The Effect of the Position of the Zygomatic Musculature of the Experienced Baritone Singer on the Voice Spectra

Jennifer Helen McQuade

INTRODUCTION

Voice pedagogy literature is replete with information pertaining to the importance of body posture in singing. Methods that promote the development of kinesthetic sensitivity, such as the Alexander Technique and the Feldenkrais Method, have been incorporated into the art of singing as a means to improve vocal efficiency. Voice teacher Dr. Elizabeth Blades-Zeller, for example, worked jointly with Feldenkrais expert Dr. Samuel Nelson using Functional Integration, a specific hands-on approach, to release one singer’s neck and shoulder tension. Over time, the singer was able to produce a clearer, freer, and more full-bodied tone. But, what of facial postures? Little research has been conducted that explores the positions of the muscles of the face in singing. The face, a singer’s most obvious means of expressing his/her natural instrument, is deserving of more focused consideration.

The study of the muscles of the face in singing is a critical issue in voice pedagogy, since anything that impacts the shape of the vocal tract contributes to the resultant vocal timbre. Significant changes in vocal timbre occur when a singer overextends the jaw, keeps the mouth open in a fixed position, or exhibits various other such physical maneuvers while singing. Similarly, it is possible that the position of the zygomatic musculature may contribute to the quality of a singer’s sound. Richard Miller suggests that the position of the zygomatic musculature in singing alters the shape of the vocal tract, thereby affecting vocal timbre. In Solutions for Singers, Miller discusses the importance of the zygomatic muscles not only related to their role in facial expression but as they relate to resonance balancing.

Raising of the zygomatic area for singing need not provoke widening of the eyes, furrowing of the brow, dilating of the nostrils, wrinkling of the nose, or laughter, actions caused by other muscles, including the risorius, the smiling muscles. When a pleasant expression (not a smile) accompanies complete inspiration, prior to velopharyngeal closure, the velum rises slightly, changing the shape of
the resonator tract in the velopharyngeal area. This slight elevation of the zygomatic musculature is commonly observed among major singing artists who adhere to the international school of resonance balancing.\(^7\)

Furthermore, Miller adheres to the old adage “inhale as though smelling the fragrance of a rose.”\(^3\) As such, he suggests, “Having the zygomatic muscles follow patterns associated with pleasant facial expression achieves an uncontrived adjustment of the entire buccopharyngeal cavity.”\(^4\) Depending on the uniqueness in the physiology of the vocal tract of any given singer, slight movements of these muscles may produce different resonance balances from one singer to the next.

**HISTORICAL REFLECTIONS**

**Facial Postures and Singing**

As far back as 1723, singers were becoming aware of the importance of facial postures. In his treatise, *Observations on the Florid Song*, Pier Francesco Tosi makes a few insightful observations on facial postures.

> When he [the student] studies his lesson at home, let him sometimes sing before a looking-glass to avoid those convulsive motions of the body, or of the face which, when once they have took footing never leave him.\(^5\)

Lacking scientific instrumentation for viewing the vocal folds and analyzing the singer’s sound, Tosi used a simple mirror as a primary tool for analyzing a singer’s physical movements.

Approximately a half century later, Giambattista Mancini offers his views of singing in his book, explaining in detail the importance of the position of the mouth in singing, since “it is the source for the clarity of the voice and the neatness of the expression.”\(^6\) He advocates the “smiling position” and says, “Every singer should position his mouth as he positions it when he smiles naturally, that is, in such a way that the upper teeth be perpendicularly and moderately separated from those below . . .”\(^7\) Nineteenth century master teacher, Francesco Lamperti, mentions the position of the mouth in singing.

> The mouth should be smiling and the lips should be drawn sufficiently tight to merely show the upper row of teeth, that the sound, striking on a hard surface, may vibrate with greater intensity, and thus give a ring and brilliancy to the voice.\(^8\)

This so-called “smiling” position of the mouth in singing may be what Richard Miller refers to as the raising of the zygomatic muscle.\(^9\)

Concerned with both body and facial postures, Manuel Garcia in his writings advocates that the lips and mouth be sufficiently open so that the voice will not sound encumbered. His son, Manuel Garcia II, was one of the first to discuss what he called the clair (clear/open) and sombre (dark/covered) timbres of the voice. All these legendary historical pedagogues were aware that the position of the facial muscles plays a major role in the identification of different vocal timbres and considerably influences the quality of the sound of one’s voice.

More recently, Ingo Titze focuses on acoustic wave resistance and the singer’s sensation of tone placement. Of the zygomatic area, he says, “Our sensation of where the tone is localized is quite possibly related to the localization of pressure maxima in the vocal tract.”\(^10\) He goes on to mention familiar concepts such as “singing into the mask” and “resonating the cheek bones,” all with the goal of achieving an acoustic pressure maximum (tone placement). He explains, “Due to the presence of multiple formants, there may in fact be several such locations where vibrotactile sensation is maximized.”\(^11\)

In his article, Titze focuses on the muscles of the face and its importance in optimizing vocal intensity.

In his seminal text, *The Science of Vocal Pedagogy*, Ralph Appelman suggests, “The shape and size of the oral cavity may be varied by the movement of the mandible, the tongue, and the lips.”\(^12\) He condemns those teachers who seek a minimum of lip movement in singing; he praises the professional singer, however, who “has learned that lip-rounding and lip protrusion when singing the rounded frontal vowels provide a stability and comfort not available when he fails to utilize the wide variety of shapes and sizes which this most flexible orifice is capable of forming.”\(^13\)

Victor Alexander Fields’s *Training the Singing Voice* examines the various viewpoints on aspects of the singing voice by prominent voice pedagogues.\(^14\) Fields refers to Mursell’s and Glenn’s idea that “every part of the vocal mechanism acts and reacts most intimately upon every other part.”\(^15\) Their position lies in the scientific finding that the act of phonation originates in the nerve centers of the cerebral cortex. Furthermore, they agree, “There are also direct subcortical [neural] interconnections...
between the larynx and the diaphragm, the larynx and the ear and the larynx and the facial muscles.”¹⁶ This final statement supports the idea that the muscles of the face in singing, such as those of the zygomatic area, act as an extension to and have a direct connection with the sound produced from the larynx. Fields adheres to Shaw’s belief that a favorable position of the vocal orifice, mouth, and lips will allow for optimal vocal resonance.¹⁷ Arnold Wagner found that changes in facial expression resulted in changes in tone quality, suggesting that “facial expression should not be neglected by the student or teacher of interpretation.”¹⁸

More recently, in The Functional Unity of the Singing Voice Barbara Doscher demonstrates her understanding of the muscles of the face and mouth in singing. Of the facial muscles, she suggests, “Raising of the cheeks by both male and female singers in their high ranges seem to obtain maximum stretch of the soft palate without putting undue stress upon the palatine arches.”¹⁹

One particular edition of the popular forum, “Point Counterpoint,” a feature of The NATS Bulletin of the late ’70s and ’80s, contains a discussion of issues of the voice pertaining to the zygomatic area by several voice pedagogues.²⁰ In it, William McIver speaks about the ways in which a singer can ensure proper resonance other than by raising the soft palate. He mentions the smiling position (“the horizontal aspect of singing”), which is achieved with “the slight lift to the corners of the mouth, [and] the lift to the cheeks, [to] ensure the chiaro elements in the sung tone.” He also indicates “the vertical aspect of singing” which is associated with such common references of “warmth and richness” and ensures the oscuro elements in the sung tone. McIver concludes that it is important to bring the bright and dark aspects of the voice into harmony.²¹

In the same column of May/June 1981, the smiling position is given further consideration.²² Charles Chapman says that the smiling position is “useful in the studio to correct certain vocal difficulties such as an overly-heavy, dark voice, or breathy, slack tone.”²³ Chapman points out that a negative aspect of the smile position is that it “usually results in greater firmness of the velum (whether ‘up’ or ‘down’) and a somewhat smaller upper pharynx.”²⁴ He explains, “This is probably because of the generally antagonistic relationship of the lip-cheek muscles to the complex ‘swallow’ group, which indirectly includes the tongue.”²⁵ Conversely, he says that the smile can form a larger space in the laryngopharynx, which may add brightness to voices that are otherwise considered “dark.” He suggests that the shape of the lips for the smile position may prove beneficial for high voices of lighter quality.

Scott McCoy states, “With the exception of the lip movements required for vowel and consonant production, the articulatory mechanisms of the face generally serve expressive rather than linguistic functions.”²⁶ Of the zygomatic muscles, specifically, he maintains, “In spite of what I personally have been told by some of my own former teachers—and colleagues—there is no physiological connection between raising the cheeks (through contraction of the zygomatic muscles) and lifting the soft palate.”²⁷ Similarly, Melissa Malde in “Mapping the Structures of Resonance” in the May/June 2009 edition of the Journal of Singing, says “There is no connection between the cheekbones (zygomatic arches) and the muscles that lift the soft palate (levator veli palatini and the tensor veli palatini). These muscles are attached to the inside of the temporal bone.”²⁸

Spectral Analysis and Singing

Spectral analysis in relation to the singing voice has a history dating back to the 1930s when W. T. Bartholomew proposed that the laryngeal tube played an important function in the generation of the singer’s formant.²⁹ In the following two decades, spectrographic analysis in relation to the singing voice grew increasingly more popular, and by the 1960s, many well researched books were emerging.

Garyth Nair’s Voice Tradition and Technology is a tutorial that merges the knowledge of voice science and voice pedagogy with computer-assisted, real-time analysis as a means to explore the function of the voice and to provide feedback to the vocal student.³⁰ Nair offers a supplement to the traditional process of voice training. The marriage of vocal art and science is expertly made in this package consisting of both literature and software. Tools such as this can supply visual feedback of the effects of various positions of the muscles of the face. The spectral images will display, in frequency levels, the similarities and/or differences of the various facial muscle positions.
Richard Miller suggests that analysis of spectral images can assist a singer in finding what he refers to as an "equilibrium of acoustic strength manifested by an ideal distribution of lower and upper harmonic partials (overtones), clustered in formants" in the singer’s sound.\textsuperscript{31} In 1997 Miller conducted a study at The Cleveland Clinic to investigate the degree of velar elevation when singing the four nasal continuants [m, n, ŋ, j]. Although the published results from this study did not deal with the zygomatic musculature, in a personal communication between Miller and former student and lab technician, Dr. Mark McQuade, he shed light on the issue of zygomatic elevation.

The theory promulgated by a number of pedagogues, including me, is that when the zygomatic muscles elevate during inhalation, the shape of the vocal tract is altered, particularly in the faucial (velar region). We observed this when we did a study at Cleveland Clinic a number of years ago, during the process of examining the degree of velar elevation with the four nasal continuants, especially when inhalation was taken through the mouth. Our study was restricted to the degrees of elevation and was not directly related to the subject of the zygomatic musculature, which was therefore not mentioned. However, the student subjects all took the initial breath in the zygomatic-elevation posture.\textsuperscript{32}

He also spoke of another study (this one using fluoroscopy) conducted in Memphis at the University of Tennessee Medical Group that speaks to the issue of zygomatic elevation.

In the Memphis video that we did with the 4 male singers, it was apparent that the vocal tract, including the velum, was affected by the facial posture during inhalation. There appeared to be a direct relationship between zygomatic muscle elevation and velar position.\textsuperscript{33}

Miller’s personal views on the posture of the zygomatic musculature are clearly outlined.

Inasmuch as the risorius muscles often (but not in sad human expression) are frequently cooperative with the zygomatics, old adages such as “sing with a pleasant expression,” “breathe as though inhaling the fragrance of a rose,” etc., clearly are meant to affect the shape of the resonance chamber. I frankly do not know of other research that deals directly with the issue, but I believe that there is ample evidence in historic tradition that supports the idea.\textsuperscript{34}

Kenny and Mitchell conducted a study utilizing long-term average spectra of trained female singers to assess whether or not acoustic features are at all associated with perceptions of a singer’s overall quality of voice. They suggest, “Recent research has struggled to identify acoustic cues that attract the highest perceptual rankings from expert listeners.”\textsuperscript{35} Their study concentrated on the “open throat” technique and did not identify any changes in the zygomatic area. While this study does not deal with perceptual preferences and targeted different muscles in singing, the use of spectrographic analysis by Kenny and Mitchell addresses the resultant changes on the spectrum when singers are asked to sing with two different throat postures.

Smith, Finnegan, and Karnell attempted to demystify the characteristics of a resonant voice and the way it is physiologically produced. Their goal was to “test the hypothesis that resonant voice is produced by narrowing the laryngeal vestibule and is characterized by first formant tuning and more ample harmonics.”\textsuperscript{36} These authors use the Lessac “call” technique that is characterized as a “loud, resonant, somewhat higher pitched voice” and results from “coordinating vibratory sensation with a particular facial posture that is characterized by increased space between the teeth, some stretch in the cheek muscles, lip rounding, and a sensation of a relaxed half yawn.”\textsuperscript{37} Miller suggests that changes in the zygomatic musculature may alter the shape of the vocal tract and, while the authors of this study do not refer to “zygomatic” changes, they do suggest that the cheek muscles play an important role in the call technique. Like Miller, these authors speculate that alterations of the overall shape of the vocal tract may affect the quality (loudness and richness) of the voice. The results of their study suggest that voice quality is related to the harmonic amplitude on the spectrum in the area of 2.0 to 3.5 kHz. and that perceived brightness is not necessarily related with a resonant voice.\textsuperscript{38}

Facial postures in singing—although a consideration among voice pedagogues for centuries—has become a topic of concern in the writings of only a handful of the authors of the past few decades. From the invention of the laryngoscope by Garcia II in 1854 to the more
recent research conducted by Richard Miller into the 21st century, voice pedagogy and the significance of the muscles of the face in singing have gained increasing recognition in the study of vocal resonance, timbre, and voice quality. Perhaps the most popular consideration is that of the “smile position” or the “inner smile.” These common instructions adhere to the raised position of the zygomatic muscles as opposed to the idea of the “megaphone mouth” where the muscles of the face are pulled down, resulting in the obvious lowering of the jaw and upper lip in singing. It thus becomes the duty of the individual pedagogue to decipher the germane information available in print today. Teachers, singers, and other voice care professionals are now able to use technology as a means to clarify, support, or reject long-held pedagogic beliefs about the voice for singing. Technological advances such as spectrographic analysis can assist in the research of facial muscle positioning in singing. When art and science are brought together in an equal partnership, the harmonious phenomenon of the singing voice is more fully understood.

**METHODOLOGY**

This project used spectrographic analysis to compare voice spectra that resulted from two different positions of the zygomatic musculature during a series of sung tones. The intent was not to make any judgments concerning vocal quality, timbre, or aesthetic appeal of the sounds. Instead, the study focused solely on identifying differences between the acoustic signals displayed in the spectrographic images.

Three advanced classically trained baritones were given a pitch to sing in three different ranges (E♭3; B♭3; E♭4; F4; G4). The pitches were sung on the cardinal vowels [a] and [i]. Because each individual vowel possesses certain distinct harmonic characteristics, only voice spectra of the same vowel were compared. The participants were asked to sing their notes in two ways: 1) with a lowered (or neutral) position of the zygomatic musculature, and 2) with a raised position of the zygomatic musculature.

Audio and visual recordings along with photographs were taken of the singers to assist in the data analysis. The software Spectrogram 12 was used to create and capture the spectrographic images used in the analysis.

Comparisons were made between the spectral analyses and zygomatic positions.

Four frequency ranges (0–2 KHz; 2–4 KHz; 4–6 KHz; and 6–8 KHz) were used to subdivide the data collected for each subject based on: vowel, pitch, zygomatic position, range of frequency (Hz), and the corresponding intensity level, measured in decibels (dB). Using both [a] and [i] vowels, three baritones, and these four frequency ranges, a sampling of 120 identified areas was considered for calculation.

This study was limited to the use of one single voice type. The baritone voice was selected in this study since that voice type displays a harmonically rich spectral image, due to a lower fundamental frequency, allowing one to more easily view what takes place in the upper harmonics of the sung tone. Only three singers were used to conduct this pilot style study, which will eventually lead to a more robust study. It should be noted that, of the three singers, one had a history of pedagogic instruction that favored the raised position of the zygomatic musculature in singing, while the other two singers were not trained to consider the position of the zygomatic area at all.

**TREATMENT OF THE DATA**

The visual recordings and photographs taken of the singer’s face aided in determining singer success in achieving the required raised or lowered position of the zygomatic arch muscles while performing the exercises. A small black mark was drawn on the zygomatic area of each singer to aid in the measurement of change from the lowered position to the raised position of the zygomatic musculature. A ruler was also placed beside the face of the singer to assist in measuring the difference of each individual singer’s muscle movement. Controlling the placement of the ruler was difficult; therefore the emphasis was placed on the visual change of the zygomatic musculature movement as evidenced in the photographs. Each singer’s spectral images for the lowered position were only compared to his own images for the raised position. They were not compared between the singers.

**SUMMARY**

For every sung pitch on each of the vowels, changes in the spectral images from the down position to the raised position were detected. The raised position, in
most instances, produced a spectral image that exhibited greater intensity across a wide range of frequencies. It was noted that a direct correlation existed between the degree of variation in the acoustic intensity and the ascending changes in pitch. In other words, the higher the pitch, the greater the calculated decibel difference.

The spectral images shown in Figures 1 and 2 demonstrate the E♭₄ pitch sung on the [i] vowel. A quick comparison of the lowered versus raised positions of the zygomatic musculature for each pitch (sung by the same subject) demonstrates an increase in intensity in all three major formant regions. The singer’s first formant (2500–3200Hz) is bolstered by an increase in the intensity of the ninth harmonic (H₉ at ~2799Hz). At approximately 1800Hz, the second formant is strengthened by a considerable increase in the intensity of H₆ (~1866Hz). The first formant (~300–650Hz) also shows increased acoustic energy due to the rise in amplitude of H₂ (~622Hz). These increases in acoustic intensity are evidenced from Figure 1 to Figure 2 by arrows indicating changes in brightness (yellow and red) occurred.

The next two spectrographic images (Figures 3 and 4) demonstrate E♭₃ on [a] in both the lowered and raised positions of the zygomatic musculature, respectively. Figure 4 exhibits an increase in intensity in two of the major formant regions. The singer’s formant is marked by an increase in intensity in the up position. Here, the changes are marked with arrows indicating the evidence of a more vibrant hue of blue that appears in the color spectra. The increase in intensity of H₇ (~1092Hz) and H₈ (~1248Hz) strengthen the second formant.

Although the overwhelming majority of cases revealed increased harmonic intensity in the raised zygomatic position, there were a few exceptions noted. Among the 120 identified areas (based on the two vowels, two zygo-
matic positions, four frequency ranges discussed above, and three singers), seven cases (5.8%) were identified in favor of the lowered zygomatic position. These seven cases were the calculated difference in decibel levels from the lowered position to the raised position of the zygomatic musculature.

**CONCLUSIONS**

No single piece of technology currently exists that can capture all the components of a sung tone. Spectrographic analysis is an incredibly useful tool, but not even this kind of technology is able to capture everything. One cannot take a spectral image of a sung tone and know exactly who or what produced it (for example, the shape and length of the vocal tract, the length and mass of the vocal folds, or any number of other physical and acoustic variables), but one can observe acoustic changes within the voice spectra when specific physical maneuvers are imposed on the vocal instrument.

The use of spectrographic analysis in the voice studio is growing in popularity. This accessory can then serve as a tool and reinforce what the ear alone may not be able to detect. Throughout the history of voice pedagogy, voice teachers have advocated for the “smiling position,” tonal balance (chiaroscuro), “raising the cheeks,” “tone placement,” and to sing with a “pleasant facial expression.” This study demonstrates the measurable acoustic results that are achieved when singers practice such dictas. In the case of the position of the zygomatic musculature, no instruction can be given to the singer as to an exact amount of lift required in order to achieve a sung tone that has more intensity. This study found that, in the majority of cases (94.2%), any amount of lift in the zygomatic musculature resulted in voice spectra with increased acoustic intensity.

**RECOMMENDATIONS FOR FURTHER STUDY**

It would be interesting to find out if the results found in this study would be similar for sopranos, mezzo sopranos, tenors, and basses. This study would also benefit from the addition of both frontal and lateral radiologic studies (fluoroscopic technology) to see what takes place on the inside—whether or not a lift in the zygomatic area causes visible or measurable changes to the shape of the vocal resonator tract. If the position of the zygomatic musculature does in fact affect the shape of the vocal resonator tract, then the role of the zygomatic area for the singing voice becomes that much more crucial in the study of voice pedagogy. In order to achieve the most accurate results possible, a study would be designed to encompass the following: 1) a high quality audio recording; 2) a high definition video recording of both the frontal and lateral external views; 3) photographs taken of both the frontal and lateral external views; 4) frontal and lateral radiologic images; 5) motion capture technology; and 6) a larger sample group of singers. The major difficulty with a study of this type is that whenever radiology is involved, the ability to obtain external photographs of ample quality and a quality sound recording is affected. And, of course, there are the medical concerns such as the subjects’ exposure to radiation. Despite the fact that fluoroscopic technology minimizes the amount of radiation to which subjects are exposed, questions still arise. Some might argue that using science in this way removes or damages the creative nature of the singing art. However, when science and technology provide insight into long standing pedagogic maxims, it only helps to further the teaching of singing.

**NOTES**

3. Ibid., 94.
4. Ibid.
7. Ibid., 30.
Jennifer Helen McQuade


11. Ibid.


13. Ibid.


21. Ibid., 21.


23. Ibid., 8.

24. Ibid.

25. Ibid.


27. Ibid.


31. Ibid., 64–65.

32. Richard Miller, email to Mark McQuade (February 5, 2006).

33. Ibid.

34. Ibid.


37. Ibid.

38. Ibid.


43. Miller, 93.

Canadian coloratura soprano Dr. Jennifer Helen McQuade maintains an active performance schedule in the United States and Canada with credits in opera, oratorio, and music theater. Stage appearances include the Queen of the Night in The Magic Flute; the title role in The Ballad of Baby Doe; Laetitia in The Old Maid and The Thief, Elmire in Tartuffe; Nella in Gianni Schicchi; Emma in Jekyll and Hyde; Younger Heidi in Follies; Lilly in The Secret Garden; and both Cinderella and Rapunzel in Into The Woods. In addition to her stage roles and performances of oratorios such as Handel’s Messiah and Rutter’s Requiem, McQuade has appeared with the McGill Contemporary Music Ensemble, and sang the Canadian premiere of Theldon Meyer’s Vocalise. She has served as a Young Artist with the Natchez Festival of Music and has taken part in the Opera Theatre Program at the Fairbanks Summer Arts Festival in Alaska where she appeared as Judy in This is the Rill Speaking.

McQuade has extensive training in the more traditional operatic and art song styles of singing as well as in contemporary commercial music styles such as music theater, jazz, cabaret, pop, rock, country, folk, gospel, rhythm & blues, and rap. During the summer of 2007, McQuade attended Shenandoah University’s Contemporary Commercial Music Vocal Pedagogy Institute where she was awarded certification in Somatic Voicework™ The LoVetri Method.

McQuade has presented research and performed at National Association of Teachers of Singing and College Music Society conferences. In 2013, McQuade shared her research at the 8th International Congress of Voice Teachers, held in Australia.
McQuade served as Instructor of Voice at the University of Central Oklahoma and Associate Professor of Voice at Oklahoma Baptist University. During her time in Oklahoma, she taught Applied Voice, Diction for Singers, Vocal Pedagogy, Auditioning for Singers, and created/directed a high profile contemporary a cappella vocal ensemble. Currently, she teaches Applied Voice, Music Appreciation, and directs the MSU Singers, and is collaborating in the development of a minor in Musical Theatre at Minot State University.

McQuade holds a Bachelor of Music from Mount Allison University, an Artist Diploma from The University of Western Ontario, a Master of Music in Solo Voice Performance from McGill University, and a Doctor of Arts in Vocal Pedagogy from The University of Mississippi.

The sun was warm but the wind was chill. You know how it is with an April day When the sun is out and the wind is still, You're one month on in the middle of May. But if you so much as dare to speak, A cloud comes over the sunlit arch, A wind comes off a frozen peak, And you're two months back in the middle of March.

Robert Frost, from “Two Tramps in Mud Time”