship of that individual to the whole. The timbre of the ensemble to which a singer is trying to blend has an equal effect on that student’s ability to blend as the choral technique he/she utilizes. This is significant support for grouping singers by level of solo ability. According to Ternström and Sundberg, trained singers who have a developed singer’s formant are more likely to blend into a choral sound which has other singers who are also able to make efficient use of their upper partials.

Reid et al. asserted that the Opera Australia chorus artists they studied achieved choral blend without compromising use of the singer’s formant. Their singers sang with the same technique in both choral and solo modes. However, according to the experience of this author, the blend of an opera chorus is most likely not the blend which is sought in an undergraduate choral environment. As stated above, it is the timbre of the ensemble to which a trained singer is trying to blend that determines whether the singer’s formant or emphasized upper partials may be used. Even with tiered choruses, an advanced undergraduate choir will most likely
contain singers at various levels of technical prowess. Since most undergraduate students are in the process of growing and changing, it is unlikely that a chorus at this level would be able to reproduce the results of the Reid et al. study. In the opinion of this author, attempting to emulate an opera chorus sound would most likely result in unhealthy pressed phonation for many singers. While tiering choirs does help trained singers to sing in a more efficient way in choir, it is not likely that it would enable them to sing exactly as they do in solo mode. Tiered choruses enable singers to bring choral mode singing into a more efficient technique of phonation and articulation, but choral mode for the trained undergraduate singer is most likely not going to be perfectly in line with solo mode.

In his award-winning dissertation, Fagnan wrote that upper partials can be raised and more efficient glottal closure can be achieved while blend is still maintained. He did not say that these higher partials and more efficient glottal closure were equal to those found in well-trained solo singers, but he did hold up the Bel Canto method of solo singing as a method of excellence toward which choral singers ought to strive. The results of his study showed gains in upper partials, but the extent to which these gains close the gap between choral mode and solo mode singing was not determined.

In his experiment, Fagnan taught each group the Bel Canto vocal techniques of coup de glotte (stroke of the glottis), chiaroscuro tone (balanced light and dark), and efficient breathing. Before and after recordings show
that his techniques raised upper partials, and according to his aesthetic, blend was maintained. According to Fagnan’s results, there is a way to create a choral environment which addresses solo singing goals without sacrificing blend. His choruses developed a greater use of upper partials after the application of his techniques. He did not include a comparison of higher upper partial choral singing with solo singing. Research which does compare these two modes shows a difference in upper partial energy between choral mode and solo mode singing (except in opera choruses). Acousticians, Sundberg, Rossing, Ternström, Letowski and others have performed numerous experiments that demonstrate this clear difference. Though acoustic and physiological differences between modes appear in both trained and untrained singers, certain aspects of choral and solo singing are similar, and emphasizing these similarities is helpful to the student singer.

**Breath**

Use of the breath mechanism should be the same in both solo and choral mode. Encouraging students to maintain the efficient breath management taught in the vocal studio will help to keep them from manifesting vocal faults in the choral rehearsal. As mentioned above, singers will sometimes under-support in an effort to sing quieter and blend. Addressing what is not correct is as important as addressing what is.
In most amateur choirs, instruction on how to breathe efficiently for singing is imperative for untrained singers, but voice performance majors should already be receiving this instruction in private lessons. Additional instruction in the choral rehearsal may be confusing for select students. Some students will be in an untrained phase and need guidance, and others will be in an early trained phase and be confused by guidance in this area. Instructing students to do what they do in voice lessons and pointing out that breathing in choir is exactly like breathing for solo singing is helpful. Students should be reminded that their definitive guide for breath management is the private vocal instructor. Prompting trained singers to breathe like they do in lessons calls attention to this important pillar of similarity between choral and solo modes.

**Posture**

Correct breathing begins with correct posture. Posture, both standing and sitting, should be the same for choral and solo modes. Although solo singers do not normally sit in voice lessons, they should know how to use their bodies for singing and should adapt to a sitting environment with little problem.

Untrained singers may mistakenly utilize the poor posture they use in daily life-- too collapsed. Others may utilize posture which is too rigid -- trying to emulate a tall and open carriage, but missing essential elements of
freedom and buoyancy. For a choir of primarily untrained singers, instruction on posture is advantageous. For trained singers, reminding them to stand or sit as they would for solo singing is all that is needed.

**Freedom of Jaw, Tongue, Lips**

“Freedom” refers to functional efficiency in singing, in this case, efficiency of jaw, tongue, and lips. There are times, in an effort to modify vowels toward a choral unity, the shape of the articulators may be different in choir. However the approach, the element of freedom and ease which is so important in solo singing, should be the same in choral singing. Ternström referred to the modification of vowels in chorus as the *choral dialect*. He found that in blended choral singing, all vowels are more similar to one another than they are in solo singing. This dialect, he concluded, helps to maintain tuning and blend of the ensemble.

Vowels are used differently in choral mode. In order to blend, one must create an acoustic signature which is similar to the acoustic signatures of the other singers. Therefore, if a student is studying with a teacher who espouses a particularly bright [a], that vowel may not be appropriate for a choral situation. The student’s articulation of [a] will need to be different in solo and choral mode. In order to alleviate confusion, the choral conductor must make this difference clear. The unified vowel of the choral context may

---

be different than the one singers use in solo repertoire, but the *manner* in which he or she produces that vowel should be the same. The freedom of jaw, tongue and lips which one associates with good solo singing are equally viable in a choral situation. Though somewhat paradoxical, instructing students to “use good technique and match the vowel,” seems to yield a result which honors the goals of both solo and choral mode.

**Opening of the space in mouth and throat**

It would be hard to find a voice teacher who recommended singing with a closed throat. ‘Open the throat’ is almost as frequently heard as ‘support the voice,’ sing on the breath’ or ‘place the voice.’ These expressions have the potential for inducing malfunction in singing because they are imprecise. The singer must concretely understand... what to experience as ‘the open throat.’

Richard Miller, *The Structure of Singing*

The concept of openness in the mouth and throat is the same in choral and solo singing. However, the way in which this space is manifested in a choral environment may be different in untrained versus trained singers. In their book, *Group Vocal Technique*, Frauke Haasemann and James M. Jordan differentiate between trained and untrained singers. They suggest that one might learn in private voice lessons how to create the necessary interior space and to understand what the experience of that openness should be. But, they continue, “that concept is impossible for a choir to learn. The
amateur singer has to drop the jaw for ascending passages and close the mouth for descending passages.”  

Singers who are receiving private instruction but who are not yet proficient may benefit from a reminder about opening the interior space which their teachers have shown them. Singers who are newly proficient may need guidance as to how to maintain that space without overpowering the ensemble. The goal is for choristers to maintain space and control dynamic. This is a tall order. Sometimes even trained singers will collapse space in an effort to control dynamic. A trained voice has a more complex resonance signature, and it will appear louder even when the amplitude is the same as other voices. In addition, our ears are more sensitive to higher pitches. The soprano with a complex solo tone will have to sing well below the amplitude of other singers in order to blend. Placement of this type of singer is an important consideration for the choral director. A complex voice singing lower pitches will fit into the choral landscape with greater ease. Placing a complex solo voices on a high part and admonishing them to blend could be counterproductive as best, inconsiderate at worst.

It is imperative that singers maintain space while in the choral environment, just as they do in the solo environment. If a singer, trained or untrained, is unable to control volume while maintaining space, then that student should be asked, respectfully, to switch to a lower part for the

---


76 Benade, ibid.
offending note or passage. For most singers, it is difficult to sing relatively high pitches *below* the amplitude of singers who are singing relatively low pitches. Yet, for the singer with a complex tone, this is what is required in order to achieve blend. Every effort should be made to support high passages with greater dynamic in the lower choral parts so that singers can maximize space as well as control relative dynamic with maximized efficiency and ease.

**Phonation**

We have established that phonation is different for choral and solo modes. Phonation refers to the vibration created by the vocal folds. In solo mode, the vocal folds close completely in each cycle of vibration. In choral mode, the vocal folds do not close completely. More air flows through the glottis during its open and closed phase. As mentioned above, Sundberg and Ternström called this choral technique *flow phonation*. They consider this type of technique healthy by scientific standards, however they point out that some teachers of Western classical solo singing may not deem it to be optimal for students of solo singing.

**Resonance**

Resonance refers to the signature of formant frequencies which are unique to each individual. As the small sound from the vocal folds travels through the throat, pharynx and mouth, certain aspects of the tone are
amplified and certain aspects are attenuated. Frequencies of the tone which are amplified form peaks in the resonance signature. Those peaks are called formants. The first two formants, F1 and F2, change with the articulation of the vowel being sung. Upper formants, F3, F4, and F5 (the singer’s formant), are less mobile, and they combine to create what we think of as a singer’s individual timbre. Research shows that in choral mode, untrained singers use either the same resonance as solo singing (Ternstöm) or more upper partial resonance than solo singing (Letowski et al.). Their voices are either the same or more resonant in a choral environment. This is good for the individual and for the chorus. Books on choral methodology often teach techniques of how to build choral “core” or resonance.77 78 79 80 A resonant core of tone is important for a chorus, and developing resonance in untrained singers yields a good result (Fagnan.) However, there is a point at which the student may actually develop resonance beyond the bounds of optimal choral mode singing when compared with other singers in the ensemble.

Conductors of blended choral environments strive to achieve core and resonance in individual voices, but no one voice should utilize a resonance signature which is significantly more complex than the rest of the choir. Too

much resonance, particularly in the upper partials, makes a voice unique, special, soloistic, and it may protrude out of the choral texture.

For trained singers, the same timbre is not sought in blended choral and solo modes. But ideally, freedom of the mechanism remains constant in both modes. Because the phonation process necessarily informs the resonance process, a change in the former yields a change in the later. Use of flow phonation will decrease sound pressure levels of upper partials, and thus allow a trained voice to produce a more homogenous resonance within the choral texture.

Spacing and Placing Singers

There are several methods of spacing and placing singers which have been explored and empirically tested in the available literature. Methods include placing singers in sections, placing singers in mixed formations, placing singers according to acoustic matching as in Weston Noble’s well-known technique, and finally, spacing singers laterally with varying measured intervals. Most of these techniques have been tested to identify which create the most pleasing choral sound for the audience. While improved choral sound is of interest, this discussion is concerned primarily with which formations might improve vocal efficiency, freedom of mechanism and ease of production for the individual singer.
Acoustic placement refers to a technique whereby singers are matched with voices with whom they blend. Blending voices are placed next to one another. Gradually, singers are added one by one until all singers are placed. Blend must be present on both sides of each singer. Lateral spacing refers to a technique wherein singers are placed with a length of space between each one (usually 12 to 30 inches).

Woodruff constructed a study in which the attributes of acoustic placement and lateral spacing were evaluated by auditors as well as by the singers themselves. He found that a combination of acoustic placement and lateral spacing was preferred by auditors and singers over acoustic placement alone. Lateral spacing, however, was viewed positively by singers and auditors even when acoustic placement was not used. Of these techniques, lateral spacing is the most important factor. Acoustic placement, however, can boost the effectiveness of lateral spacing, and it may reduce the vocal change singers must make to achieve blend.

In a similar study, Giardiniere wrote that acoustic placement or voice matching allows singers to have individual vocal timbres and freedom in vocal production while singing in a choral ensemble. Likewise, Eckholm noted that acoustic placement of singers may lead to better blend, phrasing and overall tone quality, in addition to benefiting vocal production, vocal

---

comfort and the aesthetic satisfaction of the singers. Woodruff found that attention to acoustic placement was effective only when combined with lateral spacing. This combination of acoustic placement with lateral spacing reduced the amount of vocal change experienced by the individual singer.

James Daugherty is one of the pioneers in choral acoustics. He has written several academic papers on lateral spacing of singers in the choral ensemble and the effect of that spacing on the individual chorister as well as the perceived blend of a choir. Like the Woodruff, Daugherty finds that spacing positively influences choral sound preferences for auditors and individual singers more so than choral formation. In his studies, auditors were able to distinguish between mixed and sectional formations, but the greatest positive difference in blend quality was attributed to spacing, not formation.

While mixed formation does not produce a noticeably better sound for the listener, Daugherty asserts that the experienced singer may prefer it. In addition, he suggests that acoustic placement or voice matching could be beneficial for choral ensembles because it encourages sensitivity to ensemble blend and allows singers to consider their own vocal sound. He points out that perhaps this technique would be most effective if singers are allowed to participate in the process of placement. In his studies, choristers showed a preference for lateral spacing with little difference in preference between

---

section or mixed arrangements. Singers stated that the spacing improved vocal production as well as their individual ability to hear themselves and others.

Ternström developed the *self to others ratio* and wrote extensively about this concept. He found that the functional excellence of a singer in choral mode is based upon two acoustical signals: his or her own personal dynamic when singing in an ensemble situation (feedback) and the rest of choir (reference). Ternström writes that if the singer is too quiet, then he/she will not be able to hear his or her own signal. Conversely, if the singer is too loud, the individual sound will protrude through the choral texture. The upper limit of sound is determined by the singer’s desire to blend. The lower limit is determined by a singer’s need to receive feedback from his or her own voice. Ternström established an ideal self to others ratio for choral singing and found that choristers performed best if they heard the reference (the rest of the choir) and the feedback (his or her own voice) in roughly equal amounts. When reference became 5 or more decibels louder than the feedback, intonation errors became greater then 20 cents. When the feedback became more pronounced than the reference, intonation errors also occurred, but more gradually.

Of the three placement techniques (sectional, mixed and acoustic), acoustic placement receives the most support from these authors. It was preferred by singers and found to benefit vocal production, vocal comfort and
aesthetic satisfaction. However, significantly more than any placement technique, attention to spacing was found to improve blend and lessen the singer’s perception of vocal change.

Lateral spacing was found to be the single most important formation element which contributes to acoustic excellence and singer comfort. Spacing singers with twelve to thirty inches between each person creates a choral environment wherein the self-to-others ratio is balanced, and good intonation is more easily achieved. In multiple studies, singers preferred this type of spacing over any other single placement technique. Utilizing lateral spacing in combination with acoustic placement received highest praise both from singers and auditors.

**Conclusion**

For the undergraduate voice performance major who has developed upper partials in his/her resonance signature, *western classical solo singing* and *blended choral singing* require different vocal techniques. Achieving artistry in both of these diverse areas requires that the individual be aware of the difference, able to negotiate between slightly different techniques of phonation and articulation, able to maintain the techniques of engaged respiration, bodily freedom and vocal flexibility which are common to both solo and choral modes of singing.
Choral conductors may help the undergraduate singer negotiate between these different modes by creating an environment which encourages the technical goals of the solo singer as much as possible without sacrificing the ultimate choral goal of blend. When trained singers are matched with other singers who have similar resonance signatures, they are able to blend more easily, and they experience less vocal change in choral mode. This can be achieved on a broad scale by using a tiered choir format, where singers who have similarly developed voices are placed in the same choir. It may be achieved on an individual level by using acoustic placement or voice matching within each ensemble.

The single most effective procedure a choral conductor can use to achieve blend while maintaining a high level of individual vocal freedom is to space students laterally with twelve to thirty inches of space between each singer. Students who are laterally spaced maintain a balanced self-to-others ratio. In this formation, singers can hear themselves in roughly equal proportion to others around them enabling them to sing in tune to a greater extent. In addition, auditors perceive a greater sense of blend from ensembles in a laterally spaced formation. Choirs which make use of both lateral spacing and voice matching techniques were shown to be even more effective in achieving blend and maintaining vocal freedom for the individual.

Utilizing lateral spacing, voice matching, and tiered placement of well-trained singers brings vocal efficiency in choral mode closer to that of solo
mode. However, it is unlikely that trained singers’ vocal efficiency in choral mode will be equal to that of solo mode in an undergraduate choral environment where blend is sought. In most cases, the advanced undergraduate solo singer will diminish vocal freedom to some extent when attempting to blend in an undergraduate choir. The glottal closure of flow phonation is less efficient in choral mode than it is in solo mode for these singers. Rehearsals, particularly those which are in addition to a regular class schedule, must be carefully planned so that trained solo singers (usually juniors or seniors) are not adversely affected by a large volume of flow phonation singing. On the other hand, voice performance majors who are not yet considered “trained” (usually freshmen or sophomores) sing with the same or even more efficiency in choral mode as compared with solo mode. Ironically, these singers may be better able to maintain a rigorous schedule of added rehearsals because the lower level of their vocal efficiency is less likely to be adversely affected by flow phonation.

Whether trained or untrained, members of a chorus gain much in terms of musicianship, repertoire and artistry. Singers who are unable to negotiate the differences between choral mode and solo singing mode fail to benefit from the advantages that choral singing offers. However, it is clear that choral singing is not one-size-fits-all. The technique is different from solo singing, and some students who endeavor to achieve excellence as soloists may not be able to acquire the skills necessary to be competent choral
singers. While the difference in phonation for trained singers is small, it is not non-existent, and some undergraduate singers may not be able to do both well.

For most undergraduate students, however, choral singing mode and solo singing mode are similar enough to warrant the pursuit of both. The undergraduate years are a time of experimentation and diversification. Much is to be gained by the singer who pursues excellence in both areas. Both modes of singing serve to enrich the musical and artistic experience of the undergraduate singer. And ultimately, both seek to express and illuminate some aspect of the human condition through music. Singing technique, be it in solo mode or choral mode, is only a means to this worthy goal. As Zoltan Kodaly so eloquently stated, in the end “it is not technique that is the essence of art, but the soul.”

---

Bibliography

American Academy of Teachers of Singing. “Choral singing: responsibilities in the relationship between the conductor, voice teacher, and singer.”


Coffin, Berton. _Sounds of Singing: Principles and Applications of Vocal_


Lamartine, N. C. “A curriculum of voice pedagogy for choral conductors: the effect of solo voice exercises on individual singer technique, choral tone, and choral literature.” Doctoral diss., The University of Arizona,
2003.


Reid, Katherine L. P. et al., “The acoustic characteristics of professional


Slusher, H. K. “A comparison of the perspectives of college choral directors,
voice teachers, and voice students concerning solo and choral singing.”

Doctoral diss., The Ohio State University, 1991.


Ternström, Sten. “Preferred self-to-others ratios in choir singing.” Journal of


Thurman, L. and Van Lawrence. “Voice Care for Vocal Athletes in Training.”


Timberlake, Craig. “Loudness and Projection as Related to Vocal Pedagogy.”


